ERCIM NEWS

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Special: Space Exploration

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Cover image by courtesy of ESA

David Southwood,
Director of Science, European Space Agency

Once upon a time there used to be a bumper sticker that said "If you can read this….thank a teacher." In the 21st century as we land probes on remote parts of our solar system, drop into orbit around Venus or Mars or deliberately crash into the Moon, one should acknowledge that "If you have got here….thank an IT guy." We take so much for granted. Rockets which can get us off the planet are now more than half a century old, telecom and navigation systems are more than forty and man landed on the Moon just under 40 years ago. Back then we expected to have built lunar colonies and be arriving at Mars by now. It is a commonplace to say that we were wrong but it is less common to stand back and just look at what has happened and what we have had that we never expected. The advances have largely been due to those IT folks.

The capabilities offered by IT systems and modelling have changed our world and what we can do to understand it and indeed to leave it much more than gaining the simple ability to get off the planet. Last year ESA landed the Huygens probe on Titan. To my utter incredulity we saw radio telescopes across the Earth directly pick up the signal from a transmitter 10 times further from the Sun than us and about as powerful as a terrestrial mobile phone. The world held its breath as 'ET phoned home'. But it was not the phone, it was software sophistication, mathematical ingenuity and computer power which got that signal out of the background.

However it was also simulation and modelling that got the probe safely down on a surface that had never been directly seen. Landing the baby on Titan had also involved an enormous amount of computing and modelling work in advance. One had an idea (and so a model) of the Titan atmosphere from the Voyager spacecraft flyby more than twenty years before. Otherwise, the latest information only arrived from the first Cassini spacecraft flyby just under three months before landing and two months before release from the mother ship – when targeting would be fixed. Simulation and modelling played a key role in making that a much more secure process.

The last decade's revolutions in computing, simulation and information have paid off for our exploration of what lies beyond our solar system as well. Here my favourite example is the GAIA mission, whose industrial build phase we have just kicked off in the last few months. Most simply expressed the purpose of the mission is counting the stars in the sky. It will find very accurately the position and then the motion as well as the colour of 1 billion stars within our own galaxy, the Milky Way. It is a grand mission and tackles a grand problem – where did our galaxy come from and how will it evolve? It is going to allow us to 'deconstruct' our galaxy and to examine nature's clockwork in detail. This is a space mission that certainly requires very sophisticated optical systems and detection systems but which is made possible only by the advance of information technology, mathematical modelling, simulation and data processing. The megabytes of data continuously fed down every second over the five year life will have to be built into an enormous data mountain to be mined for years to come but that mountain has to be put together properly in the first place by careful and efficient processing. In other words informatics and mathematics are the key to success. I for one would say thank you to the IT people. With you, we are doing things we could only have dreamed of even at the dawn of the space age. You are determining our future and helping open up our horizons.

David Southwood

New ERCIM Project

A New Palette of Open Source Services for Communities of Practice

by Christine Vanoirbeek

The IST European Integrated Project 'PALETTE – Pedagogically sustained Adaptive Learning through the Exploitation of Tacit and Explicit Knowledge' commenced in February 2006. The project aims to develop a set of innovative, interoperable and standard-based services that enhance learning in communities of practice.

A community of practice is a frequently interacting group of people (the community) who share a concern, a set of problems, or a passion about a topic (the domain of the community), and who deepen their practical knowledge and expertise in that domain (the practice of the community).

Such communities are recognized as effective environments for supporting the learning of professionals, organizations and educational institutions. They have several characteristics that distinguish them from formal organizations. Collaborative learning is a key issue: members learn from each other by making their knowledge and practices explicit, sharing them with their peers, and reflecting on them.

The rapid development of new technology (eg Web-based platforms, wireless communications, mobile devices and multimedia content) means that great potential exists for such applications. However, recent research underlines a lack of adequate scaffolding in the form of technical support, and use of the technology to:

- express, represent and share practices and authentic problems
- debate and reflect on the practices and life of communities
- develop, reify and exploit knowledge inside and outside communities
- aid engagement, participation and learning.

To achieve its objectives, PALETTE will provide communities of practice with a set of services classified into three categories: information, knowledge management and mediation services. These will provide the community's participants with support for:

- data production, exchange and reuse between autonomous and heterogeneous applications
- reification of explicit and tacit knowledge about practices
- advanced communication and collaboration between communities.

Services will be tested using various pedagogical scenarios. In line with new learning practices, these will be designed to encourage the exploitation of diverse mental models, knowledge resources and the skills of individuals both inside and outside communities.

The PALETTE's R&D process relies on a design approach that takes into consideration the underlying processes of social participation, community building and development of identity. It is articulated around negotiation of meaning, which is the basis of any individual and collective learning process.

The open-source services resulting from PALETTE will not only address the needs of communities currently involved in the project, but also provide the conditions for engagement of other communities. The participation of further users is encouraged, as it will enhance the project and contribute to its development.

With a good balance between technological and pedagogical experts, the consortium aims to provide support for a broad range of activities performed by communities of practice. The project must therefore deal with different types of information, make use of various applications and accommodate several environments. An important challenge is to provide users with interoperable tools allowing exchange of data, and to integrate them into different scenarios of use. Interoperability covers several levels, addressing technological considerations (use of XML and related

Synergies between ERCIM Projects

ERCIM is participating in several research projects as coordinator or partner. In these projects ERCIM institutes and their partners carry out the research while the ERCIM office takes care of administrative tasks. As coordinator of several European projects and networks, ERCIM sees one of its missions to promote synergies among these different initiatives.

Joint DELOS/MUSCLE Summer School

A joint MUSCLE / DELOS summer school on 'Multimedia Digital Libraries, Machine Learning and Cross-Modal Technologies for Access and Retrieval' will be organised 12-16 June in San Vincenzo, Italy (see announcement on page 8).

MUSCLE and DELOS 'ENGAGE'd' in the Philippines

The Networks of Excellence 'MUSCLE' and 'DELOS' participated in the first ENGAGE conference in Manila, Philippines, 29-31 March 2006. The networks have sent a represententative to present their scientific achievements to the Southeast Asian research community. The workshop was part of the EU-funded initiative 'ENGAGE' encouraging and stimulating future RTD cooperation in the field of Information Society Technologies between Europe and Asia-Pacific region For more information about the 'Engage' project, see http://www.engage-ist.org/

CoreGRID and Grid@Asia Interactions

The CoreGRID Network of Excellence and Grid@Asia - an EU-funded 'specific support action'- established close links, in particular with the participation of leading CoreGRID experts in the Grid@Asia advisory board. CoreGRID teams are also actively contributing to the success of the Grid@Asia workshops held in China to foster collaboration in GRID research and technologies between the European Union and Asian countries.

http://www.ercim.org/activity/projects/

technologies), organizational constraints, and higher-level understanding of manipulated information. This can include agreement on data exchange models and associated semantic information, through ontologies and standards used in the learning domain.

The PALETTE project intends to provide innovative learning models and technical solutions that increase of the overall quality of learning in communities of practice. In addition, it will contribute to the development of standards in this area.

Link:
http://palette.ercim.org

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New ERCIM Project

Advancing Clinico-Genomic Trials on Cancer

by Manolis Tsiknakis

ACGT is an EU-funded 'Integrated Project' admininstrated by ERCIM. ACGT will develop a bio-medical GRID infrastructure supporting seamless mediation services for sharing clinical and genomic expertise. Such interactions will allow joint clinico-genomic trials and help finding quicker and efficient routes to identifying patients' individual characteristics that make one treatment more appropriate than another.

The completion of the Human Genome Project sparked the development of many new tools for today's biomedical researcher to use in finding the mechanism behind disease. While the goal is clear, the path to such discoveries has been fraught with roadblocks in terms of technical, scientific, and sociological challenges.

The underlying motivation of ACGT is provide researchers and patricians with optimal means and resources to fight cancer.

Imagine that for selected cancer patients, biopsies are taken before, during and after treatment, made anonymous and the analyses are stored promptly in an accessible fashion. Imagine also that the patient's data can readily be compared with those from other trials. And imagine that one can drill down into clinical and other databases in an intelligent search in hours rather than months. This might lead to the rapid identification of cancer profiles, and of their corresponding optimal therapy.

To realise this vision, ACGT brings together internationally recognised leaders in their respective fields, with the aim to deliver to the cancer research community an integrated clinico-genomic ICT environment enabled by a powerful GRID infrastructure. ACGT has formulated a coherent, integrated workplan for the design, development, integration and validation of all technologically challenging areas of work:

- delivery of a European bio-medical GRID infrastructure offering seamless mediation services for sharing data and data-processing methods and tools, and advanced security
- semantic, ontology based integration of clinical and genomic/proteomic data - taking into account standard clinical and genomic ontologies and metadata
- delivery of data-mining GRID services in order to support and improve complex knowledge discovery processes.

Participants of the ACGT kick-off meeting, held from the 27 February to 1 March 2006, in Juan les Pins, France. The meeting gathered the research teams from the 25 partner organisations involved in this initiative. On this occasion, a local press conference was organised to highlight support from the European Commission and ERCIM's central role in this new scientific endeavour.

The technological platform will be validated in concrete settings of advanced clinical trials on cancer. Pilot trials have been selected based on the presence of clear research objectives, raising the need to integrate data from all levels of the human being.

ACGT promotes the principle of open source and open access, thus enabling the gradual creation of a European biomedical Grid on cancer. Hence, the project plans to introduce additional clinical trials during its lifecycle. It is in line with the priorities and objectives of the IST programme. It targets at the fulfilment of urgent needs of the cancer research community, a key area of societal importance.

Link: http://acgt.ercim.org

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CALL FOR PARTICIPATION

Joint DELOS-MUSCLE Summerschool on

Multimedia Digital Libraries, Machine Learning and Cross-Modal Technologies for Access and Retrieval

San Vincenzo, Italy, 12-17 June 2006

About one hundred European universities and research centres have been involved in the last few years in projects funded by EU addressing multimedia data analysis, computer vision and object recognition, and multimedia management in large audio and video collections. Two ERCIM-administrated Networks of Excellence are addressing these subjects. DELOS is working in new generations of digital libraries; MUSCLE has many work packages oriented towards exploiting machine learning for multimedia data retrieval and for cross-media analysis. Both have jointly planned to organise the Summer School on 'Multimedia Digital Libraries, Machine Learning and Cross-Modal Technologies for Access and Retrieval', with the aim of promoting advanced experiences and implementations, and improving the knowledge in these fields.

Technologies for multimedia digital libraries span over many disciplines: information systems, knowledge representation, computer vision, audio and image processing, compression and storage, machine learning and information retrieval, multimedia data mining, cross-media analysis, user interfaces and interoperability. On these topics, the School program has planned highly qualified lectures given by international researchers, addressing theoretical approaches and practical solutions. The duration of the School is five days, with nine half-day lectures.

Lecturers

- James Wang, Pennsylvania State University, USA
- Fernando Pereira, Instituto Superior Tècnico Lisboa, Portugal
- Nicu Sebe, University of Amsterdam, The Netherlands
- Milind Naphade – IBM T J Watson Research Center, UK
- Alex Hauptmann – Carnegie Mellon University, USA
- Padraig Cunningham – Trinity College Dublin, Ireland
- Jia Li Pennsylvania State University, USA
- Alan Smeaton, Dublin University, Ireland

A maximum number of 50 free admissions is granted to university students, PHD students and young researchers under research grant under first come first serviced policy.

More information:
http://www-rocq.inria.fr/imedia/DelosMuscleSummerSchool2006/

Sponsored by ERCIM

SOFSEM 2006: Current Trends in Theory and Practice of Computer Science

by Julius Stuller

SOFSEM is a successful annual international conference devoted to the theory and practice of Computer Science. Its aim is to foster co-operation among professionals from academia and industry working in various areas of Computer Science. Its 32nd edition was held in Merin, located about 60 km south of Prague on the right shore of Slapska prehrada ('Slapy Dam'), Czech Republic, 21-27 January 2006.

SOFSEM (historically from SOFtware SEMinar) is the foremost Czecho-Slovak Computer Science conference being at the same time the most important joint activity of CRCIM and SRCIM; it is organised every third year in Slovakia while in-between twice in the Czech Republic.

Invited speaker Georg Gottlob.

SOFSEM offers a unique opportunity to quickly obtain a representative overview of the areas that are selected as the topics of the year. To avoid excess diversity among the conference participants and to foster the atmosphere of close professional interaction, SOFSEM is organised in tracks with topics narrow enough to attract a community of researchers that share very specific fields of interest. The schedule is tailored so that a unique opportunity to interact with other participants (invited speakers, researchers, students) of the tracks is given. For SOFSEM 2006, the following 4 tracks with selected topics have been chosen:

- Wireless, Mobile, Ad hoc and Sensor networks (Track & PC Chair: Jiri Wiedermann, Institute of Computer Science - ICS, Prague, Czech Republic)
- Foundations of Computer Science (Gerard Tel, University of Utrecht, The Netherlands)
- Semantic web technologies (Julius Stuller – General Conference Chair, ICS, Prague)
- Database technologies (Jaroslav Pokorny, Charles University, Prague).

SOFSEM conferences are well known for very high quality invited speakers. This was again confirmed by this year SOFSEM edition – in total ten invited speakers gave very interesting talks:

- *Future and Emerging Technologies:*
  Keith G. Jeffery,UK: 'Beyond the Horizon' project
- *Wireless, Mobile, Ad Hoc and Sensor Networks:*
  - Sotiris Nikoletseas, Greece: Models and Algorithms for Wireless Sensor Networks (Smart Dust)
  - Christian Schindelhauer, Germany: Mobility in Wireless Networks
- *Semantic Web Technologies:*
  - Marie-Christine Rousset, France: Somewhere in Semantic Web
  - Dimitris Plexousakis, Greece: Evolving Ontology Evolution
- *Database Technologies:*
  Georg Gottlob, Austria: Monadic Queries over Tree Structured Data
- *Foundations:*
  - S. Barry Cooper,UK: How Can Nature Help Us Compute?
  - Burkhard Monien, Germany: Selfish Routing in Networks
  - Andre Schiper, Switzerland: Group Communication: From Practice to Theory
  - Hajnal Andréka, István Németi, Hungary: New Physics and Hypercomputation.

The proceedings were published in LNCS No. 3831 by Springer-Verlag.

SOFSEM provides an ideal framework for discussions and meetings, for establishing personal contacts, and for socializing. Consequently it is especially well suited for young computer scientists. An integral part of the SOFSEM 2006 was the Student Research Forum (Chair: Maria Bielikova, Slovak University of Technology, Bratislava) organised with the aim to publish and discuss students' projects in the field of theory and practice of computer science. The forum offered the students the opportunity to receive feedback on both the originality of their scientific work results and the work in progress.

The organizers would have not been able to organize such a successful conference without the help of sponsors among which the ERCIM contribution was the most important.

As usually SOFSEM has been used as a platform for spreading the ERCIM ideas both directly via ERCIM President Keith G. Jeffery's invited talk presenting the 'Beyond the Horizon' project and a small exhibition advertising ERCIM, and indirectly by the involvement of ERCIM researchers in its scientific program.

Link:
http://www.sofsem.cz

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With profound sadness we learnt of the death of Gilles Kahn, Chairman and CEO of INRIA and INRIA's representative on ERCIM's Board of Directors. Gilles passed away Thursday 9 February 2006.

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We share the pain and sorrow of his family to whom we present our condolences and express our sincere sympathy.

Chairman and CEO of INRIA since May 2004, Gilles Kahn was a scientist of international renown and a recognised expert in programming environments and computer aided proof environments.

Gilles was an enthusiastic scientist, talented researcher, open minded and had a great sense of humor. He dedicated his sharp intellect to scientific excellence and technology transfer, facilitating exchanges and interactions among all stakeholders. Those who knew him will remember his kindness and generosity. ERCIM will miss him.

Jérôme Chailloux, ERCIM Manager
Keith Jeffery, ERCIM President

Fellowships in GRID Research

The CoreGRID Network of Excellence currently offers three fellowship positions for postgraduate students:

- Integration of the Swiss ISS concept into the German VIOLA Meta-Scheduling environment
- Fine-grain, block-level security for large-scale, high-performance storage systems
- Workload Modelling for Grid Performance Evaluation and Benchmarking (CFP3-04).

The fellowships are open to candidates from all over the world. The duration will be 14 to 18 months in two different CoreGRID partner institutes sharing a joint research agenda.

More information:
http://www.coregrid.net

The ERCIM "Alain Bensoussan" Fellowship Programme

ERCIM offers 18-month fellowships in leading European information technology research centres. Fellowships are available for PhD-holders from all over the world.

The Fellowship Programme has been established as one of the premier activities of ERCIM. Since its inception in 1991, over 170 fellows have passed through the programme. ERCIM has now named the programme to honour Alain Bensoussan, one of ERCIM's 'founding fathers'. As president of INRIA, Alain Bensoussan initiatiated the creation of ERCIM in 1989 together with Cor Baayen from CWI and Gerhard Seegmueller from GMD (now part of Fraunhofer Institute).

Conditions

Applicants must:

- have obtained a PhD degree during the last 4 years prior to the application deadline or be in the last year of the thesis work with an outstanding academic record
- be fluent in English
- be discharged or get deferment from military service
- start the grant before January 2007 (for the April application deadline)
- have completed their PhD before starting the grant.

Fellowships are generally of 18 month duration, spent in two of the ERCIM institutes. In particular cases a fellowship might be of 9 month duration spent in one insitute. The fellow will receive a competitive monthly allowance which varies depending on the country. In order to encourage mobility a member institute will not be eligible to host a candidate of the same nationality. Further, a candidate cannot be hosted by a member institute, if he or she has already worked in this institute for a total of 6 months or more, during the last 3 years.

The programme focuses on topics defined by the ERCIM working groups and projects administrated by ERCIM. In addition, applications are also welcome for other areas in which ERCIM institutes are active. Detailed description of the topics is available on the ERCIM web site.

ERCIM does not only encourage researchers from academic institutions to apply, but also scientists working in industry.

Deadlines

Next deadlines for applications:

- 30 April 2006
- 31 September 2006.

More information:
Detailed information, conditions and online application form is available at:
http://www.ercim.org/fellowship/

W3C launches Chinese Office

The World Wide Web Consortium (W3C) announces the launch of its Mainland Chinese Office on 27 April 2006. The Office is based at the Advanced Computing Technologies, School of Computer Science & Engineering of Beihang University in Beijing, China. An opening ceremony will mark the start of two days of presentations and panels (27-28 April 2006 at the Ruxin Conference Center of Beihang University in Beijing).

Presentations will be done by the representatives of the Chinese industry and academia, as well as members of the W3C Staff. The latest will present current W3C work related to the Mobile Web Initiative, the Internationalization, Rich Web Client Activity, Semantic Web, and Voice Browser Activities..

Beihang University is a respected university in China with more than 50 years history. It has actively and intensively developed its international academic exchange and collaboration programs. The School of Computer Science and Engineering of Beihang University, hosting the W3C Chinese Office, ranks among the top computer science schools in China with more than 130 full-time faculty members.

Links:
W3C Chinese Office: http://www.chinaw3c.org/
Opening Ceremony Programme: http://www.chinaw3c.org/schedule.en.htm
Beihang University: http://act.buaa.edu.cn/english/Default_En.asp

W3C launches Incubator Activity

W3C provides a new approach for discovery-stage work. The W3C Incubator Activity is a new initiative which aims to foster development of emerging Web-related technologies that complements the current W3C Recommendation Track. The Incubator Activity offers the W3C Membership and the Web community a new, streamlined process for discussing and developing interesting and possibly controversial ideas that are not (or not yet) clear candidates for standardization.

"With the Incubator Activity, W3C Members and Invited Experts can now combine Web technology discovery with the outstanding technical resources of W3C and see what develops," said Steve Bratt, W3C Chief Executive Officer. A first Incubator Group (XG) has been created within this new activity. It addresses the issue of 'Content Labels', the goal of which is to find a way of making any number of assertions about a resource or group of resources. In order to be trustworthy, the label containing those assertions should be testable in some way through automated means.

Links:
Incubator Activity: http://www.w3.org/2005/Incubator/
W3C Recommendation Track:
http://www.w3.org/2005/10/Process-20051014/tr

Outreach Activities related to EU-funded Projects

W3C Held Seminar on Using Web Services

W3C invited the public to the free seminar "Using Web Services - From Infrastructure to Semantics" in Paris, France on 6 March. Focusing on semantic enhancements to Web services applications, this event provided concrete examples of business challenges and how they have been resolved through the use of Web Services. W3C Member organizations including Amadeus, Canon, INRIA, and Nokia, demonstrated solutions already implemented in enterprise environments.

This seminar was a deliverable of the WS2 project, supported by funding under the Sixth Research Framework Programme of the European Union.

Links:
Web Services Seminar: http://www.w3.org/2006/03/ws2-seminar.html
WS2 EU project: http://www.w3.org/2004/WS2/

W3C Presented at 3GSM World Congress 2006

This year, W3C was present at the 3GSM World Congress in Hall 2 stand G78 on 13-16 February in Barcelona, Spain. W3C staff presented this new initiative including the recently published 'Mobile Web Best Practices' document (in Last Call)

and showed recent work on best practices for mobile content authors. "With authors' help, mobile telephones and computers can offer usable and interoperable Web browsing worldwide," said Philipp Hoschka, Mobile Web Initiative Leader.

Links:
W3C Mobile Web Initiative: http://www.w3.org/Mobile/
3GWeb EU project: http://www.w3.org/2006/3GWeb/

Latest W3C Recommendation

- 14 March 2006: XForms 1.0 (Second Edition)
  First published 14 October 2003, revised 14 March 2006, John Boyer, David Landwehr, Roland Merrick, T. V. Raman, Micah Dubinko, Leigh L. Klot

A complete list of all W3C Technical Reports:
http://www.w3.org/TR/

W3C Track at WWW2006

W3C is providing content for the 15th International World Wide Web Conference - WWW2006, to be held at the Edinburgh International Conference Centre (EICC), on 24-26 May 2006, in Edinburgh, Scotland. This year, W3C will report on the range of achievements since last year's conference, such as in the Mobile Web Initiative, Web services, semantic Web, rich Web applications, style and layout, Web security, etc.

Link:
W3C Track'06: http://www.w3.org/2006/05/w3c-track.html

Call for Participation

W3C Second Workshop on Internationalizing W3C's Speech Synthesis Markup Language

Heraklion, Crete, Greece, 30-31 May 2006

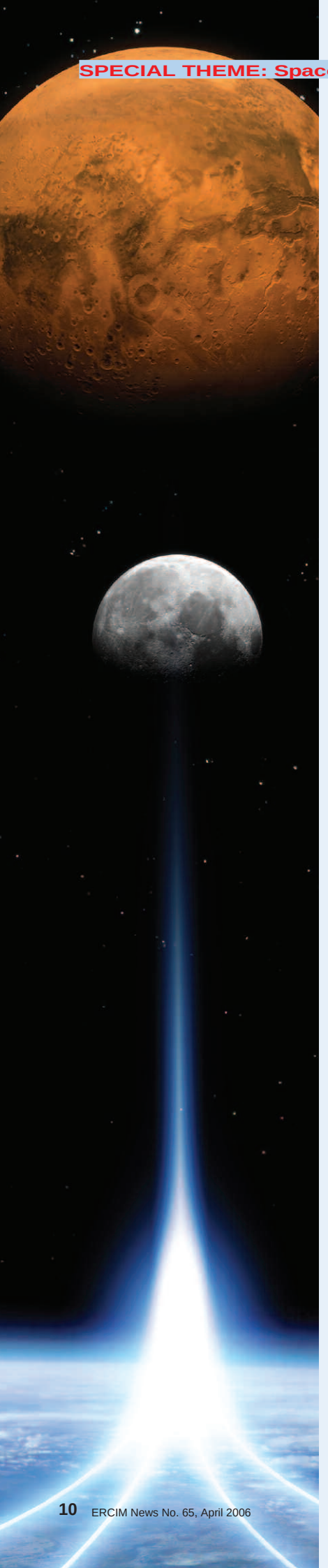
A first W3C Workshop on Internationalizing W3C's Speech Synthesis Markup Language was held in Beijing in November, 2005. As the result of the Workshop, various requirements on SSML extension for Chinese, Korean, Japanese and Polish speech synthesis were identified and prioritized. The Working Group is now organizing a second workshop in Greece, in order to solicit additional suggestions to increase the use of SSML for other non-English languages. The group is especially interested in suggestions on how to improve the rendering of multiple, non-English languages including (but not limited to) Russian, Turkish, Arabic, Persian, Hebrew, Hindi, and Bengali.

Links:
"Workshop II" CfP: http://www.w3.org/2006/02/SSML/cfp.html
Voice Browser WG: http://www.w3.org/Voice/

W3C Names Ubiquitous Web and Interaction Domain Leaders

W3C is pleased to announce new management of Activities related to the Web's user interface. Philipp Hoschka leads the newly created Ubiquitous Web Domain which includes the Device Independence, Mobile Web Initiative (MWI), Multimodal Interaction and Voice Browser Activities, and continues his role as W3C Deputy Director for Europe. Chris Lilley leads the Interaction Domain which includes the Graphics, HTML, Math, Rich Web Clients, Style, Synchronized Multimedia and XForms Activities.

Link:
W3C Activities: http://www.w3.org/Consortium/activities



IT and Mathematics for Space Exploration - Introduction to the Special Theme

by Peter Allan and Pierre Rochus

We stand at an exciting point in the exploration of space. Water, essential for life as we know it, is found almost everywhere. Probes to the planets are making new discoveries, such as ice on the surface of Mars and methane on Titan, one of the moons of Saturn. Telescopes, both in space and on the ground, are delivering unprecedented quantities of data that are radically changing our understanding of the universe. We used to think that the matter of which we are made was only a small fraction of the total matter content of the universe and that dark matter made up the bulk. It now appears that dark energy, which as yet we do not understand at all, is actually the dominant component of the universe, causing it to accelerate, not slow down.

Looking back over three quarters of a century of space activities enables us to consider the next fifty years on a much more solid basis than the pioneers of space: the Russians Constantin Edouardovitch Tsiolkovski (1857-1935) and Serge Korolev (1907-1966), the Germans Hermann Oberth (1894-1989) and Werner von Braun (1912-1977), the Americans Robert Hutchings Goddard (1882-1945), the Belgians André Bing and Karel Bossart. They had a dream…, we live it! The first era of the space age was one of experimentation and discovery. We are now on the threshold of a new era of the space age, devoted to mastering operations in space. Unlike the earlier space era, in which governments drove activity in space, certain space applications, such as communications, are being driven by the commercial sector. Space enters homes, businesses, schools, hospitals and government offices through its applications for transportation, health, the environment, telecommunications, education, commerce, agriculture and energy. Space-based technologies and services permit people to communicate, companies to do business, civic groups to serve the public and scientists to conduct research. Much like highways and airways, water lines and electric grids, services supplied from space are already an important part of our global infrastructures.

Many activities on earth are no longer possible without spacecraft and we cannot imagine the future that new applications space research will bring us in addition to meteorology, monitoring, disaster predictions and telecommunications. It gives rise to spin-offs and developments in often unexpected applications for every day life. In short, space research is a challenge to our imagination as far as technical achievements are concerned and addresses the study of fundamental questions for humanity. Our security and economic well being depend on the nation's ability to operate successfully in space. With the dramatic and still accelerating advances in science and technology, the use of space is increasing rapidly. We live in an information age, driven by needs for precision, accuracy and timeliness in all of our endeavors - personal, business and governmental. As society becomes increasingly mobile and global, reliance on the worldwide availability of information will increase.

Space-based systems, transmitting data, voice and video will continue to play a critical part in collecting and distributing information.

Think of space and you think of advanced technology, but pure mathematics has an important role to play too. The most magical predictive-mathematical event in the history of science was the discovery of Neptune by astronomers John Couch Adams and Urbain Jean Joseph Leverrier who calculated the position of a new planet which they thought was altering the orbit of Uranus. Since 1996, the presence of 105 planets has been confirmed around 91 stars. New candidates are announced

frequently and others await confirmation. So we can now safely say that planetary systems are the norm rather than the exception.

This issue with the Special Theme: IT and Mathematics for Space Exploration presents some of the tools which make all these discoveries and applications possible through highly sophisticated software to control spacecraft and payloads, transmit data across the solar system, process and analyze the vast quantities of raw data and make the data easily available to all through grid technology. The progress of astronomy is about to hit a wall in terms of processing, mining and the interpretation of huge datasets. A fully scalable and distributed information system to overcome this problem for wide-field imaging is presented. The same principles are being applied to other sciences. Synthetic Aperture Radar enables us to remotely look at Earth and Planetary Surfaces with great accuracy. For the Earth, commercial providers can complement the photographic images with data that identify the location and type of foliage in an area and provide evidence of recent activity there. They can produce radar-generated maps with terrain elevations, transmit this information around the globe and combine all of it into formats most useful to the customer. This service is of increasing value to farmers and ranchers, fisherman and miners, city planners and scientists. To increase safety in Space, the Threat of Space Debris and Micrometeoroid to Spacecraft Operations must be controlled and mastered. Large-Format Science-Grade CMOS Active Pixel Sensors for Extreme Ultra-Violet Space Science will improve space weather missions. Nonlinear Dynamics and Chaos are present in many fields of Astrodynamics. Computation of distributions of Finite Time Lyapunov exponents provides valuable information on the local stability of the orbits. When dealing with huge sets of model parameter values, Grid-based techniques make such explorations faster than common techniques.

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ARTICLES IN THIS SECTION

Synthetic Aperture Radar - Another Look at Earth and Planetary Surfaces

by Christian Barbier

Synthetic Aperture Radar (SAR) image formation and its exploitation are the subject of intensive research at the Centre Spatial de Liège.

SAR is an active, microwave radar imaging technique that has the ability to provide high-resolution images of the Earth and planetary surfaces, independently of solar illumination (ie day and night) and cloud cover (ie in all weather). Contrary to classical visible-light imagery, extensive processing, referred to as aperture synthesis, focusing, or reconstruction, is required to convert the raw image into an intelligible image (see Figure 1).

The two fundamental dimensions in an SAR image are slant range (perpendicular to line of flight) and azimuth (parallel to line of flight). Target discrimination in range involves the correlation of each echo with the corresponding transmitted pulse. In 'classical' Stripmap SAR imaging, high azimuth resolution (typically 10m) is obtained by integrating successive echoes from a given target over the time interval during which the target is illuminated by the radar beam. This results in the synthesis of an antenna with an effective azimuth aperture of up to several kilometers. An increase of the swath width can also be made at the expense of azimuth resolution, by periodic switching of the radar beam between adjacent sub-swaths. Medium- (150m) to low- (1000m) resolution images can be obtained using this so-called ScanSAR imaging mode (Figure 2).

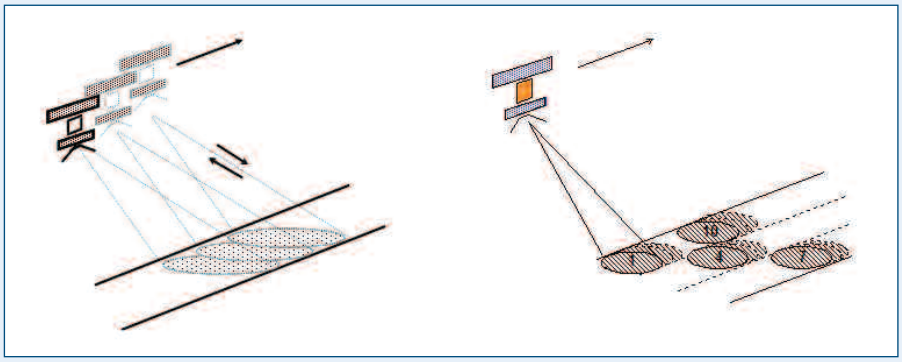

Figure 2: Stripmap SAR (left) vs. ScanSAR (right) imaging modes.

A frequency-domain, phase-preserving SAR processor has been developed for reconstructing full SAR images. This processor is also capable of generating quick-look, low-resolution SAR and ScanSAR images directly from raw data. It will be an integral part of the ground processing chain of the Argentine SAOCOM satellite, which will carry a full polarimetric L-band SAR as the primary payload.

In addition to its amplitude, which yields traditional imaging, the SAR signal is also characterized by a phase and a definite polarization status, both of which allow additional information channels.

Exploitation of the phase channel yields the SAR interferometry (InSAR) technique, typical products of which are digital terrain models and terrain displacement maps (Figure 3). An interferogram is generated from two phase-displaced SAR images of the same scene, acquired from two neighbouring orbits of the carrier satellite. Provided the phase difference between corresponding pixels is only determined by the optical path difference (which is the case if, among other conditions, the observed surface and the atmosphere do not vary in time

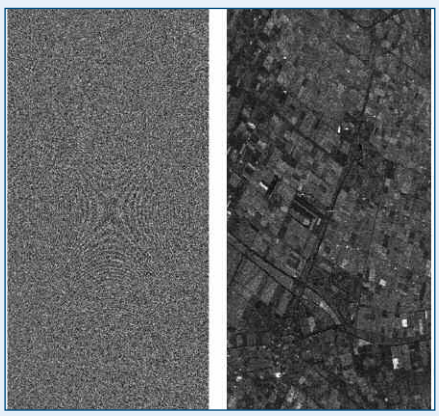

Figure 1: From SAR raw data (left) to a focused image (right).

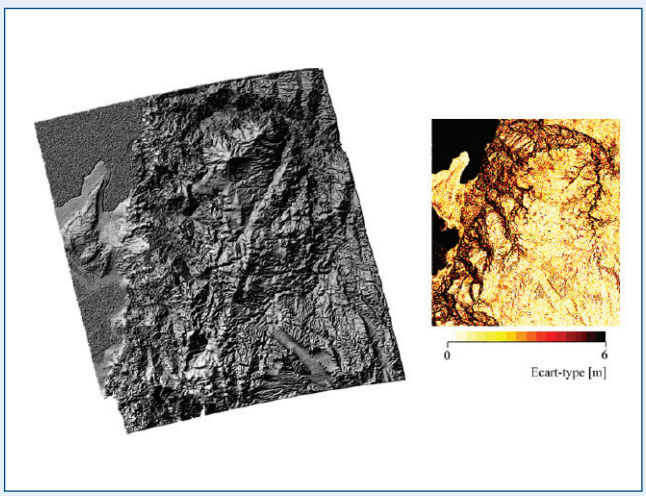

Figure 3: Digital elevation model of the Jordan border of the Dead Sea (left) with the corresponding height standard-deviation map (right).

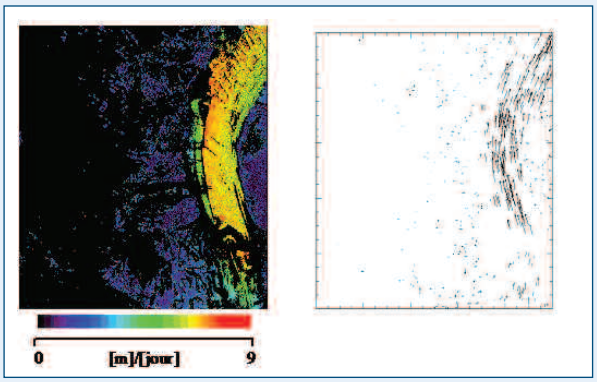

Figure 4: Coherence tracking measurements of the Shirase glacier, a fast flowing ice stream in Antarctica. Left: amplitude of the measured displacements. Right: vector representation.

between the two passes), altitude information can be extracted from the interference pattern. An InSAR processor was developed and demonstrated based initially on ERS-1/2 imagery, and then on RADARSAT, JERS, and ENVISAT data. It will also be part of the SAOCOM package.

Time variations of the surface three-dimensional structure at a centimetre or sub-centimetre scale can be detected by comparing SAR interferograms at different epochs (differential SAR interferometry - DInSAR).

DInSAR also allows displacements to be measured with a very high accuracy, but only along the line of sight. To circumvent this limitation we have developed a method now known as coherence tracking. This technique is based on local coherence maximization, which is used in the co-registration process to generate a map of local azimuth and range displacement with respect to the global co-registration. This is managed with sub-pixel accuracy, and was successfully applied in a glaciology study (Figure 4).

Exploitation of the polarization state (SAR polarimetry – PolSAR) provides information on the backscattering mechanisms underlying echo formation. InSAR and PolSAR can be combined to form a new advanced processing technique known as polarimetric SAR interferometry (PolInSAR). Both PolSAR and PolInSAR are the subject of intensive research at CSL.

Links:

Excellent SAR tutorials can be found at the following addresses:

Alaska Satellite Facility scientific SAR User's Guide:
http://www.asf.alaska.edu/about_sar/about_sar.html

ESA ENVISAT/ASAR Product Handbook:
http://envisat.esa.int/dataproducts/asar/CNTR.htm

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Advanced On-Board Software for Planetary Exploration

by Andy Smith, Mark Woods and Martin Townend

As our exploration of the Solar System moves from fly-bys and orbiters to close-up investigations, intelligent robots are increasingly coming into their own. This article describes how SciSys' cutting-edge software aims to control two such expeditions.

Software is a key enabler of robotic exploration and has long been acknowledged as integral to the success of any space mission, whether it's telecommunication, Earth observation, navigation, or space exploration. Today advanced software applications such as formation flying and autonomous navigation are often the driving force behind future space missions. SciSys is currently concluding several studies into the use of advanced on-board software for planetary exploration. This article describes two of these technology studies which are targeted at today's proposed Mars / Moon missions, namely aerobots and rover intelligent planning and scheduling. An expert in on-board software for planetary exploration, Bristol-based SciSys is currently involved in many aspects of ESA's Aurora programme, whilst recent space exploration missions in which SciSys has played a key role include Mars Express and Beagle 2, Rosetta, Venus Express, SMART-1 and Huygens.

Planetary aerobots could transform the way we explore those planets and moons which support an atmosphere. Traditional orbiters offer a 'bird's eye view' of the planet, covering vast swathes of land, with limited resolution. On the other hand, rovers or landers provide a highly detailed characterization of their local surroundings. Bridging this gap, the planetary aerobot can travel large distances whilst at an altitude

Figure 1: A visualisation of a planetary aerobot in the Martian atmosphere.

which allows for the acquisition of extremely high resolution images.

An aerobot would carry a variety of sensors to collect data on the planet's atmosphere and a camera system to build 3-D Digital Elevation Models (DEMs) of the surface below. By relating the informa-

tion to images created by satellites, the exact whereabouts of the aerobot can be pinpointed. This is crucial for scientific understanding of an area as it allows scientists to piece together an accurate mosaic of a region using actual planetary latitude/longitude references. Such references can also be used to categorize and discover suitable landing sites for future missions for example.

SciSys, with the University of Wales, Aberystwyth (UK) and Joanneum Research (Austria), is currently developing and testing a vision-based software package which builds 3-D models and localises the aerobot using vision data. The project will deliver two main components, namely: an Imagery-based Localisation Package (ILP) module which will implement the on-board Digital Elevation Model (DEM) generation, image prioritisation, vision-based localisation, data storage and uplink management; and a test framework to validate and evaluate the ILP module. The test framework will include a dedicated software simulator and a real prototype balloon fitted with a comprehensive payload ie camera system, on-board computer, altimeter and wireless communications.

The ILP requires an advanced image prioritisation data management system since the aerobot would only be able to upload its data to the orbiting spacecraft at limited times. Image prioritisation is a process by which the ILP stores images which are, by a prior-agreed set of standards such as high gradient variability, judged to be of interest to the scientific community. Those which are of less interest may be compressed more substantially or simply not stored at all.

Figure 2: A proposed design for the ExoMars Rover, a future Aurora mission.

As Steve Squires, Principal Investigator for NASA's Mars Exploration Rover (MER) mission, has commented "it takes MER a day to do what a field geologist could do in 45 seconds". For a complex mission, there is a need to increase the intelligence of the On-Board Software (OBSW) so that it can perform more tasks autonomously without the need for ground assistance. There are a number of technologies from the field of Artificial Intelligence which can help out on future Mars missions. SciSys is currently carrying out research into Intelligent Planning and Scheduling (IPS) which offers engineers the prospect of having a rover which can validate their activity plans with real-time information and repair these plans autonomously should they fail. Ultimately therefore, it offers the prospect of more science.

The potential of IPS for an actual rover mission has never been demonstrated in a test environment representing ESA's Aurora programme. The Mars Mission On-board Planner and Scheduler (MMOPS) project aims to address this. SciSys, with the University of Strathclyde (UK) and Heriot-Watt University (UK), are working on a project to develop an on-board IPS application capable of mission plan validation and repair. Trials involving engineering and operations personnel will then explore the benefits and optimal trade-off between factors such as autonomy vs. complexity, risk and net benefit to a mission.

As these examples illustrate, SciSys' own experience with the complex and challenging task of robotic planetary exploration has shown that strong relationships with universities and research centres is a key element for success.

Links:

SciSys: http://www.scisys.co.uk

ESA's Aurora programme:
http://www.esa.int/SPECIALS/Aurora/

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MEXAR2 Support to Space Mission Planners

by Amedeo Cesta, Gabriella Cortellessa, Simone Fratini, Angelo Oddi and Nicola Policella

MEXAR2 is a fielded AI system in daily use at ESA since February 2005. It provides continuous support to human mission planners in synthesizing plans for downlinking on-board memory data from the MARS EXPRESS spacecraft to Earth.

A critical problem for interplanetary space missions is to maximize scientific results while guaranteeing data return to Earth. A research team of the Institute of Cognitive Science and Technology of the Italian Research Council (ISTC-CNR) has developed an AI system, named MEXAR2, currently in daily use at the European Space Agency (ESA-ESOC). MEXAR2 provides continuous support to human mission planners in synthesizing dump plans for downlinking on-board memory data from the MARS EXPRESS spacecraft to Earth. The MARS EXPRESS mission has ambitious goals for the scientific experiments on board. The seven payloads with which the orbiter is equipped are expected to maximize their data return to take advantage of the opportunity offered by proximity to the Red Planet.

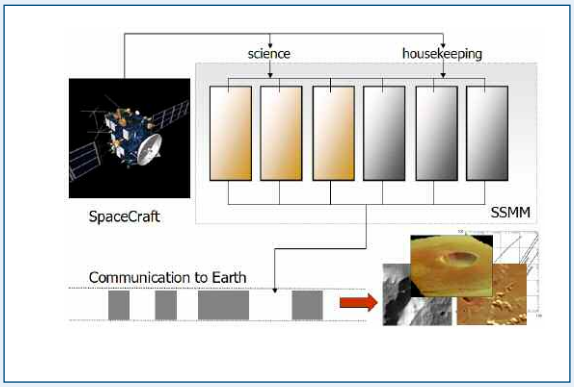

Figure 1: Bringing data from Mars to Earth.

New information from Mars is not only arriving to the space scientific community but, through the media, is also being disseminated further.

Obviously, in a deep-space mission like MARS EXPRESS, data transmission to Earth is fundamental. The space probe continuously produces a large amount of data resulting from the activities of its payloads and from on-board device monitoring and verification tasks. All data must be transferred to Earth during bounded downlink sessions. The presence of a single pointing system implies that the space-probe either points to Mars to perform payload operations, or points to Earth, to download the produced data. As a consequence, on-board data must generally be first stored in a Solid State Mass Memory (SSMM) and then transferred to Earth.

The average data production on a single day can be around 2-3 Gbit while the transmission rate of the communication channel, which varies between 45Kbs and 182Kbs, may not be sufficient. The on-board memory is subdivided into different banks, called packet stores, in which both scientific and spacecraft management data can be stored. In particular, the latter must reach Earth daily so as to allow safety checking of the different operations on board. It should be noted that each packet store assigned to science data is managed cyclically, so if new data are produced before the previous data have been dumped to Earth, the older data are overwritten and the related observation experiments have to be re-scheduled. Even if the on-board memory is about 9.4 Gbit, the irregular distribution of transmission windows, the different transmission rates of such windows and the different data rates for data production (eg, the stereo camera can produce files close to 1Gbit) may frequently create usage peaks close to the packet store capacities.

To complicate matters there is an additional uncertainty factor in data production for some instruments due to different compression algorithms. Dump plans for the on-board memory are usually computed for a nominal expected production of a certain payload activity, a POR (Payload Operation Request), but mission planners may discover that on-board data are more than expected so they have to recompute a dump plan.

The role of the software previously used to support the decision making was secondary; it was relegated to constraint checking tasks. On the contrary, by integrating Artificial Intelligence problem solving methods and Human-Computer Interaction techniques, MEXAR2 implements a proactive approach to plan synthesis while, at the same time, fostering human intervention and control during problem solving. In general, data dump generation can now be performed more quickly and with less effort and the quality of plans exceed that provided by the tools previously used.

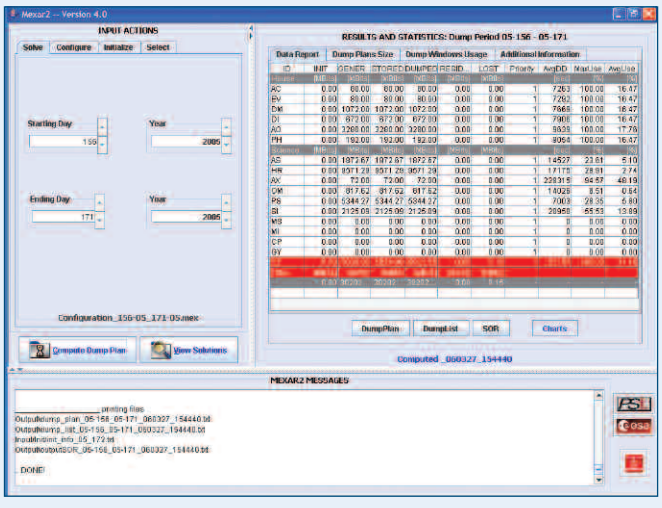

Figure 2: Mexar2 Interaction Module.

From the user standpoint, the problem of uncertainty in data production is addressed very satisfactorily and the time saved for producing plans has been estimated as up to 50%.

The ability of MEXAR2 to generate plans over multiple days very quickly, allows mission planners to consider alternative solutions in order to avoid data loss. It is worth noting that, before the introduction of MEXAR2 in the Mission Planning System, mission planners were satisfied with a single solution; MEXAR2 makes it possible to activate interesting optimizations. This allows problematic intervals in the schedule of future payload operations to be identified and an alternative allocation of the tasks involved to be negotiated with scientists thus minimizing overwrites. Additionally, users appreciate the usability and flexibility of the interface services and the fact that MEXAR2 runs on several platforms so that they can easily employ it from different machines. The previous procedure for synthesizing dump plans quite often obliged staff to work overtime; this effect has been eliminated with MEXAR2.

The scientific community has gained a number of benefits from MEXAR2: observation data are available earlier and data loss is minimized. As already said potential overwrites can be quickly detected and fed back to the scientists for science plan updates. Thanks to MEXAR2 the use of the downlink channel is optimised and more data can be downlinked. We can conclude that the use of MEXAR2 has resulted in an important increase in the scientific return from the mission.

Link:
http://pst.istc.cnr.it/

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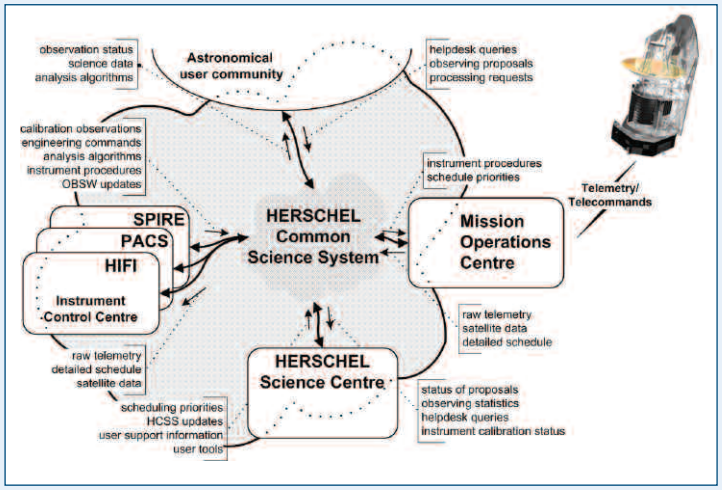
Designing for Software Reuse — the Herschel Common Science System

by Peter Roelfsema

The development and operation of instruments in scientific satellites requires much software, to support instrument and satellite tests, for calibration and for scientific data gathering and analysis. Traditionally, different software systems are built for different mission phases. To support Herschel Space Observatory (HSO) instrument activities in all mission phases, ESA and SRON Netherlands Institute for Space Research adopted a new approach: an integrated system for data management and processing. The system allows for continuous reuse of components over the entire 20-year project lifespan.

SRON is the Dutch national centre of expertise for the development and exploitation of satellite instruments in astrophysics and earth system science. One of its projects is the building and operation of the Heterodyne Instrument for the Far Infrared (HIFI). HIFI is one of three astronomical research instruments on board the Herschel Space Observatory, a European Space Agency (ESA) cornerstone mission, which will be launched in 2008. The HSO should have a 3.5-year operational lifetime followed by many years of research based on the archived data. The main aim of the HIFI instrument will be to observe regions in the universe where stars and planetary systems are being formed to help further our understanding of the lifecycle of stars and planets.



Overview of data flows through the Herschel Common Science System during the operational phase of the Herschel Space Observatory.

The various data flows and processing centers of the HSO are indicated in the figure. The three Instrument Control Centers monitor the instrument behavior and carry out and analyze calibrations. The Herschel Science Centre (HSC) plans and maintains the overall scientific schedule of the mission and the Mission Operations Centre (MOC) maintains contact with the satellite. These five centers and the astronomical community are interacting with the mission objects - products and software- through a common repository - the Herschel Common Science System (HCSS).

When the instruments are operated, commands are sent to the control computer inside the instrument to carry out observations by letting it execute steps needed to set up the instrument for a measurement, reading out the signals from the detection system and packaging the read-outs for transmission to the ground. On the ground, using calibration procedures and parameters, the read-outs are converted to values that astronomers can use for comparison with physical models of the observed region. Tools to support these activities are implemented in the context of the HCSS: a commanding engine, a data storage and retrieval facility and analysis tools for scientific and calibration analysis. The full object oriented design is implemented utilising an object database with Java and Jython based application software.

In space missions, reliability and robustness is a prime condition; the software must be extremely well tested and verified. This is especially important for software elements involved with commanding the instruments, as improper commanding may have permanent adverse effects on instrument performance. Since the detailed behavior of the instrument in flight might well change with time –for instance, due to aging effects or subsystem failures- an essential requirement on all software is that it is not only robust but also easily modifiable.

During the building, integration and testing of the instrument all activities outlined above are performed and therefore tools designed for the operational phase can be used in earlier phases as well. The joint Herschel ground segment design team realized this in 1996 when the HSO satellite and instruments were still in the conceptual stage. For HCSS, development started parallel with instrument building and testing. By replacing the Mission Operations Centre with functionality to control the instrument under laboratory conditions all other HCSS elements could be used in the same mode as envisaged during operations. This would promote extensive 'pre'-use of operational software during the instrument test phase providing early

and extensive user testing of this software. Additionally for the tests only minimal extra software facilities needed to be implemented.

Over the past years, large parts of the HCSS have been implemented by a joint team of some 20 developers from the instrument teams and ESA distributed over many locations in Europe. Ten years after its original inception and at least two years before its true operational use, the HCSS and its development concepts have already proven to be successful. Instrument tests are currently being supported by using HCSS functionality for instrument and test support equipment commanding, for data storage and retrieval and for data processing. All these components were designed for the operational phase and their use in instrument testing shows that foresight has already started paying off. One example of real life testing is the use of the HCSS data analysis component for analysis of scientific data obtained with ground-based instruments equivalent to HIFI. The success of the HCSS tests suggests that this reuse will stay successful through the pre-launch and science harvesting phases.

Links:
http://www.sron.nl
http://sci.esa.int/Herschel

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Testing the Robustness of Spacecraft Control Software

by Olaf Maibaum

Software robustness is a key factor for long-term space missions. To ensure mission success, the testing of software and systems is of utmost importance. This paper describes the testing of software robustness in a software-in-the-loop test bed as realized in the project SiLEST.

Space is an inhospitable environment for electronic and mechanical components. Radiation and thermal conditions cause accelerated aging of sensors and actuators, and the applied loads during take-off and manoeuvring can cause damage. Such conditions – unusual on Earth – are common in spacecraft operations, and the on-board software must be robust enough to cope with them autonomously as far as possible.

Intensive testing is necessary to demonstrate the robustness of software. Such evaluation must be performed at the system level as an 'in-the-loop' testing of the software. The traditional test approach is a 'hardware in the loop' (HiL) test. In this approach, the software runs on a controller board that mimics the target hardware. Using the native interfaces it is coupled with devices, which can be real hardware or simulations that reproduce the behaviour of sensors and actuators in the system. The dynamic behaviour of the environment is also implemented. The main disadvantage of an HiL test is the need for real-time simulation. With the increasing complexity of systems, the effort required for effective testing increases drastically.

Another approach is to test the software in a 'software-in-the-loop' (SiL) test bed. This method makes use of interfaces, sensors, actuators and an environment that are completely realized in software, ie simulated. Since the software being evaluated communicates with other system elements via simulated interfaces, no specialized hardware environment is needed. Tests can be run during the system design phase, and are not restricted – as with HiL test beds – to the integration phase. In addition, the integration of the software as part of the simulation is feasible. Further debugging is also facilitated in an SiL test bed.

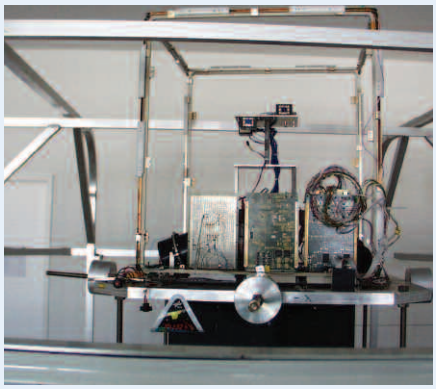
However, the coupling in an SiL test bed generates a change in timing. This is the result of changes in the software that are necessary to establish the coupling, and means that timing failures can be masked. This is a drawback of SiL test beds, and requires further efforts to analyse the timing behaviour of the software.

To prove and demonstrate the advantages of SiL tests, an SiL test bed has been developed in the cooperative project SiLEST (Software in the Loop for Embedded Software Tests), with the additional objective of analysing the timing behaviour. SiLEST is a collaborative effort involving the German Aerospace Center (DLR), IAV GmbH, Webdynamix GmbH, the Technical University of Berlin, and Fraunhofer Institute for Computer Architecture and Software Technology (FIRST).

The aim of SiLEST is to test the robustness of embedded control software with simulated flaws in the electrical environment. Test objects are the Attitude Control Software (ACS) of the BIRD micro satellite from the space domain, and an engine control unit from the automotive domain.

The proper performance of the ACS is tested with noisy or lost sensor signals or jerky actuator movement. In such cases the ACS will at least switch to 'satellite save mode' to ensure the survival of the satellite until troubleshooting is available from the ground.

The engine control unit is tested in an SiL test bed with nominal behaviour and with



Records from the BIRD micro satellite are used for testing the control softare.

faults such as the cable break of sensors, short circuits, signal noise, blocked mechanical components and so on.

During development, the SiL test bed will prove its adequacy for robustness tests in a closed loop. To achieve this, the test results of the SiL test bed are compared to the results of HiL test beds, and additionally in the case of the ACS with records from operations of the BIRD micro satellite.

The tests of the ACS are performed by the German Aerospace Center (DLR), while the tests for the engine control system are executed by the cooperation partner IAV.

A further objective of SiLEST is to increase the automation level and the efficiency of the tests. The test cases are described in XML. An adaptable XML test-case editor has been developed by the cooperation partner Webdynamix. This editor allows the creation of test cases for SiL and HiL tests and fulfils the requirements of the partners from both the space and automotive domains. Using plug-ins it is possible to integrate specialized data editors for the data input into the test cases. For example, a graphical editor allows control curves to be drawn. The intended test automation environment offers scripting facilities and the integration of different components at different locations by Web Services, in order to satisfy the requirements of several application domains.

By the end of the project, in mid-2007, it will be possible to determine the extent to which an SiL test bed is adequate for robustness tests of embedded control software. Recommendations will be made regarding the appropriate use of SiL or HiL test beds, and an adaptable test automation environment and a test case editor for SiL and HiL test beds will be available.

The SiLEST project is funded by the German Federal Ministry of Education and Research under code 01ISC12A. The author of the publication is responsible for the content.

Links:

SiLEST home page:http://www.silest.de/

BIRD home page:
http://www.dlr.de/os/forschung/projekte/bird

Research program:
http://www.softwarefoerderung.de/

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A New Approach for Advanced Life-Support Systems Control

by Jordi Duatis, Cecilio Angulo and Joan Mas

Recent developments in the International Space Community have shown there is a rising interest in the human exploration of outer space. In particular, the objective of sending a manned mission to Mars by 2030 has been set. The feasibility of such a mission will require Life Support Systems (LSS) able to provide vital elements to the exploration crew in an autonomous, self-sustained manner, as re-supply from Earth will not be possible. Bio-regenerative LSS (BLSS) are considered to be the LSS technology alternatives that can meet this demand. Developing effective BLSS is a challenge for the Control community because of the high degree of automation, indeterminism, non-linearity and total instability. Agent-based approaches are being analysed as a suitable means of overcoming these difficulties.

Life Support Systems (LSS) provide the necessary conditions to sustain human life in a hostile environment over prolonged periods of time. Current LSS used in manned spacecrafts (eg the International Space Station) control the atmosphere composition (ie the percentages of oxygen, nitrogen and carbon dioxide) and regulate pressure and temperature by means of physico-chemical processes, most of which require periodic re-supply of fungible materials. Other vital elements are to some extent recycled (eg water) or uploaded from Earth (eg food). Re-supply is a major problem for the feasibility of long-term planetary missions. Such missions are currently in the scope of Space Exploration programs

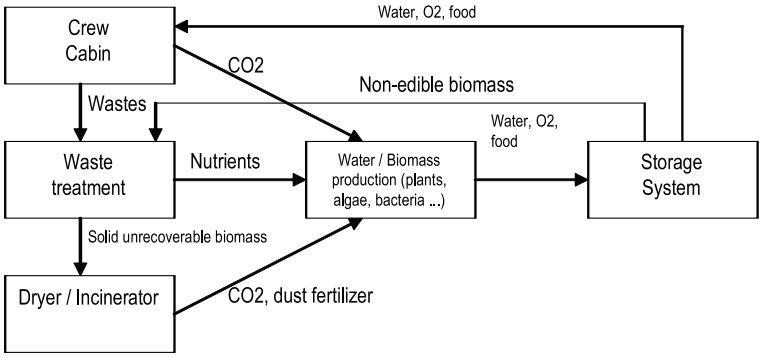

Figure 1: Life Support System biological relations.

encouraged by ESA or NASA, whose objective is to establish permanent manned outposts, first on the moon and later on Mars, by 2030.

A new generation of Biological Life Support Systems (BLSS) is starting to be developed (eg NASA's BIOplex and ESA's MELiSSA). These use biological organisms (bacteria, algae, plants etc) to regenerate air, water and food with the objective of complete self-sufficiency. Microorganism cultures are employed to recycle water from wastes; higher plants are an essential source of fresh food through cultivation and harvesting, water is recycled through plant transpiration, and oxygen is produced by photosynthesis.

The goal of BLSS is very ambitious, as the fact of using living beings generates a problem in the determinism of the system. These systems are highly non-linear, with a high level of uncertainty in their behaviour, making it impossible to perform a complete analytical modelling of the processes. It is therefore necessary to develop, in parallel with the biochemical and physiological studies, new approaches to system control (Figure 1).

Model-based control systems will not be successful since they cannot deal with incomplete or inaccurate information. For instance, the maturity level of the crop must be assessed indirectly using several variables (atmosphere gas composition, plant colour, biomass, time from seeding etc). In addition, these variables will depend on a great number of factors, making predictability very poor.

New control-system architecture to cope with these problems can be effectively implemented using a Multi-Agent System (MAS). This approach allows the problem to be broken down into small parts, each dealing with specific tasks but in a coordinated manner, performing as an organization with a common objective and sharing a set of rules. In addition, designing this system as a multi-agent network will allow specific control solutions to be applied to each part as needed. The different types of controllers will become encapsulated in the agent structure and only relevant information will be shared to enable monitoring and global control. Another benefit will be the reconfiguration capability, in cases of, for instance, failure of part of the system or the need to adapt the system to new objectives.

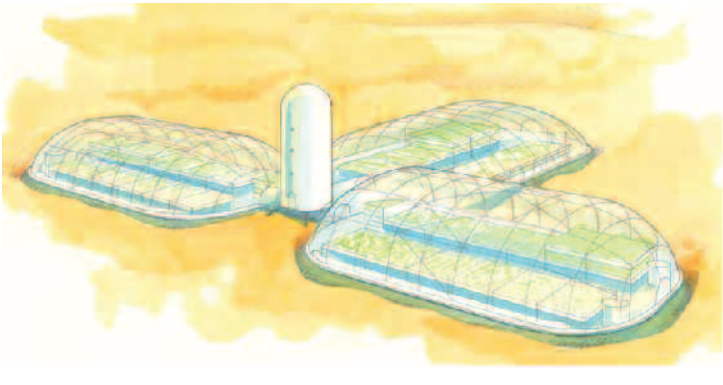

Figure 2: Mars greenhouse. Artist impression courtesy of TNO (NL).

The proposed MAS is organized in a layered structure. In the first layer, agents will be in charge of the planning and coordination of necessary tasks and interaction with the crew, requiring their intervention only when mandatory. The use of Expert Systems in this layer will allow actions to be planned in a systematic and efficient manner. For example, achieving an optimal harvest depends not only on the maturity of the crop but also on food requirements and storage capability.

In the second layer, agents will control the execution of these tasks, interfacing with the sensors and actuators of each LSS subsystem and notifying relevant process data, progress information or unexpected events to the planner layer. This layer will be heterogeneous in the sense of implementation, but for each process control an agent will be on top, permitting a standard communication with the rest of the system.

An especially critical problem to be solved is the amount of supervisory information that this system will generate. Agents specializing in information synthesis are needed to process this information before communicating it to the crew. Automated supervision of the processes will be required, providing only relevant information and requiring crew attention only when mandatory.

Links:

http://www.nte.es/

http://www.estec.esa.nl/ecls/

http://advlifesupport.jsc.nasa.gov/

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The Astro-Wise System: A Federated Information Accumulator for Astronomy

by Edwin A.Valentijn and Gijs Verdoes Kleijn

The progress of astronomy is about to hit a wall in terms of the processing, mining and interpretation of huge datasets. The Astro-Wise consortium has designed and implemented a fully scalable and distributed information system to overcome this problem for wide-field imaging. The same principles can be applied to other sciences.

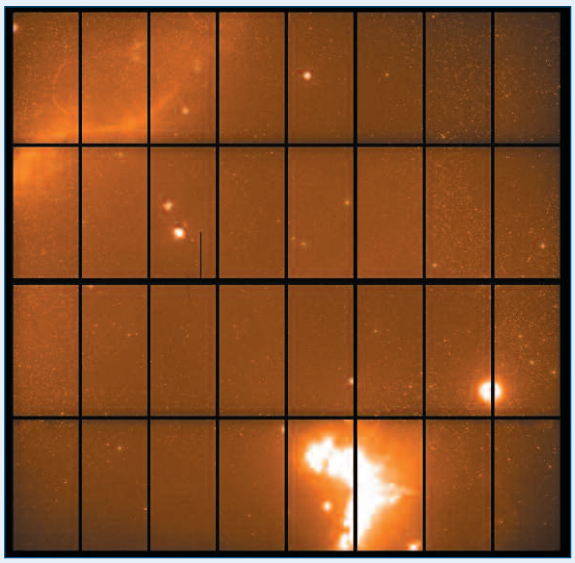
Much of modern research involves the accumulation of huge amounts of digitized data. The analysis of this data by distributed communities represents a significant challenge to project management and ICT implementation, and is relevant to fields as diverse as biology, physics, astronomy, economics and cultural heritage projects. Furthermore, the projects are often global efforts requiring collaborators in many places to share, validate and combine processed data and derived results. It is therefore necessary to develop more efficient data lineage, mining and analysis systems to allow researchers to search intelligently through previously unmanageable volumes of data.

The Astro-Wise consortium has developed an information system to meet these challenges for wide-field imaging in astronomy. The Astro-Wise consortium is a partnership between OmegaCEN-NOVA/Kapteyn Institute (Groningen, The Netherlands; coordinator), Osservatorio Astronomico di Capodimonte (Naples, Italy), Terapix at IAP (Paris, France), ESO, Universitäts-Sternwarte & Max-Planck Institut für Extraterrestrische Physik (Munich, Germany).

Large data projects in high-energy physics, space missions and astronomy typically push data through various platforms in an irreversible way (eg a TIER node setting). In such a situation, the end user has little or no influence on what happens upstream. This 'classical' paradigm is characterized by fixed 'releases' of homogeneous, well-documented data products. In contrast, the Astro-Wise system allows the end user to trace the data product, following all its dependencies up to the raw observational data and, if necessary, to re-derive the result with better calibration data and/or improved methods.

This improvement is achieved by:

- emphasis on project management; enforcing a global data acquisition and processing model, while retaining flexibility
- translating the data model to an object model, with full registration of all dependencies
- storing all I/O of the project in a single, distributed database, containing all metadata describing the bulk data (eg images) and derived results in catalogue form (eg lists of celestial sources).
- connecting to the database a federated file server that stores hundreds of Terabytes of bulk data
- an own compute-GRID which sends jobs (including clients) to single nodes or parallel clusters, which then request data from the distributed database.



A 256 Mega pixel test image of the OmegaCAM instrument, which consists of 32 eight Megapixel CCDs.

The database with all metadata and catalogues provides the infrastructure to develop tools for a variety of purposes. These include rapid trend analysis of data, complex queries and fast hunting for 'needles in the haystack' of Terabyte-sized catalogues. Thus, the system provides the user with fully integrated, transparent access to all stages of the data processing and thereby allows the data to be reprocessed and the system to be improved and expanded.

For a given project/instrument, the system initially starts in a naive, 'quick look' mode, which gradually improves as various researchers add refined information to the system under the supervision of project leaders. Approved calibration modifications automatically become public, beyond the project boundaries. A mechanism for quality control is implemented which allows for changes due to one of:

- true physical changes of parameter values
- improvements in encoded methods, or
- improved insight in either of these.

The core of the system exploits three properties in database environment. First, we apply the principle of inheritance using Object Oriented Programming (Python), where all Astro-Wise objects inherit key properties for database access, such as persistency of attributes. Second, the linking (associations or references) between instances of objects in the database is completely maintained, and for each

bit of information, it is possible to trace those bits of information that were used to obtain it. Third, each step, and the inputs used for it, is kept within the system. The database grows constantly through the addition of new information or improvements made to existing information.

All system components are distributed over Europe, enabling research groups to collaborate on shared projects. Knowledge added by one group is immediately accessible by others via a Web portal, which includes data viewing, quality labelling and compute-services (see links). Currently, researchers use the Astro-Wise system with 10 Tbyte of astronomical images. Hundreds of Tbytes of data will start entering the system when the OmegaCAM panoramic camera starts operations in Chile. This camera is dedicated to various large surveys using the Astro-Wise system.

Astro-Wise coordinator OmegaCEN-NOVA is collaborating with the LOFAR consortium and CWI to explore usage of the Astro-Wise system for LOFAR, the next generation Low Frequency Array of radio telescopes, which is being built in the Netherlands and Germany. Astro-Wise can also be applied to other fields of science. The object-oriented use of the database allows for classes of objects dealing with arbitrary forms of digitized observational data. Scans of cultural heritage, DNA sequences, data from high-energy particle collisions or financial markets can be processed using similar principles to the images of the sky.

Links:
http://www.astro-wise.org
http://www.astro-wise.org/portal
http://www.astro.rug.nl/~omegacam
http://www.astro.rug.nl/~omegacen
http://www.lofar.nl

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AstroGrid — Part of the European Virtual Observatory

by Peter M Allan

AstroGrid is the UK's implementation of the concept of a virtual observatory - being able to get at all the world's astronomical data directly from your desktop computer. It has been developed over the last 5 years with contributions from the Rutherford Appleton Laboratory and the universities of Edinburgh, Leicester, Cambridge, University College London (Mullard Space Science Laboratory), Manchester (Jodrell Bank Observatory), Queen's University Belfast, Bristol, Exeter, Portsmouth and Leeds.

The underlying concept is to provide data and computational services as grid services, such that a distributed data grid is built. The focus is on the provision of access to data, rather than on access to supercomputing power, although that can be one of the services offered. Within the UK, AstroGrid provides access to the large astronomical data resources held at the first six of the institutions listed above. If it did just this, AstroGrid would be useful, but not revolutionary. In fact, AstroGrid is an active participant in the International Virtual Observatory Alliance, a group dedicated to defining a truly international set of standards for grid-enabling access to astronomical data world wide. At the European level, AstroGrid is an active partner in Euro-VO, and leads the VO-Tech part of this Framework 6 project.

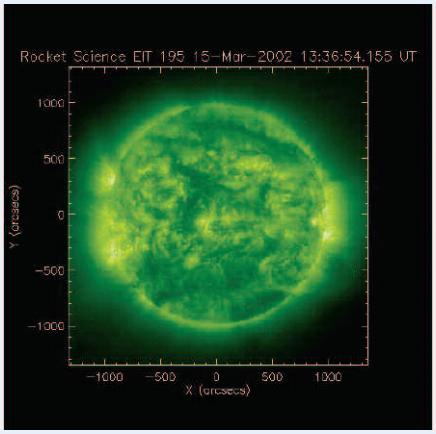
There are several virtual observatory projects around the world. AstroGrid has taken the route of deliberately deciding what astronomers really needed to make a major step forwards in their ability to analyse their data, and to build the infrastructure to do this. Some of the infrastructure has been a challenge to design and build, but we now have a system that can be used by astronomers in earnest. It is starting to be used to do real science.

The fundamental architecture behind AstroGrid consists of a set of web services with a workflow system that makes use of these services. In order to process data using AstroGrid, an astronomer builds a workflow and then executes it. They do not need to explicitly get the data from a data archive; the web services handle that. They do not need to be concerned with the storage of intermediate data; that is held in an area called MySpace. Depending on what the astronomer wants to be the result of some data search and processing, there may or may not be a requirement to have final data returned to the user's desktop. A typical simple workflow would be to get data from A and B, processes them at C and store the results at D. The actual location of A,B,C and D are not important to the user, only the result is.

As an example of the ease with which data can be obtained, as a test I recently tried to get some optical data on the quasar 3C273 (a famous object to astronomers). With a total of about ten clicks of the mouse and typing "3C273" (the system knows its position on the sky) I was offered data from the Hubble Telescope, which I chose to download from the archive in the USA to MySpace. I could then display the images on my computer. This is a fairly simple example of what is possible, but it demonstrates that a wealth of data are only a few mouse clicks away. This makes it much easier than in the past to

think of an idea, gather the data needed to test this, and do the analysis. The aim is to promote asking new questions and actually testing them because it is now easy to do so.

Most of what AstroGrid provides in the way of data processing can already be done by existing means, with enough effort. The key is the words "with enough effort". If a task will take a lot of effort to do, it may not be attempted if the value of the results is unclear. Speeding up the time from idea to result will actually get new science done, because now it is worth asking new questions. The area in which AstroGrid will enable science that really was not practical before is in responding to sudden events in the sky that require a rapid response before they fade from view. The problem of gamma-ray burst sources is such a problem of current interest. These objects suddenly emit in gamma–rays what appears to be the total energy output of a whole galaxy in a few minutes. They then fade rapidly from view, making it very difficult to observe with other telescopes. AstroGrid allows an automated rapid response system to be built to gather those vital follow-up observations in time.



The Astrogrid science service allows a user to make a movie of solar images by means of a simple interface.

The facilities of AstroGrid are available via a web browser or by using a workbench on your desktop. These are described at www.astrogrid.org, from where the workbench can be downloaded.

While AstroGrid currently provides access to a large variety of data resources and it has some useful applications, it does not currently have a large number of applications for processing those data. These will come along in the future. However, the infrastructure is a completely open one and there is a simple way in which existing free standing applications can be hooked into AstroGrid, so there is considerable scope for a rapid increase in applications software, given the effort to do so.

Link:
http://www.astrogrid.org/

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The Geolocation of GERB Data

by Martin J. Bates, Peter M. Allan, Brian Coan, Andy Smith and Brian C. Stewart

Determining the pointing of a telescope to 0.4 arcminutes might not seem unduly arduous, but when the telescope in question is on a satellite rotating at 100 rpm and subjecting it to a loading of 16g, then things become a little more difficult. This is one of the challenges faced when processing data from the Geostationary Earth Radiation Budget Experiment (GERB), a climate instrument on board EUMETSAT's Meteosat Second Generation (MSG) series of weather satellites.

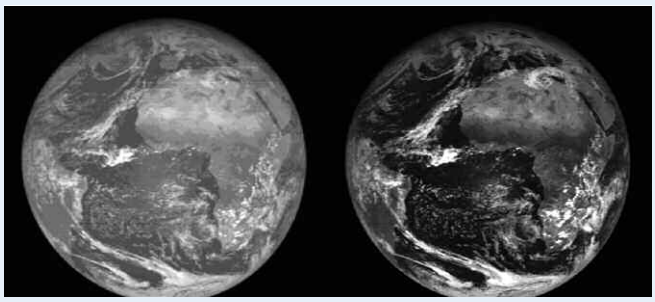
The first GERB instrument was launched on the MSG-1 satellite (now renamed Meteosat-8) in August 2002. The second in the series of four has recently been launched, in December 2005. GERB exists to make high accuracy broadband (total energy) measurements of the visible and infra-red radiation emitted by the earth. MSG is in a geostationary orbit, and GERB's 18° field of view covers the entire Earth disk, building up an image from 282 x 256 individual pixel measurements. GERB is the first radiation budget experiment to be sited in geostationary orbit, and hence the first to make repeated measurements (every 17 minutes) of the same area of the globe. The GERB instruments are positioned close to 0° longitude and hence view Europe, Africa and the Atlantic Ocean.

GERB data processing is carried out in near real time by a distributed ground segment, with a first stage of processing (level 1.5) carried out at the CCLRC by the GERB Ground Segment Processing System (GGSPS), and higher level processing (level 2) performed at the Royal Meteorological Institute of Belgium (RMIB):

- in level 1.5 processing an initial radiance (power per unit area per unit solid angle) measurement is derived, and the latitude and longitude corresponding to the centre of each pixel is derived in a process known as geolocation
- in level 2 processing, radiances are converted to fluxes (power per unit area), and corrections are made for the relative sensitivity of the instrument to different wavelengths (the 'spectral response') and the response to radiation from a point source (the 'Point Spread Function').

All communication with the satellite is carried out through the Mission Control Centre at EUMETSAT in Darmstadt. Imperial College handles GERB instrument commanding and operations, and leads the GERB International Science Team.

The GERB pixel size is approximately 44 km at the sub-satellite point, but in the



Two of the first images taken with the latest GERB instrument on 01 February 2006, on board the MSG-2 satellite. The image on the left measures both infra-red and visible radiation; that on the right measures just the visible. The GERB instruments are situated in geostationary orbit close to 0° longitude, viewing Europe, Africa and the Atlantic Ocean, and make 3 such images in each channel every 17 minutes. Each image is comprised of 282x256 pixels, and near the centre of the image will correspond to a distance of 44km on the ground.

GERB processing the position of each pixel must be located to an accuracy of about one tenth of this. This is because of the need in higher level processing to co-locate the GERB data with data from the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) instrument, a multi-channel instrument which is the main imager on MSG and is used in operational weather forecasting. This latter instrument produces images at higher spatial resolution (3km), and is used in the level 2 GERB processing for scene identification and spatial resolution enhancement.

This sub-pixel accuracy requirement means that the GERB pixels cannot be geolocated using the GERB image alone. Instead, the following information is used:

- the MSG satellite position and orientation is obtained from the (SEVIRI) Image Processing Facility (IMPF) at EUMETSAT
- ground-based calibration and alignment measurements are used to determine the GERB pixel pointing directions
- timing information from the GERB instrument is used to track the GERB scanning mechanism
- geometry is used to convert the GERB position and pointing direction into latitude and longitude coordinates on the Earth's surface
- matching of GERB and SEVIRI images during the higher level RMIB processing is used to validate the geolocation and perform any one-off adjustments to alignment parameters and offsets.

However, MSG is a spin-stabilised satellite: it uses its own angular momentum to maintain a stable orientation in space. MSG rotates at 100 rpm, and this produces a number of complications.

A 'Start of Line' (SOL) pulse is generated by the satellite on each rotation. It is designed to arrive a fixed time before the Earth passes the instrument viewing window, and it acts as a 'get ready' signal to the onboard mechanisms. However, the timing of this pulse can vary from its nominal value, due to the tilt of the satellite and the performance of the Earth and Sun sensors which generate the signal. The GGSPS uses timing corrections generated by the IMPF to compensate for drifts and fluctuations in the SOL pulse.

MSG's rotation means that the earth flashes past the GERB instrument nearly twice a second. However, to make a measurement, GERB needs to hold a steady image for 40 milliseconds. GERB uses a de-spin mirror, rotating at half the speed of the satellite and in the opposite sense, to achieve this. However, this requires the MSG spin axis and that of the de-spin mirror to line up precisely. Any misalignment can cause a shift and a blurring of the image in a north-south direction. This alignment can change with time, due to thermal effects and the burning of fuel by the satellite, and work is ongoing to track and compensate for these changes.

The GERB instrument is placed near the outside of the 3.2 m diameter MSG satellite, where at 100 rpm it experiences a loading of approximately 16g. This places large stresses on the instrument, particularly on the de-spin mechanism, and also causes structural distortions, both to the GERB instrument itself and to the platform on which it sits. The de-spin mirror position is monitored more than 100 times during the acquisition of each Earth measurement, and the amount of blurring resulting from non-uniform motion is estimated and accounted for in higher level processing. The GERB pixel pointing directions were measured on ground from laser measurements: comparisons with SEVIRI images suggest that these pointing directions have been distorted by the 16g loading, and corrections have been derived. The GERB instrument is placed on shims to correct for the predicted bending in the platform on which it is located.

Further work is required to account for shifts in the relative alignment of the MSG and GERB spin axes, but geolocation accuracies better than 0.5 GERB pixels are currently being attained. Improved accuracy has been obtained by matching SEVIRI and GERB images as part of level 2 processing at RMIB, and this will form the basis of an initial data release in spring 2006; both methods will continue to be developed over the coming months to enable the target geolocation accuracy to be reached in a second data release.

Acknowledgements

This work would not have been possible without the help of colleagues at EUMETSAT, Imperial College and RMIB. The GERB instruments have been built by a European Consortium which includes RAL, Imperial College, Leicester University, the National Physical Laboratory and RMIB, as well as industrial partners in the UK, Belgium and Italy. The first GERB instrument was funded by the United Kingdom Natural Environment Research Council (NERC), together with funding agencies from Belgium and Italy. Development of the GGSPS, and its operation for the first GERB instrument, have been funded by NERC and the European Commission (Framework IV). Subsequent GERB missions are being funded by EUMETSAT.

Link: http://ggsps.rl.ac.uk/

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Galaxy Filament Detection using the Quality Candy Model

by Pierre Gernez, Xavier Descombes, Josiane Zerubia, Éric Slezak and Albert Bijaoui

A joint project between INRIA and the French Riviera Observatory proposes to apply a marked point process to detect a galaxy filament network. The method is based on a model initially developed for road network extraction in remotely sensed images.

Beyond one billion light-years, when averaged over 30 Mpc, the visible Universe can be seen as a gas of galaxies, uniformly distributed. At smaller spatial scales, astronomical observations and dedicated numerical simulations have shown that the repartition of the luminous matter is not so homogeneous.

The three-dimensional distribution of galaxies in the today Universe is indeed characterised by a complex network of filamentary structures which delineates

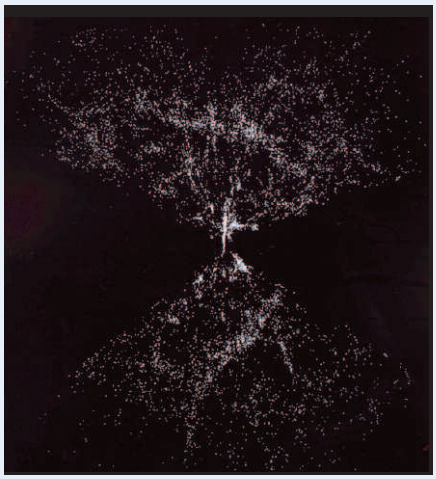

Figure 1: Three dimensional view of galaxies up to 500 billion light-years, from the two CfA observation cones (credits: Center for Astrophysics, Harvard).

spherical regions of about 100 million light-years in diameter devoid of objects, suggesting a sponge-like or cell-like topology for the underlying matter density field. The finite age of the Universe and the low enough peculiar velocity of galaxies imply that information about the initial conditions are preserved at such large spatial scales. Characterising the properties of the galaxy clustering puts therefore strong constraints on the theoretical models for the formation of structures under the influence of gravity in an expanding Universe known to be dominated by dark matter and energy components. Identifying elongated structures like filaments, which might only occupy 10% of the volume, and measuring their statistical properties would allow one to go beyond the information provided by the usual two-point correlation function measurements which suffer from degeneracies with respect to the topology.

As shown in Figure 1, such a filament is not a single structure with sharp edges, but instead a fuzzy set of points more or less scattered, which makes its detection difficult. Another difficulty in the detection process comes from the difference of spatial scales between sparse and prominent compact features. The gradual disappearance of structures with increasing distance results from the use of a magnitude-limited sample. The apparent luminosity of any object is fainter as distance increases, and only the few galaxies with the highest intrinsic luminosity are then included.

Up to now, there are only a few methods to extract the filamentary structure. The Minimal Spanning Tree (MST) method has been mostly used. Recently, we have adapted a method based on marked point process, initially proposed for road network extraction to this framework. The network of filaments is modelled by a marked point process, that is to say a random set of objects whose number of data points is also a random variable. The objects of this process are segments described by three random variables corresponding to their midpoint, their length and their orientation. The segment distribution is simulated by a density probability. In order to find the segment configuration that better fits the filamentary network, we define a density probability which takes into account the interactions between segments. The configuration of segments composing the filament network is estimated by the minimum of the energy of the system which has two components: the prior term forces the segment configuration to be a network. It takes into account the geometrical constraints of the network: slow curvature and good crossing points between the segments. The network structure is obtained by penalising segments which are not connected. The curvature constraint is optimized by quality functions with respect to the connection angles and the orientation between the segments. The overlaps between segments are forbidden in order to have neat crossing points. The second term is a data term which helps this network to best fit the data. Results are shown on Figure 2 starting from data kindly provided by the center for astrophysics at Harvard.

Figure 2 : Network extracted by the "Quality Candy'' model (credits: Ariana, INRIA/I3S).).

Link:
http://www-sop.inria.fr/ariana/personnel/Xavier.Descombes/Resfigaro/Figaro.html

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Modelling the Long-Term Evolution of Orbital Debris

by Luciano Anselmo

Current space missions around the earth have to deal with a problem mostly ignored just 25 years ago: man-made orbital debris. Besides the more than 9,000 objects (50% of which are break-up fragments) routinely tracked by the U.S. Space Surveillance Network, typically larger than 10-20 cm and with a combined mass exceeding 5,000 metric tons, the circum-terrestrial space is populated by a very large amount of smaller particles, down to sub-millimetre sizes, which is continually being replenished by international space activities.

While the impact of large objects is potentially able to induce catastrophic fragmentations, particles in the millimetre and centimetre size range can severely damage critical spacecraft subsystems. A cost effective shielding against millimetre sized debris is sometimes feasible, but avoiding penetration following the impact of a particle close to one centimetre is considerably more difficult and expensive, as International Space Station designers know well.

The best approach to investigate the future evolution of orbital debris and the practical effectiveness of mitigation measures is to develop models and software codes able to realistically describe the relevant physical processes (orbital dynamics, air drag, on-orbit explosions, slag discharge from solid rocket motors, collisions, surface degradation, etc…) and the operational practices (launches, release of mission related objects, disposal options) connected to the space activities in orbit around the earth.

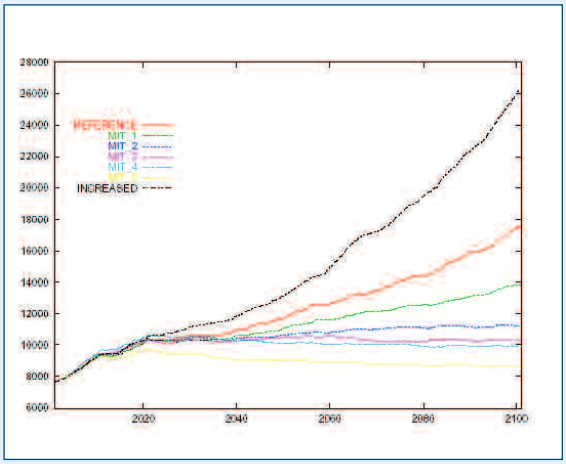

Figure 1: Long-term evolution below 2000 km of the number of objects larger than 10 cm.

However, this becomes a very demanding task, in particular if the goal is to model the orbital debris evolution over several decades or more.

In spite of the inherent difficulties and limitations involved, a few groups around the world have developed a quite complex set of computer codes to simulate in detail the long-term evolution of the debris population. One of these groups is based in Pisa, at the Space Flight Dynamics Laboratory of ISTI-CNR. Since the 1990's, under three European Space Agency (ESA) contracts, this group has developed a couple of dedicated software tools, plus several support programs. One of these tools, the Semi-Deterministic Model for Space Debris Mitigation analysis (SDM), has been continuously upgraded to include more and more sophisticated traffic and mitigation options.

In its various versions, SDM has been used in several international studies, eg research promoted by the Inter-Agency Space Debris Coordination Committee (IADC), to investigate the relative effectiveness of some mitigation measures, such as on-orbit explosion prevention and satellite end-of-life de-orbiting, proposed in order to control the growth of orbital debris. The results have contributed to discussions at the United Nations (Technical Report on Space Debris, United Nations, New York, 1999) and to the adoption of internationally recognized mitigation guidelines and codes of conduct (IADC Space Debris Mitigation Guidelines, Inter-Agency Space Debris Coordination Committee, 2002; European Code of Conduct for Space Debris Mitigation, European Debris Mitigation Standard Working Group, 2004).

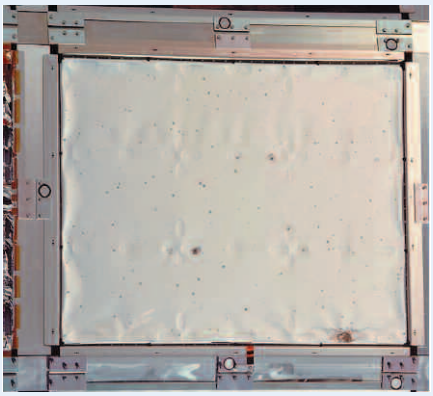

Figure 2: Space debris impacts on a panel of the Long Duration Exposure Facility, left in orbit for 5.7 years (by courtesy of NASA).

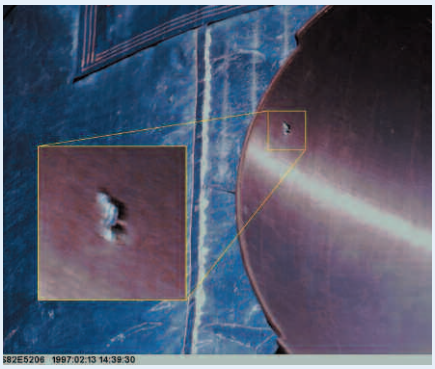

Figure 3: Hole in an antenna of the Hubble Space Telescope due the impact of a centimetre sized orbital debris. The external surface of the telescope is pitted by more than 1500 impacts (by courtesy of NASA).

There are only a few sources of orbiting objects able to catastrophically fragment by impact spacecraft and rocket bodies: launches, on-orbit explosions and, of course, collisions. Because at present the catastrophic collision probability is still very low, new launches – involving satellites, upper stages and mission related objects – and explosions are the

leading sources of sizeable objects and this explains why a large international effort has been initiated in order to passivate spent rocket stages and remove spacecraft at the end-of-life from critically important regions of space (eg the geostationary ring and low earth orbits, below the altitude of 2000 km).

As far as the sinks are concerned, aside from high eccentricity orbits, for which the luni-solar perturbations may produce an effective reduction of the orbital lifetime, the only mechanism able to remove sizeable objects from space is the air drag from the residual high atmosphere. However, its effectiveness is proportional to the local atmospheric density and the area-to-mass ratio of space objects. Thus, it is not very efficient in removing large orbital debris above 650 – 700 km. This means that even maintaining the current relatively modest level of space activity, the amount of abandoned satellites, spent upper stages and large debris is destined to grow, at altitudes greater than 650 km, providing one of the ingredients of a possible collisional chain reaction.

Assuming an updated business-as-usual scenario, and taking into account the recent evolution of space activities and the most probable future trends, the Monte Carlo simulations carried out with SDM have shown that only the adoption of drastic mitigation measures, such as upper stage and spacecraft explosion prevention and end-of-life manoeuvring to limit the residual permanence in the most crowded regions of space, are able, in low earth orbit, to stabilise, and then progressively reduce, the number of objects larger than 10 cm. However, the final outcome critically depends on the

The Need for Situational Awareness: European Space Comes of Age

by Richard Crowther

Europe already has a number of systems in orbit which provide communications and Earth observation as an operational service, but it will be the advent of the Galileo navigation system which signals Europe's entry into the major league of space-farers along with the United States of America (USA) and the Former Soviet Union (FSU). In the same way that the Ariane launch vehicle guarantees that Europe has independent access to space, the need to ensure the integrity of systems such as Galileo will require that Europe has an independent space situational awareness (SSA) capability.

Space surveillance forms the basis of SSA and is the ability to track and understand what exactly is in orbit from either space or from the ground, and is key to ensuring the free and effective use of space and for monitoring space treaty compliance. As the spatial density of objects in orbit increases, protected regions are being created around the geostationary region, in low Earth orbit, and are being considered in medium Earth orbit. There is increasing pressure to remove objects from these regions at the end of their operational life but limited ability to measure compliance. SSA protects assets (and their associated services) by providing warnings of potential hazards, natural or man-made, unintentional or deliberate, in a timely manner to allow preventative actions to be taken. A particular example is conjunction analysis seeking to determine potential intersection of trajectories between tracked objects, and taking avoidance measures if necessary (and possible).

SSA will be needed to achieve the levels of mission assurance required to deliver and maintain a safety critical service such as that envisaged from the Galileo system as it allows the cause of an anomaly encountered in orbit to be assessed on the basis of informed judgement rather than just surmise. It is important to be able to differentiate between natural phenomena and a hostile action seeking to deny service and thus space weather monitoring is another key element of space situational awareness. The USA recognised the importance of SSA early in the development of its own comprehensive space infrastructure and is manifested in the form of US Space Command with its mission to protect the USA through the control and exploitation of space. The USA is determined to preserve its asymmetric advantage in space to such an extent that the US Air Force is now taking the further step of planning to field defensive and offensive space systems to protect US satellites against enemy assault and to disable those of a potential adversary. Even without Galileo, Europe is becoming increasingly reliant upon space-based resources that provide high-speed data and voice communications, navigation, and weather data. These assets represent many billions of euros worth of public and private investment and play a key role both in national economies, European prosperity, and wealth creation, and such resources need to be protected. These same capabilities underpin growing European military dependence on space and along with intelligence gathering, surveillance, and reconnaissance functions represent a key element of future European cooperation in defence and security. Europe has a choice, it can develop a situational awareness capability either unilaterally or through cooperation which its international partners. Europe's long standing partnership with the USA in the fields of human spaceflight, solar system exploration, and space and Earth sciences has proven extremely valuable. The recent agreement between Russia and Europe in bringing the Soyuz launcher to the Guyana Space Centre and the commitment of China to the Galileo programme demonstrate other potential axes that could be further developed. Whichever route Europe chooses to follow, it needs to establish its SSA requirements now and to examine the potential options for fulfilling its obligations and ambitions. A system such as Galileo without SSA is not sustainable in the longer term and without a SSA capability, Europe will effectively be flying blind in space.

Links:

Orbital Debris: A growing threat to space operations, Crowther, R., Phil. Trans. R. Soc. Lon. A (2003) 361, 157-168

Space Junk: protecting space for future generations, Crowther, R., Science, Vol. 296, p1241-1242 (2002)

break-up models adopted. In certain cases, the low earth orbit population of objects larger than 10 cm is growing, though slowly, even in the mitigated scenarios, and the long-term onset of an exponential growth cannot be avoided, unless old abandoned spacecraft and rocket bodies are actively de-orbited (a prospect prohibitively expensive with the limits of existing technology).

Figure 1 shows the long-term evolution, below the altitude of 2000 km, of the number of objects larger than 10 cm, according to different mitigation scenarios investigated with SDM. Each line was obtained by averaging twenty Monte Carlo runs. The reference case is characterised by the current launch activity, taking into account the phasing out of obsolete launchers and the introduction of new rocket families. Mission-related objects are released according to present practices, while break-up prevention measures are progressively introduced, leading to no more explosions after 2030. In the increased scenario the number of space launches is augmented by 1% per year. In MIT_1 no mission related object is released after 2020, while in MIT_2 through MIT_5 the satellites launched after 2010 are manoeuvred at the end-of-life, in order to reduce their residual permanence in low earth orbit to 75, 50, 25 and 0 years, respectively.

At present, in the framework of a fourth ESA contract (2004-2007), SDM is undergoing broad and profound changes, in terms of overall concept and architecture, trajectory propagators, collision risk evaluation and debris mitigation options, to be better suited for investigating high earth orbital regimes, in particular those associated with high eccentricity orbits and with navigational and geosynchronous satellites. The technical manager of this contract is Alessandro Rossi, Carmen Pardini and Luciano Anselmo are work package leaders. The ESA technical supervisor is Rüdiger Jehn, of the European Space Operations Centre in Darmstadt, Germany.

Links:
http://www.iadc-online.org/
http://www.unoosa.org/pdf/reports/ac105/AC105_720E.pdf

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The Threat of Space Debris and Micrometeoroids to Spacecraft Operations

by Frank Schäfer

The historical practice of abandoning spacecraft and upper stages at the end of mission life has allowed roughly 2 million kg of debris to accumulate in orbit. The debris with sizes ranging from micrometers to meters poses a threat to current and future space missions. In addition, spacecrafts are constantly impacted by micrometeoroids. As a result of extremely high relative impact velocities, millimeter-sized particles can penetrate spacecraft structure walls and severely damage or destroy spacecraft components. Potential outcomes of such encounters in orbit range from temporary perturbations of spacecraft operations to termination of the mission.

To date, there are roughly 9,000 catalogued objects in orbit with a size larger than 10 cm (Figure 1), of which only about 600 are functioning satellites and the remaining ca. 8,400 classified as space debris. Most of the Space Debris mass consists of non-functional satellites and upper stages of launchers. The majority of millimeter- and sub-millimeter-sized debris particles were generated through one of the ca. 170 explosions that have been registered up to now. Such explosions can be caused by spontaneously triggered combustion of residual amounts fuel in upper stages or by overcharged batteries. The micron-sized debris particles mostly stem from the combustion products of solid rocket motor firings and fragments of varnish. The encounter velocities between space debris and spacecraft in low earth orbits are in the range up to about 15 km/s, which corresponds to head-on collisions. Micrometeoroids can have much higher impact velocities, depending on their origin. Even tiny particles possess considerable kinetic energies as a result of the very high impact velocities.

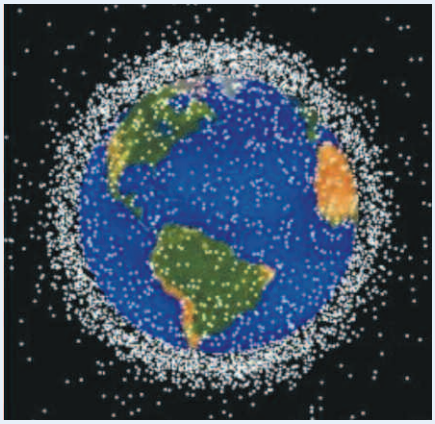

Figure 1: Catalogued Space Debris particles in low earth orbit.

The Effects of Hypervelocity Impacts on Spacecraft

Hypervelocity impacts can affect spacecraft in various ways. Micron sized particles can degrade sensitive spacecraft surfaces and equipment, like mirrors and optical sensors. Larger particles with sizes ranging from tens to hundreds of microns can penetrate coatings and foils as well as solar cells. Damage such as this has been observed on satellite surfaces returned to Earth (LDEF, HST solar arrays, EURECA) and on the windows of the U.S. Space Shuttle which have been replaced many times due to impact damage. Millimeter-sized parti-

cles can penetrate satellite structure walls or shielded walls of manned spacecraft, posing a serious threat to equipment, astronauts, or both. To reduce the destructive effects of impacts, all modules of the International Space Station have debris shields to defeat sub-cm objects. Impacts of such large particles may also induce considerable changes in the satellite's attitude through transfer of momentum. The impact of centimeter- or decimeter-sized particles will typically lead to complete destruction of important spacecraft parts or even to disintegration of the spacecraft. Prominent examples of collisions involving large fragments with spacecraft are the 1996 collision between the French CERISE military satellite and a 1 m fragment that was generated from the explosion of an Ariane 4 upper stage 10 years prior, and the 2005 collision between an American Thor rocket motor with a large fragment of the third stage of a Chinese CZ-4 launcher. Many satellites and manned space-stations are known to have performed collision avoidance manoeuvres with catalogued Space Debris parts, such as ESA's ERS-1 and ENVISAT satellites, the U.S. Shuttle, the MIR station and the ISS, to name only a few. Besides the effects of structural damage, every hypervelocity impact generates metal vapour plasma that can result in electromagnetic interference or result in plasma-induced discharges: The European Space Agencies' (ESA) OLYMPUS communication satellite may have failed as a consequence of hypervelocity impact of a Perseid meteoroid in 1993.

Experimental Investigation of the Vulnerability of Spacecraft Equipment

Consequently, measures to protect spacecraft against space debris are being investigated all over the world. Most of the studies concentrate on reducing the vulnerability of spacecraft by introducing external shielding. These studies ignore the intrinsic impact protection capability of the equipment under consideration. To overcome this shortcoming, ESA funded work to investigate the vulnerability of satellite equipment to hypervelocity impacts and the corresponding equipment failure modes (ESA contract 16483, Michel Lambert). The considered equipment was fuel and heat pipes, pressure vessels, electronics boxes, harness, and batteries. All equipment was placed behind aluminium honeycomb sandwich panels (Al H/C SP), representing the typical satellite structure wall. The impact experiments were performed at Fraunhofer Institute for High-Speed Dynamics - Ernst-Mach-Institut - in Freiburg, Germany, under the supervision of Robin Putzar, using their powerful two-stage light gas gun accelerators to simulate experimentally hypervelocity impacts of Space Debris particles in a laboratory environment. Cooperating partners were QinetiQ of Farnborough, UK (Hedley Stokes), and OHB-System AG in Bremen (Rolf Janovsky, Oliver Romberg). One novel aspect of this project was that the equipment was evaluated in its normal operating mode, thus being highly representative of actual spacecraft operation. In the following sections, some results of impact tests on operating harnesses and computers placed behind typical satellite structure walls are provided and discussed.

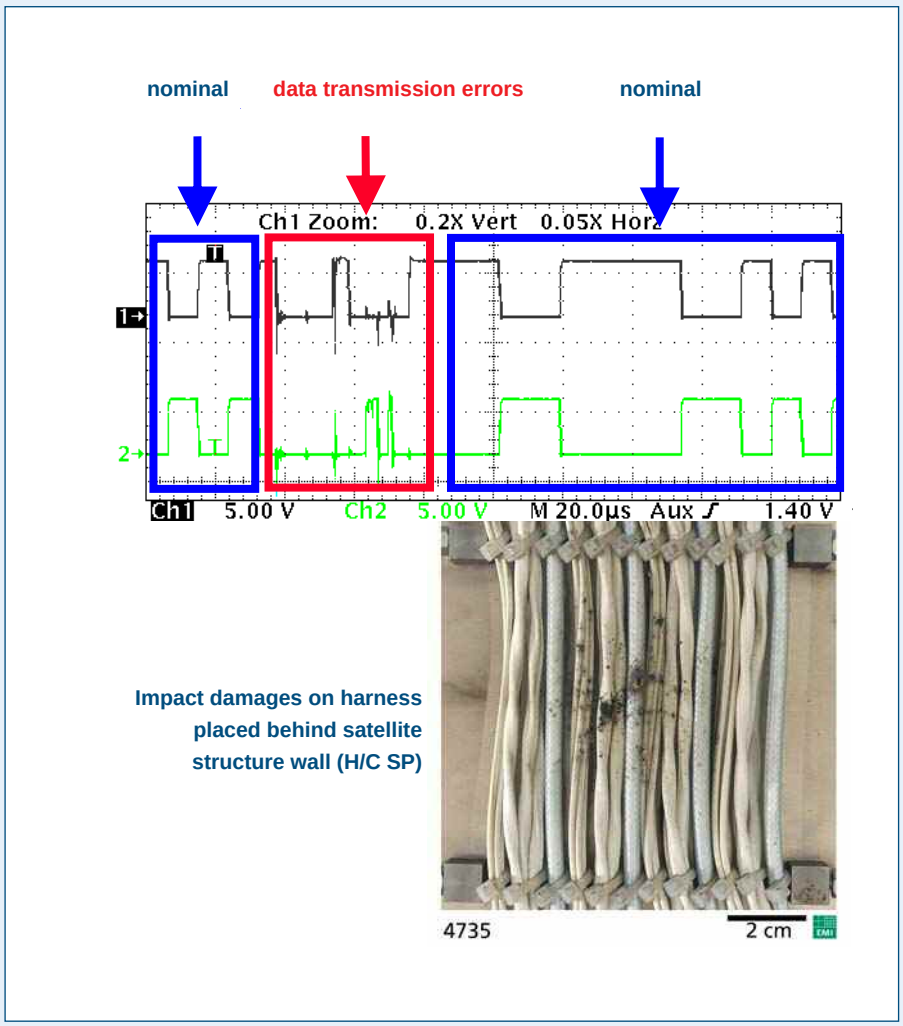

Figure 2: Temporary errors in data transmission encountered during impact on satellite harness.

Investigation of Data Transmission Degradation within Electrical Harnesses

The main function of harnesses onboard satellites are power distribution and data transmission. Harnesses onboard spacecraft are typically arranged in bundles and can be routed through several paths throughout the spacecraft. Electrical harness can claim large areas at the inner surfaces of the satellite structure wall. On a typical spacecraft, the total weight of harness can amount to several percent of the overall spacecraft weight. Harnesses primarily are critical due to the fact that they are often located just behind the satellite structure wall. An impacting particle which penetrates the spacecraft structure may endanger

unprotected harness, since the impact fragments are dispersed into a 'spray cone' that may hit and severely damage large parts of unprotected harness. Each harness submitted to hypervelocity impact testing consisted of several operating power- and twisted-pair data cables, and one radiofrequency (RF) line, transmitting a 9.35 GHz signal. An example of data transmission measurements is shown in Figure 2, where the differential transmission method is used. As can be seen, there is temporary data transmission errors during several tens of microseconds, followed by nominal operation of the cables at later stages after the impact again. Larger impact energies can lead to more violent impact damages that can cause longer temporary perturbations up to permanent failure of operation e. g. the severing of cables. It is to be expected that such damages lead to a functional deficiency of the entire spacecraft.

The larger the stand-off between structure wall and harness, the lower the probability of failure is. Therefore, if it is feasible, harnesses should be moved away from structure walls. If additional spacing cannot be realised, wrapping the harness in a moderate amount of protective fabrics, such as Nextel or Kevlar, should improve dramatically the protection performance. NASA has followed such procedures successfully for ISS harnesses routed outside the manned modules.

Study of Hypervelocity Impact Influence on Spacecraft Computer Operations

Computer boxes are needed for on-board data processing/handling (OBDH), control-, monitoring-, telecommunication (TC), telemetry (TM), avionics and payload equipment. A share of 20%-40% of a satellite bus volume consists of computers. Computer boxes contain Printed Circuit Boards (PCB) with analogue and digital components, capacitors, inductors, resistors, and micro-chips, which are enclosed in a milled aluminium box with a thickness of about 2 mm for electromagnetic compatibility and radiation shielding reasons. The criticality of electronic hardware is slightly reduced by the fact that most electrical components are redundant. Moreover, the delicate electronics are shielded passively by their own housing. However, the complete failure of an e-box will result at least in complications until the redundant system has taken over, if a redundant system exists. Otherwise failure of an e-box could mean the loss of a complete subsystem, ie, the OBDH, TC, TM, with potentially catastrophic consequences for a mission. During the hypervelocity impact tests, the computer-boxes were operating in what is considered normal mode, performing basic read- and write-operations. The observed failure modes were temporary failure and permanent failure. The temporary failures caused interruptions in the operation of the processor, followed by nominal operation a few milliseconds later. The reason for temporary failures is assumed to be related to conductive penetrating dust-like fragments causing transient shorts. Any temporary failure ie, temporary loss of operational performance of electronic components may manifest itself to the systems operator as an in-flight anomaly. Such in-flight anomalies, including faulty data transmission and 'ghost commands', have been reported by spacecraft operators and may possibly be explained by hypervelocity impacts. The permanent failures manifested as sudden loss of supply voltage or loss of nominal operation of the computer. In Figure 3, a PCB with severe impact damages (memory chip and resistors + capacitances removed, deposits of metallic spray in various locations) and the corresponding CPU signals are shown.

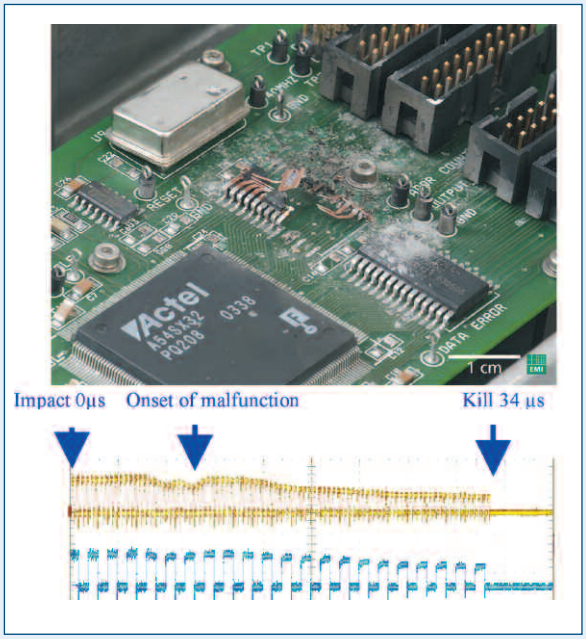

Figure 3: Degradation of computer performance followed by cease of operation shortly after encounter of the hypervelocity particle.

This study was a first step towards a better understanding of vulnerability of spacecraft equipment to hypervelocity impacts. Still, considerable efforts need to be made especially in the experimental area to generate a comprehensive picture of all effects related to the vulnerability of spacecraft equipment to hypervelocity impacts. However, the investigations performed have already led to a drastic enhancement of knowledge that can now be exploited by spacecraft designers. Amongst others, the work performed can be used by spacecraft operators to possibly provide explanations for unexplained malfunctions of equipment operations in satellite missions.

Links:

ESA website: http://www.esa.int

Fraunhofer EMI:
http://www.emi.fraunhofer.de

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Characterizing the Local Instability of Orbits in Broad Parameter Spaces

by Juan C. Vallejo and Miguel A.F. Sanjuán

Nonlinear dynamics and chaos are present in many fields of astrodynamics. Computation of distributions of finite time Lyapunov exponents provides valuable information on the local stability of the orbits. When dealing with huge sets of model parameter values, Grid-based techniques make such explorations faster than common techniques.

After the three-body problem was demonstrated to be non-integrable in 1887, the fully analytical approach to orbital dynamics problems was replaced by a time-series approach and the search for limited sets of orbits of particular interest. In the last century, the numerical approach has gained in relevance with the increase in computational facilities. Methods derived from chaos theory, born from a topological approach to this problem, have enjoyed a similar rate of progress. Today, nonlinear dynamics techniques are quite useful in real problems where chaos is present and both stable and unstable orbits must be considered.

A basic method for understanding the dynamics of a given potential is to search several types of existing invariants. Fixed points are first located and characterized, and the associated periodic orbits are then explored. These are considered to be the basis of the observed dynamics, as Poincaré noted in the case of the three-body problem. Their stability properties give an insight into their neighbourhood, since stable orbits are generally surrounded by quasi-periodic ones, and unstable periodic orbits by chaotic ones. This apparently simple scheme is not always straightforward to follow, as the complexity of high-order orbits rapidly confuses the situation. One useful and widely used approach is to compute the invariant tori and invariant manifolds. Another (complementary) approach is to compute orbital stability indicators, such as the Lyapunov exponents, the Rotation Index, the Smaller Alignment Index (SALI) or the Mean Exponential Growth Factor of Nearby Orbits (MEGNO).

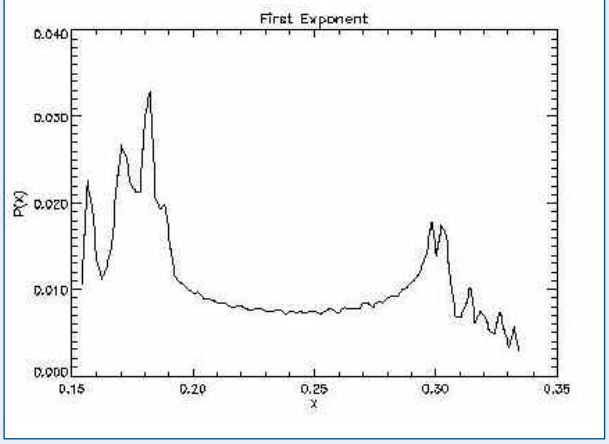

Figure 1: Local Lyapunov exponent distributions can characterize a given orbit. In this figure, a quasi-periodic orbit distribution shows the peaks associated with the Poincaré cross-section tori islands.

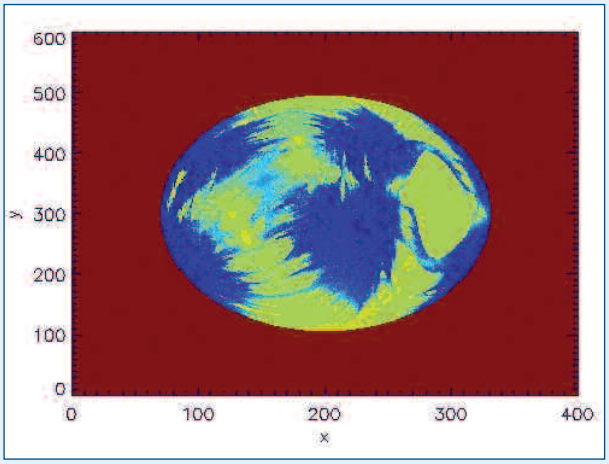

Figure 2: When plotting Lyapunov exponents for given initial conditions, fractal structures are created and destroyed depending on the model parameter values, showing how stable and unstable regions are mixed in a complex way.

The ordinary Lyapunov exponents describe the evolution in time of the distance between two nearly initial conditions, and are quite simple to compute independently on the number of degrees of freedom of the problem. A main disadvantage is their slow convergence towards the final value as they are defined as a limit when time tends to infinity. In practice, all calculations are performed numerically, finite times are used, and only approximated values are obtained. But these finite time integrations provide information on the transient dynamics that may occur during relevant time scales, and this may in itself be of interest.

When computed during finite intervals, the Lyapunov exponents are named finite time Lyapunov exponents. When the time interval is reduced to an arbitrary small quantity, they are known as local Lyapunov exponents. These values capture the very local orbital behaviour of the dynamics, and their distribution characterizes it. Our work in the Nonlinear Dynamics and Chaos Group at the Universidad Rey Juan Carlos in Madrid, is focused on analysing certain potentials through the usage of these finite time indicators.

We wanted to explore a huge set of initial conditions and model parameter values, using standard computational resources rather than cutting-edge computers. Grid-based technologies were therefore used, meaning that the required computational runs were divided into small sets to be executed in different available computational resources. These computers reside virtually in the same organization/project, but physically can be in different places and organizations. Grid projects are based on sets of computers that use a Grid Engine such as SGE, Condor or MPI, receive the computational requests, process them, and return the results using a common protocol (usually Globus as de facto protocol). The user, through the Globus layer, or typically through the usage of a friendlier layer such as Condor-G, GridWay or Nimrod, can send the requests, monitor them, or transfer the computations to selected sets of computers.

The key driver for our project at URJC is to reuse existing algorithms and computational tools in a Grid environment. Each computational run is based on the integration of one initial condition with a well-known Runge-Kutta(-Fehlberg) integrator scheme. The local Lyapunov exponent distribution is calculated and saved. We repeat this for several conditions and parameters. Using GridWay, the Grid interface has been easy to implement. A set of shell scripts feed the integrator with the proper set of initial conditions, parameter values and data identifiers. These scripts also include the GridWay commands for submitting the jobs and receiving the results. GridWay executes them in the remote machines in a user-transparent way. This wrapper strategy can be used for facing different problems and potentials with only minor modifications.

Links:
http://www.escet.urjc.es/~fisica/
http://www.gridway.org

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Orbit Computations in H.M. Nautical Almanac Office

by Don B.Taylor

Her Majesty's Nautical Almanac Office (HMNAO) is part of the Space Data Division of the Space Science and Technology Department at the Rutherford Appleton Laboratory, UK. HMNAO publishes a number of books on astronomical and navigational subjects. The principal publications in these fields being The Astronomical Almanac (AsA) and The Nautical Almanac respectively, which are joint publications with the U.S.Naval Observatory. However, The Nautical Almanac is almost entirely a production of HMNAO whereas The Astronomical Almanac is prepared by both offices.

The AsA gives information on a host of different topics in astronomy. From fundamental data such as phenomena (eg Moon's phases, eclipses, principal occultations, sunrise and sunset times etc.), time-scales and coordinate systems (eg calendar, precession, nutation, apparent place reduction etc.) to stars and stellar systems (eg lists of bright stars, variable stars, bright galaxies etc.).

A large portion of the book contains ephemerides and other information such as orbital elements and phenomena on solar system bodies. These include data on the Sun, planets, minor planets, satellites and comets.

An ephemeris is a table of calculated positions of a celestial object with the time as argument. To produce an ephemeris an analytical theory or a numerical integration of the body must be fitted to observations made of that body over a period of time. This is a major undertaking, for example in producing planetary ephemerides. Often different types of data and quality (eg photographic, CCD, spacecraft etc.) must be reduced in the orbit determination which adds considerably to the complexity of the fitting process. In the Astronomical Almanac the planetary ephemerides are from the Jet Propulsion Laboratory, U.S.A. The ephemerides for the larger minor planets in the Astronomical Almanac have been determined by J.L.Hilton at the U.S.N.O. Almanac Office. For ephemerides of the different satellite systems several authors have worked in this field. An important contribution to this subject has been made by HMNAO.

Since the 1960's researchers in HMNAO have formulated satellite theories and fitted them to observations they have made in addition to published data. The theories used in the AsA of the two Martian satellites and the eight major satellites of Saturn were derived in HMNAO. A series of CCD observations of the five major satellites of Uranus made on La Palma in 1990-1991(Jones et al (1998)) were analysed by numerical integration (Taylor(1998)). The integration was fitted to observations in the time interval April 1977 to October 1995, which includes some of the best quality photographic data, the Voyager astrographic data, CCD data and meridian circle observations. Physical parameters of the system such as the satellite masses and dynamical flattening of Uranus were determined. The La Palma data was one of the most accurate ground-based

datasets. Research into improving the orbits of the Uranian satellites is continuing.

The data given in the AsA on natural satellites is primarily for identification and for observation planning purposes. To aid in this, phenomena for the major satellites are given. This includes greatest western and eastern elongations and superior and inferior conjunctions. To facilitate these computations, from planet and satellite positions, offsets of the satellite are computed as seen in the plane of sky. These are sometimes termed differential tangent plane coordinates. From these coordinates over short intervals of time mixed functions of secular and periodic terms were fitted in which coefficients of the terms are determined (Taylor(1995)). The precision of the approximating function in each case being about 0.01". Offsets for a year can easily be represented by sets of these coefficients. From these, algorithms are set up to compute satellite phenomena (Taylor and Sinclair (2003)).

Mixed functions have been derived for the two Martian satellites, four Galilean satellites, eight major satellites of Saturn, five major satellites of Uranus and the largest satellite of Neptune. For the Galilean satellites the phenomena in the AsA are computed by the Bureau des Longitudes. The remaining major satellites, phenomena in the AsA is computed using the mixed functions representation of the satellite orbits.

The mixed functions representation of satellite differential coordinates gives a compact form for the orbits and is particularly suitable for setting up data on the web and for animations and other graphical output. Ephemerides of several of the major satellites are now given on The Astronomical Almanac Online at http://asa.nao.rl.ac.uk and http://asa.usno.navy.mil. The phenomena and website data based on the mixed functions is computed at the U.S.N.O. Almanac Office.

The AsA gives osculating elements for periodic comets returning to perihelion for the year of publication. These have been determined by B.G.Marsden at the Smithsonian Astrophysical Observatory. From a numerical integration with starting conditions from these elements and perturbations from the nine planets, tracks of the comet on the night sky can be drawn to help in locating the comet. This work is in progress and will appear on our website.

Links:
HMNAO: http://www.nao.rl.ac.uk/

Astronomical Almanac Online:
http://asa.nao.rl.ac.uk

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Large-Format Science-Grade CMOS Active Pixel Sensors for Extreme Ultra-Violet Space Science

by Helen Mapson-Menard and Nick Waltham

The Imaging Systems Division at the Rutherford Appleton Laboratory are developing science-grade CMOS Active Pixel Sensors (APS) for future space science missions. Recent work has included successful testing of back-thinned devices, and the production of a new test APS chip.

Charge Coupled Devices (CCDs) are the current detector of choice for most scientific space instruments, for X-rays to infrared radiation. CMOS sensors promise significant advantages over today's CCD technology. Firstly, modern CMOS processing enables smaller pixels than current science-grade CCDs, permitting more compact and lower mass instruments. Secondly, on-chip integration of the readout electronics minimises the size, mass and power requirements for ancillary control electronics and the associated problems of space-flight component procurement and radiation tolerance. Finally, deep sub-micron CMOS technology promises significantly higher radiation tolerance in the space environment compared to CCDs.

Our goal is the development of a large-format CMOS sensor with useful sensitivity in the extreme ultra-violet (EUV), for solar spectroscopy and imaging on ESA's Solar Orbiter. Our CMOS APS development programme has been funded through a PPARC Rolling Grant to the Space Science and Technology Department at the Rutherford Appleton Laboratory.

We have developed a 4k x 3k pixel sensor with 5μm pixels fabricated on a 0.25 μm CMOS imager process. At EUV wavelengths the absorption depth in silicon is so shallow that the oxide layers on front-illuminated CMOS sensors absorb the photons before they reach the

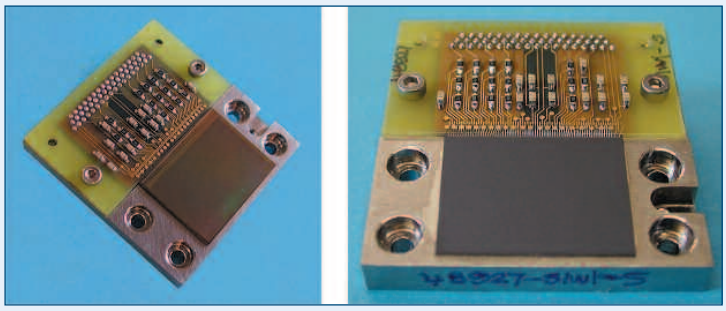

Figure 1: A 4k x 3k CMOS APS (left), with a back-thinned version (right).

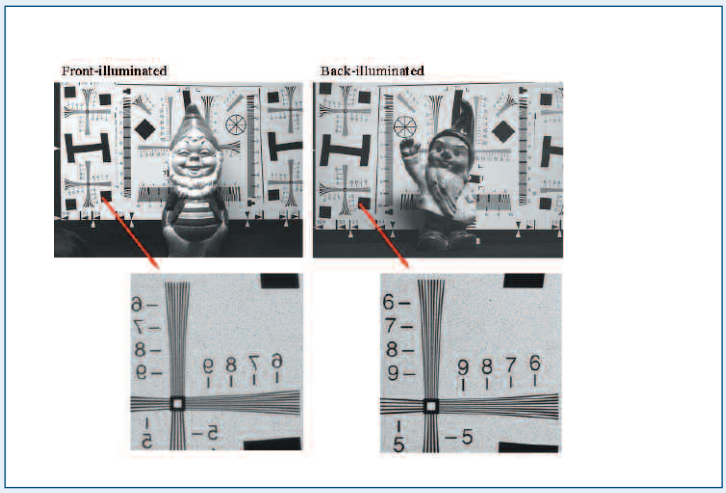

Figure 2: Test images from front and back illuminated 4k x 3k sensors.

photodiodes. Our route to EUV sensitivity relies in adapting the back-thinning and rear-illumination techniques first developed for CCD sensors. Wafer samples of our APS have been thinned by e2v technologies with the aim of obtaining good sensitivity at EUV wavelengths.

Figure 1 shows a photograph of two 4k x 3k sensors, one original sensor and one back-thinned. Each sensor is mounted on an invar block, and wire-bonded to a small printed circuit board (PCB) that carries ceramic decoupling capacitors for the power and DC bias supplies, and termination resistors for the LVDS clock receivers. A 51-way micro-D connector soldered to the underside of the PCB provides the connections interface.

The 4k x 3k APS chips were successfully tested with front and back illumination, from 200 nm to 1000 nm. Test images obtained from both front and back illuminated sensors are reproduced in Figure 2. Both were obtained with sensors cooled to 273 K. The front illuminated image was taken in white light, whereas the back-illuminated image was obtained through a 50 nm wide narrow-band filter centred at 350 nm and an infrared blocking filter. It is important to note that the back-illuminated sensor would not be expected to work well at long wavelengths, because photons penetrate sufficiently to create electrons within the readout electronics rather than in the substrate from where they are collected by the photodiode. We have yet to attempt detailed characterization of the MTF performance of the back-illuminated sensor, but we have determined that the resolution is not significantly degraded compared to the front-illuminated sensor.

The next development is a test structure consisting of six arrays of 512 x 512 10 µm pixels. Each of the arrays has been given a different pixel design to allow verification of our models, and our progress towards optimizing a design for minimal system readout noise and maximum dynamic range. These sensors are also being back-thinned by e2v technologies for characterisation at EUV wavelengths. Once the test structure has been characterised, a new CMOS APS will be developed and back-thinned with the optimal pixel design for Solar Orbiter specifications.

Links:

RAL Imaging Systems homepage:
http://www.sstd.rl.ac.uk/Divisions/Imaging_Systems.htm

e2v technologies homepage:
http://webteam.org.uk/

ESA Solar Orbiter page:
http://sci.esa.int/science-e/www/area/index.cfm?fareaid=45

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Articles in this Section

Processor Architectures

A Novel Processor Architecture for Efficient Conditional Processing: Accelerating the Von Neumann Machine

by Jan van Lunteren

Traditional general-purpose processors seem finally to have reached their limits. The substantial performance improvements achieved year after year over the past decades are diminishing as processor technology approaches physical limits and has to deal with growing power consumption. The tough requirements of several emerging applications now call for rethinking fundamental aspects of the processor architecture that have existed for almost half a century.

At the IBM Zurich Research Laboratory, we have started a research project that examines whether there are opportunities for novel processor concepts which deviate from the traditional 'Von Neumann' processor architecture. The objective of this project is to realize a new type of programmable coprocessor that is optimized for applications that run into performance problems when being executed on a conventional processor. The initial focus is on tasks that operate on streams of data such as XML processing, pattern-matching (eg, for spam filtering), compression and encryption. One of the main focal points is to optimize the handling of conditional branches, which is an important factor affecting the performance of state-of-the-art, deeply-pipelined and superscalar processor architectures, as this directly influences the fill rate of the pipeline and execution units.

In a traditional 'von Neumann' processor architecture, instructions are identified and selected for execution based on their memory addresses using a program counter. Because the program counter is incremented by default after the execution of each instruction, the basic "instruction execution flow" is sequential in nature and is usually only changed by branch, procedure-call and return instructions. This is illustrated in Figure 1(a). Conditional branch instructions can change the instruction execution flow based on the evaluation of typically one simple condition (eg greater than, less than, or equal to). If multiple conditions or a more complex condition (eg "is a given character a legal name character in a given programming language") need to be evaluated, then these have to be translated into a sequence of multiple instructions and conditional branches.

Figure 1(b) shows the new concept in its most general form: a processor architecture in which each instruction is associated with a set of multiple conditions. In each execution cycle, the conditions for all instructions in the current instruction group are evaluated, and the instruction for which all conditions match is selected for execution. If the conditions for multiple instructions match, a priority scheme is applied. Special "branch" instructions allow a jump to a

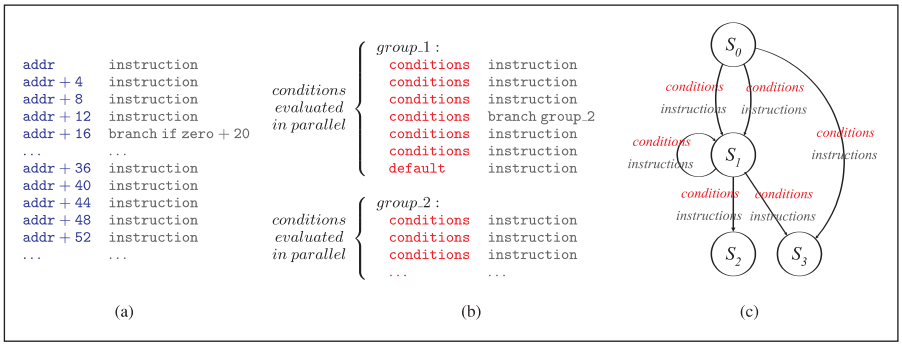

Figure 1: New concept for processor architecture.

different group of instructions. Because the execution of the instructions will typically affect the evaluation of the conditions in subsequent cycles, this will determine the actual instruction execution flow. This is illustrated in Figure 1(c), which shows an example of a specific embodiment of this concept in the form of an enhanced state-transition diagram. This diagram involves numerous potential execution paths, in which the actual path taken during execution of the program is determined by real-time evaluation of the various sets of conditions associated with the state transitions, and the instructions associated with the transitions chosen are selected for execution. (Note that the state-transition diagram shown in Figure 1(c) is small and simple; actual diagrams can be substantially larger and more complex.)

A novel programmable, state-machine technology, called B-FSM (BaRT-based Finite State Machine), has made practical implementations of the concept described feasible for clock frequencies into the gigahertz range. Based on the B-FSM technology, the novel processor concept has already been successfully applied to design prototypes of an XML accelerator coprocessor and a pattern-matching engine for intrusion detection. The latter engine will be capable of matching thousands of patterns simultaneously at processing rates of up to 10 Gb/s for FPGA (Field-Programmable Gate Array) and beyond 20 Gb/s for ASIC (Application-Specific Integrated Circuit) implementations, achieving a storage efficiency that is a factor 10 to 500 better than conventional algorithms. Ongoing research is directed at the design of a common instruction set that enables the coprocessor to be used for a range of applications. Other topics for further investigation are also the programming model and compiler.

Links:
http://www.research.ibm.com/XML/IBM_Zurich_XML_Accelerator_Engine_paper_2004May04.pdf
http://www.zurich.ibm.com/~jvl/

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Human-Computer Interaction

Artificial Characters tested by Patients at Karolinska Institutet

by Marie Sjölinder

KARMA is a joint research project between Karolinska Institutet's department for endocrinology, Mando AB and SICS. The project targets the development of a character-based therapeutic application for eating disorders, such as anorexia.

The application is intended to make the treatment accessible for the patients in their everyday environment, primarily at home, but also at school or at work.

The system consists of several artificial characters with different purposes. The main character answers questions that patients with eating disorders typically ask. The system also provides several leisure activities to distract and entertain, as patients with eating disorders tend to become far too focused on their disease.

This character answers questions that patients with eating disorders typically ask. The character has been designed in collaboration with the patients.

The system is developed using a user-centred, prototype-based iterative process. As a result of these studies, the need of the different characters and their purposes evolved. One of the characters is designed as a kind old man who gives advice. This character has the role of being positive and encouraging to help the patients maintaining their motivation. The other character is designed as a pet for the patients to care for, look after and play with. The aim with this character is to distract the patients from the disease.

The user studies showed the importance of providing a home-like virtual environment for the artificial characters to 'live' in. In fact, this was found to be especially important for this user group, since they often have bad memories of cold sterile hospital environments. The users liked the idea of 'mini-games' providing distraction within the application and even came up with several suggestions of their own. To be able to capture user needs and preferences, several different research methods have been used, for example 'Cultural Probes' when selecting functionalities to enhance motivation and provide distraction, 'Repertory Grid Technique', for appearance, looks and 'personality' of the characters, and 'Wizard of Oz' for dialogue between artificial character and patients. The system has been implemented in the Half-life2 game engine and works to such a level that we can collect dialogue with users through a Wizard of Oz study. These dialogues will provide material for the basis of the final system that will be implemented during the autumn of 2006.

Link:
http://www.sics.se/interaction/projects/karma/

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E-Learning

An Educational Portal: Bridging the Gap among Students, Educators, Parents and Administration

by Constantine Stephanidis, George Margetis, Alexandros Mourouzis and Anthony Savidis

An Educational Portal has been developed to address the needs of the educational community in the region of Crete and to foster the adoption of Information Society Technologies within the Hellenic Educational System. It provides various online community facilities and access to educational resources for supporting collaboration, assistive learning and teaching practices.

The Regional Operational Program of Crete 2000-2006 involves various activities aiming at introducing Information Society Technologies to the educational community in the region of Crete. In this context, the Educational Portal has been designed and developed by FORTH-ICS in collaboration with the Regional Administration of Primary and Secondary Education in Crete, with the main objective to promote the penetration of the Information Society ideals in the Hellenic Educational System, reflecting at the same time the cultural identity of Crete.

This effort addresses a crucial educational challenge, which is to maximize access to the information resources required to improve existing teaching, learning and research practices in education, and aims to establish a technologically aware society. In particular, the Educational Portal of Crete is aimed to:

- bridge the gap among students, educators, parents and administration, in order to increase interactivity and communication and to facilitate collaborative work and research
- enhance students' awareness and exploration of educational resources available in the Web, and thereby create opportunities for the students to increase their learning potential
- increase the use of the Web by students and teachers and thereby foster further adoption of Information Society ideals within the educational community.

Towards achieving the above objectives, the Educational Portal provides to its users the following tools and services:

- *Digital Library*
  Through the Digital Library of the portal, users may gain access to various educational resources as well as to information on the legal framework underlying primary and secondary education in Greece. The provided educational resources include, but are not limited to, articles and publications, tests and exams, teaching instructions and guidelines, and in general useful and practical educational material.

- *Special Interest Forums*
  A number of online communities of special interest can be established through the portal's forum facilities as a means for collaboration and communication among the portal users. Users can propose discussion topics and participate in evolving discussions. Furthermore, the portal provides the ability to certain groups of users to participate in private exchanges of ideas, opinions and experiences.

The Educational Portal's home page.

- *Announcements board*
  This facility allows wide dissemination of latest news and information on educational topics, as well as access to the archives of all past announcements.

- *Advanced search facilities*
  Users can use various search facilities (eg keyword-based, parameter-based) to retrieve information regarding all the available portal content (digital library resources, posted messages, announcements, etc).

- *Administration tools*
  The portal features an integrated content management system for organizing and facilitating the collaborative creation and update of dynamic content. Furthermore, it provides the administration of each school in the region with support facilities for the accomplishment of administration tasks, such as (semi-) automated generation of statistical reports.

In summary, the main beneficiaries of the services provided by the Educational Portal of Crete are:

- *Students and Teachers* - Learning and teaching are highly assisted through the available educational content, while collaboration is enhanced through the communication portal facilities.
- *Parents* - The Educational Portal provides to parents access to information related to educational activities, school contact information, courses curricula and schedules, etc. Furthermore, they have the ability to communicate with other stakeholders

within the local educational community.

- *Administrations of Schools and Educational Services* - The portal provides facilities for the management and structured presentation of information regarding all schools and educational services of primary and secondary education in Crete.

The portal development followed an iterative user-centred approach, taking into account the needs of all stakeholders within the educational community in Crete. During the development procedure, the portal was evaluated by usability experts, as well as by representative users. At the time of preparation of this article, a prototype of the portal has been made available online in order to be thoroughly evaluated by the local educational community. The Educational Portal will be soon launched for public use and made available at http://creteportal.sch.gr.

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E-Learning

eSCM - An Interactive Education and Discussion Platform for Supply Chain Management

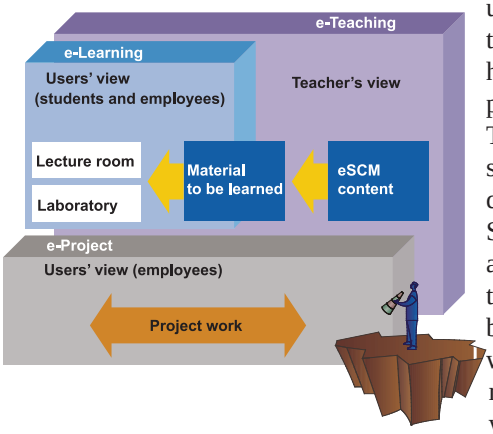
by Zsolt Kemény and Elisabeth Ilie-Zudor

As increasingly complex supply chains and related forms of cooperation emerge in today's industrial production, so does a growing demand for proper education in supply chain management (SCM), both for future professionals and employees of the companies involved. To answer this demand, the eSCM project was launched with the goal of creating an Internet-based e-learning platform for interactive education and discussion of SCM-related topics.

An Internet-based education/training platform in the field of supply chain management, for students, teachers and industrial employees: under this title, with the acronym eSCM, an EU-funded international project of 30 months' duration started in October 2004, within the framework of the Leonardo da Vinci Program. The key activity of the project is the creation of an education, training and discussion platform where future and current professionals could enhance and test their knowledge of supply chain management. Such professionals are students and employees of industrial companies, generally small and medium-sized enterprises, the so-called SMEs. In general, the creators of the platform intend only to extend traditional 'face-to-face' learning methods with distance-learning components. It is envisaged, however, that many current educational practices may impose limits on the efficiency of knowledge acquisition in such a rapidly changing field. These are likely to be discarded.

The platform has a number of significant features. The Internet-based character of the platform makes learning material accessible worldwide, eliminating travel costs and allowing further indirect savings for companies. Since participating institutions are often from different countries, a transnational view of the project is guaranteed. This aligns well with the fact that members of supply chains are increasingly located in different countries and their views of production may reflect different cultural backgrounds.

The freely configurable nature of the courses allows both instructors and students to tailor the learning material according to their specific needs. This addresses a traditional problem faced by participants of rigidly organized courses, in which some materials or knowledge acquired at high costs are never used in practice. As students can select courses according to their preferences, so can teachers personalize their lectures with additional material uploaded to the platform.



Accessing eSCM in its different views.

The platform supports a wide range of tests and examinations, including self-assessment material and interactive games, which allow students to prove their knowledge in a competitive way. Aside from resources directly related to learning, a variety of other means of interaction is provided by the platform. An agenda is used to notify students of activities. Similarly, a blackboard is provided as a means of distributing short messages among registered users of a course. A discussion forum allows interaction within a given field of SCM, where further questions may be asked and open issues discussed. Registered users can also introduce themselves and their fields of expertise by a personal homepage within the framework of the platform.

The SCM-related knowledge represented by eSCM is organized in accordance with the allegory of a 'house of SCM'. Here the foundations of the house are analogous with an underlying infrastructure, the walls and pillars within the building are the participating companies with various layers of function, and the roof depicts the cooperation activities within a supply chain. The model also expresses three layers of interest within

the collaborative production: the supply chain level, the company level and the process level. Key topics to be dealt with in the courses are:

- fundamental issues in Supply Chain Management
- eSCM Reference model
- strategic planning in SC
- tactical planning in SC
- execution in SC
- collaboration methodologies
- event management in SC
- network information management in SC
- IT systems in SC
- SC performance measurement
- business process modelling and analysis of SC
- lessons learnt from a real industrial case.

As for technical realization, the platform relies on Java technology (Tomcat 5.0), following the J2EE (Java 2 Enterprise Edition) standard. This allows it to be executed from a variety of application servers (eg JRun, Bea Weblogic, TomCat, IBM WebSphere). The eSCM platform database supports SQL Server and Access (advised for tests and lowest user loads only). An adaptation to MySQL support is in progress.

The consortium working on the eSCM project comprises five active partners: the project leader SZTAKI, Hungary; the Fraunhofer Institute for Manufacturing Engineering and Automation (FhG IPA), Germany; Politecnico di Milano; Department of Management, Economics and Industrial Engineering (POLI-DIG); and Department of Methods, Technologies and Innovative Didactic (POLIMETID). Also involved are the Università di Bergamo, Department of Industrial Engineering (UNIBG), Italy; and Polytehnica University of Bucharest, Faculty of Engineering and Management of Technological Systems (UPB), Romania. Further members of the consortium are five so-called passive partners – SMEs contributing to the platform's evaluation within their own range of business.

Link:
http://www.e-scm.org

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Control Systems

Design of an Intelligent Traffic-Control System

by István Varga, Balázs Kulcsár and Péter Tamás

Through the project 'Advanced Vehicles and Vehicle-Control Knowledge Centre', the Hungarian National Office for Research and Technology supports the design of intelligent traffic-control systems. The main goal of the project is to interlace technological transfer by connecting universities, research centres and leading industrial partners.

Automotive technologies are gaining ground in modern road traffic-control systems, since the number of road vehicles and passengers is rapidly growing. There is a perpetual need for safety-critical traffic automation, and traffic engineering makes the dynamic or static analysis and the synthesis of automotive vehicle technologies possible. The main goal of engineering is the planning and management of traffic systems.

The project supports the development of reliable and optimal control structures for urban traffic and for motorway systems. The intelligent and cooperative set-up of actuation and its linkage to the central control system is vital for avoiding traffic jams and accidents. Moreover, environmental costs (eg pollution) can be decreased. The control architecture of systemis shown in Figure 1.

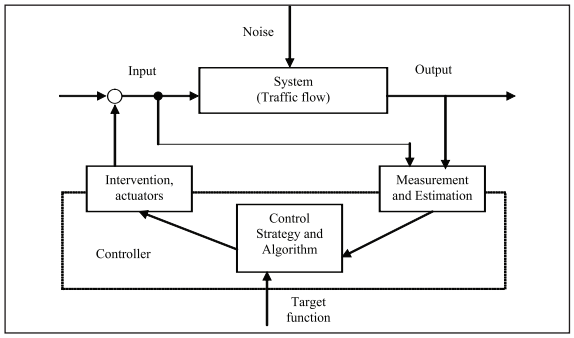

Figure 1: General traffic management and control structure.

One aspect of the project aims at developing a traffic control algorithm for future technology. The design of the traffic control system can be evaluated in two steps – synthesis and analysis. Several models and multiple control strategies exist, and engineers must decide between them using a priori knowledge of the real system. Previously collected information can help to choose the appropriate model, parameters, measurement and control methodologies to create the optimal solution.

Figure 2: Traffic jam.

In many cases, control-related variables are almost inaccessible for design unless estimation techniques are applied. In a situation like this, the approximation, computer-based estimation of the variables could be useful. Traffic simulations can be classified in several ways, including the division between microscopic, mesoscopic and macroscopic, and between continuous and discrete time approaches. The methodologies of static and dynamic analysis of traffic systems are known. Several state variables, derived from the description of the dynamic system, can be used for operational and planning aspects.

A newly emerged area is demand estimation through microscopic traffic modelling. The dynamic aspect of traffic simulation requires previously measured or estimated volumes of traffic. Since the measurement of certain variables in the dynamic description is rather costly, one tries to estimate them. For instance, the observation of constantly varying turning rates at a simple intersection is fairly costly. However, the number of turning vehicles could be applied to traffic light harmonization, or generally speaking to traffic light control.

Some time has passed since traffic issues were first addressed; in fact, traffic lights apparently existed a century ago. When they were first introduced, their purpose was to ensure the safety of people in the traffic, but as time has passed and traffic has become denser, flow-control issues have become important. Nowadays, control algorithms are extremely complicated, and take traffic-dependent light-control architectures into account. Nevertheless, complementary functions exist to augment the intelligence of such systems.

The behaviour of traffic is influenced by two main factors: the control inputs, and the disturbances incurred. The control inputs are directly related to corresponding control devices such as traffic lights and variable message signs. The manipulation of disturbance values is not possible, but in some cases they are measurable (eg demand), detectable (eg incident) or predictable over a certain time horizon. The most challenging issues relate to automatic incident detection, the modelling of uncertainties, providing a solution that offers robustness under external disturbances, the use of variable message signs in order to avoid traffic jams, and finding an optimal itinerary.

The development of an intelligent control structure ensures an optimal solution for all participants in the transportation and road traffic system.

After the first year, the most significant result of the project is the structural analysis of the references. Several comparative studies have been elaborated to create a basis for further research on estimation and optimal light-control systems. In particular, this will include:

- constrained state estimation applied for split rate variable and automatic incident detection
- model predictive control (MPC) technique in traffic light control and harmonization
- modelling and simulation of high complex traffic networks.

Links:
http://www.sztaki.hu/scl
http://www.ejjt.bme.hu

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Stochastic Systems

News from the World of Hidden Markov Models

by László Gerencsér

In the area of Hidden Markov Models (HMM), successful research with a wide range of applications has been performed at SZTAKI by the Stochastic Systems Research Group. Much of the progress is due to recent advances made in the mathematical technology relevant to the analysis of HMMs.

Hidden Markov Models or HMMs have become a basic tool for modeling stochastic systems with a wide range of applications in such diverse areas as speech recognition, telecommunication, radar, nanotechnology, data mining, econometrics and financial mathematics. Spatial HMM processes have also been widely used in biology (DNA sequencing, modeling the spatial structure of proteins, molecular imaging) and astronomy. This research area is a central theme for ERNSI, the European Research Network for Systems Identification, and for the ERCIM Working Group in Control and Systems.

A Hidden Markov Model is characterized by an unseen state process – often a finite state Markov process – and an observation or read-out process – a random function of the state. The read-outs are conditionally independent and identically distributed given the state sequence. HMMs are special stochastic systems in which the transition from state to state, and state to read-out, can be decoupled. An important example is a quantized Gaussian ARMA-process, which arises in microrobotics and mobile communication. Another important example is a Gaussian dynamic mixture.

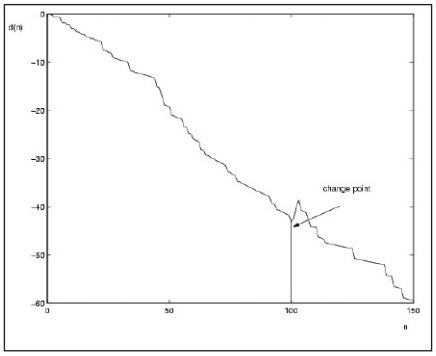
The estimation of the unseen state of a Hidden Markov Model is a basic problem in applications. It requires the estimation of the unknown dynamics of the HMM. A variety of new techniques have been developed in the last decade, with research focused on the analysis HMMs with finite state space and continuous read-outs.

The key partners of SZTAKI in this area have been IRISA/INRIA, Rennes (Francois LeGland), CNR ISIB (formerly LADSEB), Padova (Lorenzo Finesso), CWI (Jan van Schuppen), and ENST (Ecole Nationale Supérieure des Télécommunications, Olivier Cappé). The French-Hungarian collaboration was supported by the Balaton project.

The Stochastic Systems Research Group of SZTAKI launched a PhD project for the statistical analysis of HMMs in 2002

that successfully ended with the defense of Gábor Molnár-Sáska in 2006. The purpose of this research was to extend the scope of a powerful technique used in the analysis of linear stochastic systems. In particular, we have adapted a technique based on the concept of mixing that has been used successfully for a wide range of statistical problems in linear stochastic systems. A major advance stemming from the project was the extension of the constructions used in linear theory to a class of HMMs. A key step in this extension is the use of a smart weak-realization of an HMM via a nonlinear state-space system. A weak realization produces an HMM with statistical characteristics identical to those of the original HMM.

The successful adaptation of mixing techniques has led to a number of powerful results, such as the accurate analysis of performance degradation of adaptive predictors for HMMs, and a lower bound for the performance of adaptive predictors. These results play a key role in the theory of stochastic complexity and change point detection. The efficiency of a Hinkley detector to a binary HMM is shown in the Figure, where the sudden increase of the detector indicates a change around 100, the actual changepoint. Another application of the novel techniques is the analysis of Gaussian dynamic mixtures with state-dependent covariances. The Hungarian collaborators in this project were György Michaletzky (Eötvös Loránd University, Budapest) and Gábor Tusnády (Alfréd Rényi Institute of Mathematics, Budapest).



Real-time change point detection of a binary HMM using a Hinkley detector.

HMMs are widely used in modeling stochastic volatility processes in connection with financial time-series, a well-known special model being the celebrated GARCH model. A PhD project related to the statistical analysis of GARCH models was started by the group in 2003, and continues to progress. The major achievement of this project is the successful adaptation of the theory of Benveniste, Metivier and Priouret to this problem.

Another application of the technology, developed in connection with HMMs, is vision-based tracking. This was the subject of another PhD program launched by the Machine Learning Research Group of SZTAKI, lead by Csaba Szepesvári, with whom we closely collaborate. In this application the posterior density over the state space is typically multimodal. The preferred method is to use particle filters, which can yield very accurate approximations of the posterior. A surprising and counter-intuitive property of particle filters is that their performance quickly degrades as the level of observation noise decreases to zero. They proposed an algorithm called local importance sampling, which overcomes the above-mentioned efficiency problem, and outperforms its competitors in a standard tracking problem. Further applications in data mining are described in ERCIM News No. 63, October 2005 (http://www.ercim.org/publication/Ercim_News/enw63/szepesvari.html).

The current research interests of the group include the analysis of Markovian switching systems, where the read-outs are not static and the unseen states instead control a dynamic system. In addition, a project looking at applications in molecular biology is running in collaboration with the University of Dallas, Southwestern Medical School.

Furthermore, a French-Hungarian collaborative effort began in 2006, with Elisabeth Gassiat, Université Paris-Sud being the French principal investigator. This is supported by the Balaton project.

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Complex Systems

Rigorous Open Development Environment for Complex Systems — RODIN

by Alexander Romanovsky

The RODIN project will create a methodology and a supporting open tool platform for the cost-effective rigorous development of dependable complex software systems and services.

RODIN is a strategic targeted research project which falls squarely within the remit of the strategic objective 'Open Development Platforms for Software and Services' of the IST FP6 second call. RODIN focuses on tackling complexity caused by the environment in which the software is to operate and which comes from poorly conceived architectural structure.

Mastering complexity requires design techniques that support clear thinking and rigorous validation and verification. Formal design methods do so. Coping with complexity also requires

architectures that are tolerant of faults and unpredictable changes in environment. This is addressed by fault tolerance design techniques.

The project is developing a unified methodology combining formal methods with fault tolerance design principles by using a systems of systems approach, where both software and environment are modelled together.

We are tackling complex architectures: our systems approach supports the construction of appropriate abstractions and provide techniques for their structured refinement and decomposition.

The project ensures cost effectiveness, the methods and platform support reuse of existing software. RODIN thus extends existing formal methods with generic mechanisms to support component reuse and composition.

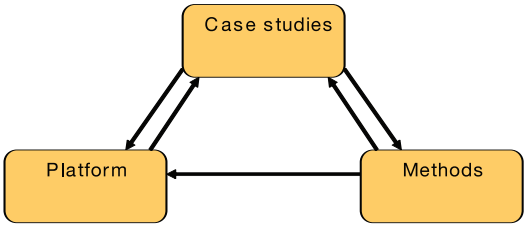
Tool support for construction, manipulation and analysis of models is crucial and we concentrate on a comprehensive tool platform which is openly available and openly extendable and has the potential to set a European standard for industrial formal methods tools.

The methods and platform are validated and assessed through industrial case studies.

The novel aspects of this project are the pursuit of a systems approach, the combination of formal methods with fault tolerance techniques, the development of formal method support for component reuse and composition and the provision of an open and extensible tools platform for formal development. In particular, we believe that the open tools platform will have a significant impact on future research in formal method tools and will encourage greater industrial uptake.

To achieve the RODIN objectives the research and development are being directed by the following criteria:

- The methods and platform should support a systems approach to software development.
- The methods and platform should support the development of systems that are tolerant of faults and unpredictable changes in the environment.
- The methods and platform should support reuse of existing software developments.
- The tools supporting the methods should be integrated on a single platform which should be open to extension by other parties.
- The methods and platform should be properly validated and assessed through industrial case studies.



The interplay between methods, tools and case studies is at the heart of the RODIN plan.

Case Studies

The methods and platform are being validated and assessed through industrial case studies:

- Formal Approaches to Protocol Engineering
- Engine Failure Management System
- Formal Techniques within an MDA Context
- CDIS Air Traffic Control Display System
- Ambient Campus.

The aim is to produce the RODIN methodology for rigorous development of complex systems. To achieve this aim the project is making advances in basic research areas related to system modelling and mapping of models, software reuse, and formal reasoning about system fault tolerance, reconfiguration, mobility and adaptivity.

This includes development of templates for fault tolerant design methods (atomic actions, exception handling, compensation), as well as for reconfigurability, adaptivity and mobility.

An open tool kernel is built as a set of basic kernel tools implemented on a platform that can be extended by plug-ins. Openness and generality of the platform are the primary aim of the development.

The work is being carried out in the Eclipse environment.

RODIN is developing a range of tools to support the application of the RODIN methodology

The overall objective of RODIN leads to the following specific measurable outcomes:

- a collection of reusable development templates (models, architectures, proofs, components) produced by the case studies
- a set of guidelines on a systems approach to the rigorous development of complex systems, including design abstractions for fault tolerance and guidelines on model mapping, architectural design and model decomposition
- an open tool kernel supporting extensibility of the underlying formalism and integration of tool plug-ins
- a collection of plug-in tools for model construction, model simulation, model checking, verification, testing and code generation.

Consortium

The consortium includes:

- University of Newcastle upon Tyne (UK) - Coordinator
- Aabo Akademi University (Finland)
- ClearSy System Engineering (France)
- Nokia Corporation (Finland)
- Praxis Critical Systems Ltd (UK)
- AT Engine Controls Ltd (UK)
- Swiss Federal Institute of Technology Zurich (Switzerland)
- University of Southampton (UK).

Two major RODIN events:

- Workshop on Rigorous Engineering of Fault Tolerant Systems, 19 July 2005, associated with Formal Methods (FME) 2005, Newcastle upon Tyne, UK
- RODIN Open Industry Day, 5 April 2006, Aix en Provence, France.

Link:
http://rodin.cs.ncl.ac.uk/

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Scientific Computing

Global Warming could Destabilize Plankton in Oceans

by Jef Huisman and Ben Sommeijer

Global warming of the surface layers of the oceans reduces the upward transport of nutrients. Computer simulations predict that plankton growth will become unstable when the supply of nutrients is reduced. This may have a negative impact on the food chains of the oceans and on uptake of the greenhouse gas carbon dioxide into the oceans. Scientists of the Universiteit van Amsterdam and CWI (the Netherlands) and the University of Hawaii (USA) presented their results in Nature of 19 January 2006.

Plankton Processes

Plankton plays a key role in the oceans. It forms the basis of the marine food web. Moreover, phytoplankton (microscopically small algae) consumes the greenhouse gas carbon dioxide during photosynthesis. Because the oceans cover more than 70% of the earth's surface, marine phytoplankton is quantitatively important for reducing the greenhouse effect on earth. Phytoplankton growth depends on light and on nutrients such as nitrogen and phosphorus. These nutrients are supplied from deeper ocean layers, and are slowly mixed upwards. In large parts of the oceans, phytoplankton is concentrated at about 100 meters depth. Phytoplankton grows well at this depth, because there is a sufficient supply of light from above and a sufficient supply of nutrients from below.

Stratification of Ocean Waters

However, warm surface layers reduce mixing of the ocean waters. This vertical stratification of the water column is widespread in the oceans. A larger temperature difference between two water layers implies less mixing of chemicals between these water layers. Global warming of the surface layers of the oceans, owing to climate change, strengthens the stratification and thereby reduces the upward mixing of nutrients.

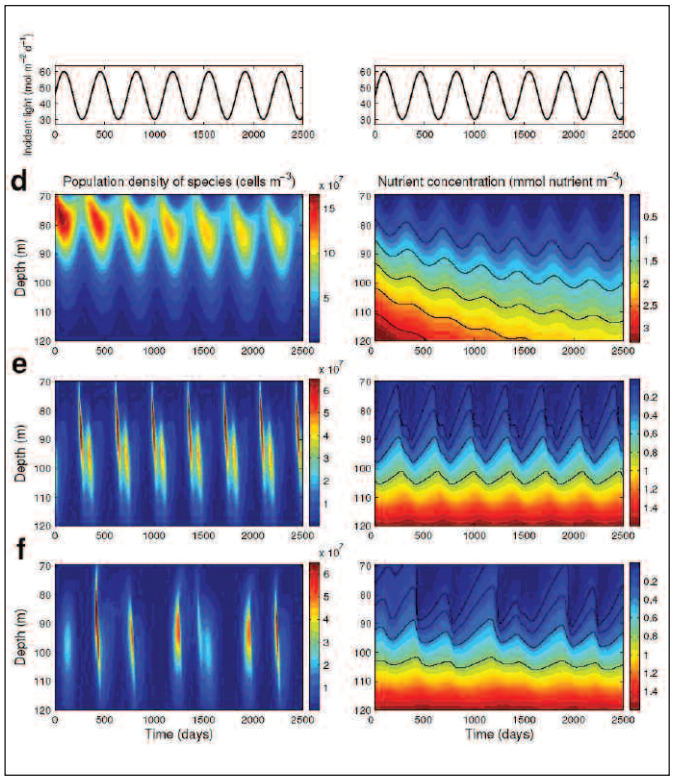

Illustration redrawn from Huisman et al. 2006, with permission from Nature

Figure 1: Model simulations at different intensities of vertical mixing.

To study how reduced upward mixing of nutrients affects the growth of marine plankton, we developed advanced computer simulations. Surprisingly, these simulations predict that plankton populations will show strong oscillations and chaos when vertical mixing of nutrients is reduced (see Figure 1). The model is forced by seasonal changes in the incident light intensity. Different values of the mixing parameter result in essentially different behaviour of the deep chlorophyll maximum (DCM). The top panel of Figure 1 (well mixed situation) shows that the DCM tracks the seasonal variability. The middle panel (moderate mixing) shows double periodicity of DCM locked in a seasonal environment. The lower panel (low mixing) shows a chaotic DCM. In all figures, the left panel shows phytoplankton dynamics; the right panel shows nutrient dynamics.

Picture: University of Hawaii.

Figure 2: Taking a plankton sample in the waters near Hawaii.

This model prediction was rather unexpected, because it contradicts conventional wisdom that deep plankton in the oceans would represent a stable system. Therefore, the scientists compared their model predictions with data from long-term time series of plankton in the subtropical Pacific Ocean (see Figure 2), carried out by David Karl of the University of Hawaii. The subtropical Pacific Ocean is strongly stratified, with a low supply of nutrients into the surface layers. Phytoplankton in the subtropical Pacific indeed exhibits complex population fluc-

tuations, consistent with the computer predictions. These results have recently been published in Nature (19 January 2006) in the article "Reduced mixing generates oscillations and chaos in the oceanic deep chlorophyll maximum".

Mathematical Model and Solution Methods

The new model predictions are based on mathematical simulation of the dynamics of the plankton species and the nutrients in the ocean. The model consists of a set of integro-partial differential equations of advection-diffusion-reaction type. The 'integro'-part in the equations originates from a nonlocal integral term describing the penetration of light into the water, subject to absorption of light by photosynthesizing phytoplankton. The numerical solution of the model was based on a finite volume method, with spatial discretisation of the differential operators as well as the integral term. The advection terms were discretised by a so-called third-order upwind biased formula, the diffusion terms by a symmetric second-order formula, and the integral term by the repeated trapezoidal rule. The resulting system of stiff ordinary differential equations was integrated over time by means of an adapted version of the widely-used computer code VODE (http://www.netlib.org/ ode/) which is based on an implicit time integration method to cope with the stiffness of the system.

Computational advances increasing the efficiency of numerical solutions of the model were essential to analyze these intriguing fluctuations in the phytoplankton as a result of global warming.

The Netherlands Organization for Scientific Research (NWO), the Dutch BSIK/BRICKS project, the American National Science Foundation (NSF), and the Gordon and Betty Moore Foundation supported the investigations.

Links:
http://www.cwi.nl/projects/pdels/Phytoplankton/
http://www.science.uva.nl/ibed/amb
http://hahana.soest.hawaii.edu/hot/hot-dogs
http://www.nature.com/nature

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Multimedia

Characteristic Structures from Videos for Indexing

by Tamás Szirányi

Finding the main actor in a video, or detecting the exact outline of objects in a surveillance video, or registering cameras in arbitrary situations are important tasks in the analysis of videos and indexing of events. These tasks are to be completed without any human intervention in difficult outdoor and indoor situations. At SZTAKI, a project is devoted to developing such new features: segmenting the focused target, outlining foreground objects, shadows, mirroring surfaces and registering cameras.

An automatic focus map extraction method has been developed (Tamás Szirányi, Levente Kovács) using a modification of blind deconvolution for localized blurring function estimation. We use these local blurring functions (so-called point spread functions, or PSFs) for extraction of focus areas on ordinary images. In this inverse task our goal is not image reconstruction but the estimation of localized PSFs and the relative focus map. Thus, the method is less sensitive to noise and ill-posed deconvolution problems. The focus areas can be estimated without any knowledge of the shooting conditions or the optical system that was used. The technique is suitable for main object selection and extraction, tracking in video and in surveillance applications, and indexing of image databases.

A new model regarding foreground and shadow detection in video sequences is shown (Tamás Szirányi and Csaba Benedek, PhD student at the Pázmány Péter Catholic University, Budapest). The model works without detailed a priori object-shape information, and is also appropriate for low and unstable frame-rate video sources. We have introduced three novel features in comparison to previous approaches. First, we have a more accurate, adaptive shadow model, and show improvements in scenes with difficult lighting, colouring effects, and motley backgrounds. Second, we give a novel description for the foreground based on spatial statistics of the neighboring pixel values, which enhances the detection of background or shadowed object parts. Third, we integrate pixel intensities with different colour and texture features in a general probabilistic framework and compare the performance of different feature selections. Finally, a

Figure 1: Examples for focus extraction on images with various textures (top row: input, bottom row: respective focus maps).

Markov Random Field model is used to enhance the accuracy of the separation. We validated our method on outdoor and indoor video sequences captured by the surveillance system at the university campus, and we also tested it through well-known benchmark video shots.

We have developed several methods for registering cameras from arbitrary motions or from biometrics (Tamás Szirányi, László Havasi and Zoltán Szlávik). We demonstrate here an application of our new robust walk detection algorithm based on our symmetry approach, which can be used to extract biometric characteristics from video image-sequences. To obtain a useful descriptor of a walking person, we temporally track the symmetries of a person's legs. In a further processing stage, these patterns are filtered, then resampled and transformed to a subspace with a much smaller dimension of an 'eigenwalk space'. Our method is suitable for use in indoor or outdoor surveillance scenes. Image registration methods are presented which are applicable to multi-camera systems viewing human subjects in motion. Determining the leading leg of the walking subject is important and the presented method can identify this from two successive walk-steps (one walk cycle). Using this approach, we can detect sufficient numbers of corresponding points for the estimation of correspondence between two camera views. This is the case both in overlapping and in a special case of non-overlapping camera configurations.

Figure 2: Different parts of the day in sequences at the entrance of Pázmány Péter Catholic University with segmentation results. Above left: in the morning ('am'), right: at noon, below left: in the afternoon ('pm'), right: wet weather.

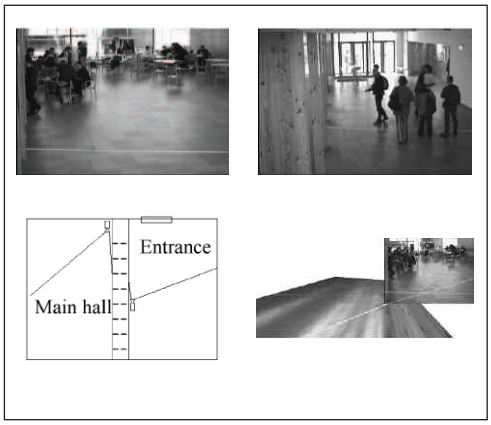

Figure 3: Top: images of the "main hall" and "entrance" (Pázmány Péter Catholic University) cameras with control lines on the ground (marked with two long paper tapes) for verification.
Bottom: on the left a schematic map of the experiment shows the placement of the cameras and their field of views. Right: result of alignment of non-overlapping views with the highlighted control lines.

Our project is partly supported by the Hungarian National Research and Development Program. With this activity, we contribute to the Network of Excellence project run by ERCIM: MUSCLE (Multimedia Understanding through Semantics, Computation and Learning).

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Pervasive Computing

Applying a Model-Driven Method to the Development of a Pervasive Meeting Room

by Javier Muñoz, Estefania Serral, Carlos Cetina and Vicente Pelechano

Scientists at Universidad Politécnica de Valencia are implementing a pervasive system for managing a meeting room. The pervasive system has been developed using a model-driven method, and the final application integrates several technologies like EIB and Web Services. Three different user interfaces are provided for interacting with the system.

Researchers in pervasive systems have developed many software systems which try to achieve the Weiser vision. These systems have been implemented in a completely ad hoc fashion, or using implementation frameworks. Developing a pervasive system following these approaches is a hard and error-prone task. In order to improve the productivity and reduce the number of errors, we have developed a method that applies the Model-Driven Architecture (MDA) and the Software Factories approaches to the development of pervasive systems. The method is based on the specification of the system using PervML, a UML-like language designed for precisely describing the functionality of pervasive systems. The PervML specification is then automatically translated into Java code. The generated code extends an OSGi-based framework in order to build the final pervasive application.

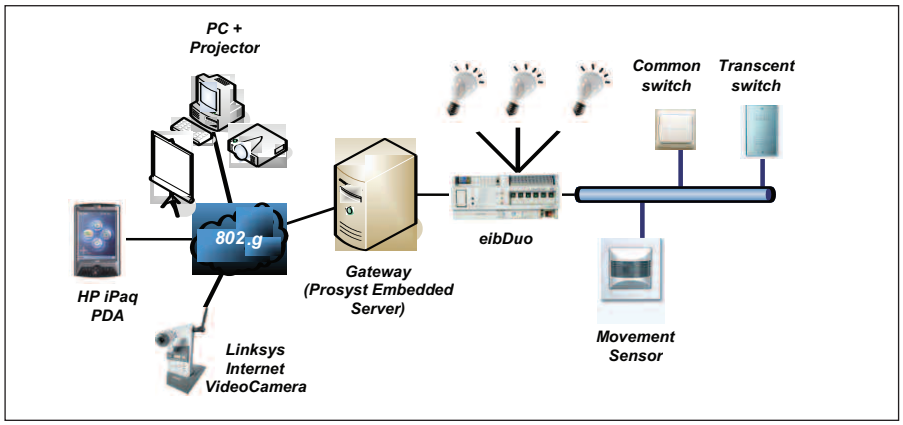

Figure 1: Network structure of the meetings room system.

The application studied here is that of the pervasive meeting room. Such a meeting room would contain features such as lighting management, multimedia reproduction, presence detection and video recording. For instance, when someone is near the projection screen, the intensity of the lightings may be automatically decreased in order to provide better visibility. Security systems may also record what occurs in the room.

In order to develop the system following our model-driven method, certain steps are followed:

- The system analyst specifies the system requirements using the service conceptual primitive. The system analyst uses three kinds of PervML models in order to describe (i) the kind of services available on the system, (ii) the number of services which are available in every location and (iii) how they interact when some condition holds.
- The system architect selects the kind and number of devices or software systems that are suitable for providing the services specified by the analyst. The system architect uses three other PervML models for describing (i) the kind of devices or software systems that are used for providing the system services, (ii) the specific elements that are going to implement each service and (iii) the actions that the device or software systems must carry out in providing each service operation.
- An OSGi developer implements the drivers for managing the devices or software systems. These drivers provide access from the OSGi-based framework to the devices or external software systems. They must be developed by hand, since they deal with technology-dependent issues.
- The transformation engine is applied to the PervML specification. Many Java files and other resources (Manifest files etc) are automatically generated as a result of this action.
- Finally, the generated files are compiled, packaged into bundles (JAR files) and deployed in the OSGi server with the implementation framework and the drivers.

The software that manages the pervasive system has been deployed in a Pentium IV barebone, which runs the Prosyst Embedded Server 5.2 as the OSGi implementation. In order to support the control devices (lights, switches and presence detector), an EIB network has been deployed.

The user interface is a key element in a pervasive system. Users interact with the system using several kinds of devices, so multiple user interfaces must be provided. Currently, we provide three different user interfaces:

- A Web interface for desktop browsers, which can be used by meeting attendees via their laptops or, for instance, by a supervisor in a central control unit.
- A native PDA application, which could be used from the PDAs of the company employees. The client application can be installed in their mobile devices since they interact frequently with the pervasive system, and the user experience is richer than using a Web application.
- A Web interface for PDA browsers, which can be used from the PDAs or other mobile devices of any room user. It is a Web interface with a resolution of 320x240 pixels.

Following the proposed method, the specification of the system functionality is independent of the devices selected for implementing the system. Moreover, the manufacturer-dependent details are isolated in the drivers' layer. With this approach, we can change all the implementation technologies just by replacing the drivers, but from the user's point of view the functionality provided by the pervasive system remains the same.

Link:
http://oomethod.dsic.upv.es

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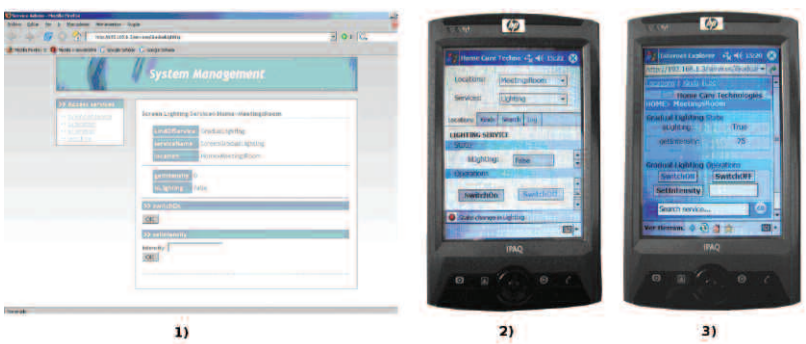

Figure 2: The three user interfaces for managing the pervasive system.

CALL FOR PARTICIPATION

I2CS 2006 - 6th International Workshop on Innovative Internet Community Systems

Neuchâtel, Switzerland 26-28 June 2006

More and more different types of applications have been using the Internet as a large distributed system in the past few years. Many challenging research problems have emerged With this recent development. Solutions to the these problems require multi-disciplinary collaboration between researchers from different fields. The goal of this workshop is to bring together researchers from various areas related to novel Internet Community Systems. Participants will have the opportunity to discuss the current state of the art and identify promising directions for research.

Topics

The scope of the workshop encompasses three complementary aspects of Internet Community Systems: theory, architectures, and information. The topics include, but are not limited to:

- Theoretical foundations and models
- Distributed architectures and applications
- Information and knowledge management

More information:
http://www.i2cs-conference.org

CALL FOR PARTICIPATION

ICIAM07 - International Congress on Industrial and Applied Mathematics

Zurich, Switzerland, 16-20 July 2007

The International Congress on Industrial and Applied Mathematics (ICIAM) is held every four years and is the most important general meeting, worldwide, for applied mathematicians. The Congress covers the full spectrum of research topics in applied mathematics, industrial mathematics and applications of mathematics in industry and scientific disciplines.

The congress celebrates and describes the contributions of applied mathematics - as an intellectual creation in its own right, as a foundation stone of technological development, and as an indispensable collaborative partner for other scientific disciplines.

The Congress is held under the auspices of the International Council for Industrial and Applied Mathematics, an international body consisting of approximately 25 professional applied mathematical societies and mathematical societies with a strong membership of applied mathematicians. Previous meetings have been held in Paris 1987, Washington 1991, Hamburg 1995, Edinburgh 1999, Sydney, 2003.

ICIAM 2007 is hosted by the Swiss Mathematical Society and the community of Swiss mathematicians.

More information:
http://www.iciam07.ch

CALL FOR CONTRIBUTIONS

International Business Informatics Challenge 2006

Student Projects and Case Studies in Business Informatics and Information System

Dublin City University invites bachelor and master students to submit projects and real-live case studies illustrating how technological solutions were developed and applied for effective information systems to solve the business needs of organisations. Selected projects will be published in the competition proceedings. Each participant will receive a free copy of the proceedings. Authors of the best project/case study will be invited to Dublin, Ireland to participate in the Business Informatics Week at Dublin City University 18-22 September 2006with travel and accommodation paid.

More information:
http://www.computing.dcu.ie/europeanmbi/news/challenge06/

CALL FOR PARTICIPATION

EUSEA2006 - Euro-Southeast Asia 2006 Forum on the Information Society

Forging Alliances between Europe and Southeast Asia for ICT Collaboration, Co-operation and Opportunities

Singapore, 19-23 June 2006

Southeast Asia, today, is one of the fastest developing economies in the world - with a GDP growth in 2004 reaching 5.9%. European companies are the biggest investors in southeast Asia, and the European Union is the 3rd largest trading partner in the region. In July 2003, the European Commission adopted a Communication on a 'New Partnership with South East Asia', setting out a comprehensive strategy for future EU relations with the region including a comprehensive regional dialogue on the different aspects of the Information Society, co-operation towards interconnection and interoperability of European Union and South East Asian networks and services and promotion of joint projects for research in ICT and industrial applications in electronic communications.

To support these objectives, DG Information Society and Media is organising with the support of the Association of Southeast Asian Nations (ASEAN) a Euro-Southeast Asia Forum on the Information Society (EUSEA2006) will be held in Singapore from 19-23June 2006.

Viviane Reding, European Commissioner for Information Society and Media, will jointly open EUSEA2006 on June 19th with the Ministry of Information Communication and Arts (MICA) in Singapore.

EUSEA2006 objectives are to offer an open ICT co-operation platform for Southeast Asians and Europeans through business, regulatory and research co-operation and through a policy to strengthen external relations. EUSEA2006 will create ICT exposure between European & Southeast Asian governments, industries, academics and researchers as well as allowing access to the best technological know-how & skilled researchers worldwide.

EUSEA2006 aims to strengthen a broader cooperation approach for the future through a two-day Conference and four-day Exhibition, offering opportunities for:

- an open co-operation platform between key stakeholders from Europe and Southeast Asia
- a policy and regulatory dialogue on ICT
- reinforcing the realization of the World Summit on the Information Society (WSIS) objectives in Southeast Asia
- ICT research co-operation projects between Europe and Southeast Asia.

The EUSEA2006 Conference, 19-20 June 2006, Shangri-La Hotel and Convention Centre, Singapore

Over 800 European and Southeast Asian ICT business leaders, researchers and regulators will discuss technological advances and explore the current and future ICT landscape of the two regions.

The EUSEA2006 Exhibition, 20-23 June 2006, CommunicAsia2006, Singapore Expo

The European ICT Pavilion (Hall 3, Stand B3-01) showcases a sample of innovative technologies, products and solutions for audio-visual, telecommunications and security developed by European businesses, research and academic communities, and public bodies. Set within CommunicAsia2006, the EUSEA2006 Exhibition opens up opportunities for Europeans and southeast Asians to forge rewarding alliances and cut new business deals. This is a unique gateway to a vibrant and prosperous IT market with over 35,000 industry professionals, decision makers, buyers, customers, and competitors from over 100 countries.

At EUSEA2006 researchers and academics will be ideally placed to promote research developments and initiatives in the field of ICT, as well as to identify future RTD collaboration partnerships and initiatives with Southeast Asian counterparts, whilst networking and creating future co-operation agreements with ICT players attending the event.

Participation is free of charge but subject to approval. Apply on-line at http://www.eusea2006.org/createMember to attend this unique event. Can you afford to miss it?

More information:
http://www.eusea2006.org

CALL FOR PARTICIPATION

ICCSA 2006 - International Conference on Computational Science and its Applications

Glasgow, 8-11 May 2006

ICCSA 2006 is the next event in the series of highly successful 'International Conferences on Computational Science and its Application' (ICCSA), to be organised for the first time this year by the Institution of Electrical Engineers (IEE).

Computational Science has undoubtedly become a vital part of many scientific investigations, affecting researchers and practitioners in areas ranging from aerospace and automotive, to physics and chemistry, from electronics and geosciences, to bioinformatics and internet security. Due to the sheer size of many challenges in computational science, the use of supercomputing, parallel processing, and sophisticated algorithms, is inevitable. The concentration of this conference is in the realms of computational science in parallel and distributed environments, encompassing the facilitating theoretical foundations and the applications of such large-scale computations. The conference offers the opportunity to discuss problems and solutions in the area, to identify new issues, and to shape future directions for research, as well as to help industrial users apply techniques of large scale parallel and distributed computations.

More information:
http://www.iccsa.org/

CALL FOR PAPERS

9th ERCIM Workshop "User Interfaces for All"

Special Theme "Universal Access in Ambient Intelligence Environments"

Königswinter (Bonn), Germany, 27-28 September 2006

The 9th ERCIM Workshop "User Interfaces for All" builds upon the results of the eight previous Workshops held in Heraklion, Crete, Greece, 30-31 October 1995; Prague, Czech Republic, 7-8 November 1996; Obernai, France, 3-4 November 1997; Stockholm, Sweden, 19-21 October 1998; Dagstuhl, Germany, 28 November - 1 December 1999; Florence, Italy, 25-26 October 2000; Paris (Chantilly), France, 23-25 October, 2002; and Vienna, Austria, 28-29 June 2004.

In the tradition of its predecessors, this Workshop aims to consolidate recent work, and to stimulate further discussion, on the state of the art in the field of User Interfaces for All, and its increasing range of applications in the emerging Information Society. The emphasis of this year's event is on "Universal Access in Ambient Intelligence Environments", and contributions are invited on a broad range of topics that advance the understanding of, and contribute towards, Universal Access in Ambient Intelligence. Areas of interest include, but are not limited to, future and emerging technologies, novel computing paradigms, computer-mediated virtual spaces, architectures and tools, interaction platforms, interaction metaphors, experimental or empirical studies, etc.

The workshop aims to solicit:

- full papers (between 16 and 20 pages), reporting original completed research and development activities relevant to User Interfaces for all and to the Special Theme of this call (Universal Access in Ambient Intelligence Environments).
- poster presentations (two-page abstract).

Publications

The Workshop Proceedings will be published by Springer on paper and electronically. Poster abstracts will be collected and published in an FhG-FIT Technical Report. Paper and poster presentation at the Workshop and paper publication in the Proceedings are conditional on registration of one author to the Workshop. The authors of the best papers will be invited to submit an extended version to the Springer international journal "Universal Access in the Information Society" (http://www.springeronline.com/journal/10209/about).

Keynote Speakers

- Prof. Dr. Dr. Norbert Streitz, FhG-IPSI, Germany
- Prof. Dr. Alois Ferscha, Institut für Pervasive Computing, Johannes Kepler Universität Linz, Austria

Important Dates

- 5 May 2006: Deadline for electronic submission of full papers and poster abstract
- 15 June 2006: Conditional notification of acceptance (confirmation will be given upon registration)
- 25 July 2006: Workshop registration
- 31 July 2006: Deadline for electronic submission of camera-ready submissions.

More information:
http://www.ui4all.gr/workshop2006/

CALL FOR PARTICIPATION

The 2006 Orbit-iEX Conference and Exhibition

Zurich, Switzerland, 16-19 May, 2006

In the conference portion, some 45 seminars will be presented. Some of the topics to be covered are the Internet and how to present oneself through the Internet, business software and solutions, security, open source, Voice over IP, and outsourcing. Most seminars last 75 minutes and can be individually booked.

The exposition covers six main themes: business software, IT services and consulting, hardware and infrastructure for the office, Internet applications related to business processes, IT-security, mobile communication and work platforms. More than three hundred exhibitors have already registered; some five hundred are anticipated.

Last year, this exposition was held in Basel; this year it will be held at the "Messezentrum Zurich".

More information:
http:// www.orbit-iex.ch

Research Foresight in Luxembourg

In 2006 the National Research Fund of Luxembourg carries out a nation-wide Foresight exercise aiming to consolidate the views of the stakeholders of public and private research in Luxembourg in order to identify research domains and priority axes for the public sector with short-term and/or long-term socio-economic interest for Luxembourg society. This Foresight exercise is seen as a participative process involving different stakeholders from public authorities, industry, research organizations, non-governmental organizations, etc.

The Foresight exercise will unfold in two phases. In the first phase of the exercise, the Luxembourg research environment will be analyzed by collecting background data, actively consulting the research actors and the public, as well as assessing the research topics in the light of the collected data.

Based on the preceding work, the FNR will retain the general research priorities/domains that should form the future FNR research programmes. The FNR will also issue recommendations to the Ministry of Research on which research priorities should be supported by public money.

In the second phase, detailed FNR programmes will be worked out in the research domains retained by the FNR using specific expert panel workshops.

For more information or if you would like to take part in the process, please visit the foresight homepage.

More information:
http://www.fnrforesight.lu

CALL FOR PAPERS

International Journal on Digital Libraries

Special Issue on Digital Libraries and eScience

The International Journal on Digital Libraries, published by Springer, is a quarterly journal aimed at advancing the theory and practice of acquisition, definition, organization, management, and dissemination of digital information via global networking.

There are an increasing number of initiatives in several countries targeted at supporting research into new forms of computational infrastructure intended to transform the conduct of scientific research in areas such as chemistry, atmospheric science, and earth science.

These initiatives, which go under a variety of names including eScience, eResearch, and cyberinfrastructure, are a response to the changing nature of scientific research, particularly in the natural and physical sciences, which is increasingly dependent upon large data sets and high-end analysis and visualization tools. eScience approaches and techniques are also beginning to appear in other disciplines such as the humanities and social sciences. Research issues being addressed in these initiatives include information retrieval, information modeling, ontologies, systems interoperability, and policy issues associated with providing transparent access to complex data sets. As such, these initiatives are concerned with many of the same research issues that the international digital library community has been grappling with for the past decade.

The purpose of this special issue is to critically examine the role that digital libraries can and should play in this emerging eScience computational infrastructure.

Topics

Papers are invited on the technical, social, and policy dimensions of eScience and digital libraries. Topics to be considered include, but are not limited to:

- the design, use, and evaluation of innovative digital library technologies in eScience
- critical examinations of eScience practices using these technologies
- how eScience and digital libraries are transforming education
- critical examination of the role of policies and scientific cultures on data sharing, open access and differences across scientific disciplines
- interdisciplinary aspects; international cooperation
- metadata and information modeling for eScience
- knowledge organization systems and subject access for eScience; eg, thesauri, ontologies, and other terminologies
- semantic interoperability, and data integration
- indexing, retrieval, and discovery of data and related science and education materials
- automatic data analysis techniques and data mining across a collection of resources
- intersection of scientific workflows with metadata generation and other digital library information management issues
- encoding systems and mark-up languages for integrating scientific data and other intellectual products
- persistent identifiers, citation, and linking between data, publications, and other science and education products
- data storage management
- digital curation, provenance, repository, and preservation issues associated with eScience
- user needs and user interfaces for creating, managing, customizing, annotating, and collaborating

Important Dates

- Submissions due: 1 June 2006
- Acceptance notifications: 1 September 2006
- Anticipated publication of the special issue: Early 2007

More information:
http://www.dljournal.org/
http://www.dlese.org/IJDL_eScience/

CALL FOR PAPERS

HCI International 2007 12th International Conference on Human-Computer Interaction

Beijing, P.R. China, 22-27 July 2007

HCI International 2007 is held jointly with:

- Symposium on Human Interface (Japan) 2007
- 7th International Conference on Engineering Psychology and Cognitive Ergonomics
- 4th International Conference on Universal Access in Human-Computer Interaction
- 2nd International Conference on Virtual Reality
- 2nd International Conference on Usability and Internationalization
- 2nd International Conference on Online Communities and Social Computing
- 3rd International Conference on Augmented Cognition
- 1st International Conference on Digital Human Modeling.

HCI International 2007 jointly with the affiliated conferences, invites you to participate in, and contribute to the international forum for the dissemination and exchange of up-to-date scientific information on theoretical, generic and applied areas of HCI.

The conference focuses on the following major thematic areas:

- Human-Computer Interaction
- Human Interface and the Management of Information
- Universal Access in Human-Computer Interaction
- Ergonomics and Health Aspects of Work with Computers
- Engineering Psychology and Cognitive Ergonomics
- Virtual Reality
- Usability and Internationalization
- Online Communities and Social Computing
- Augmented Cognition
- Digital Human Modeling.

More information:
http://www.hcii2007.org

ERCIM NEWS

ERCIM News is the magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. This issue has a circulation of 10,500 copies. The printed version of ERCIM News has a production cost of 8 Euro per copy. It is available free of charge for certain groups.

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Identity Crime

Whilst this is not a new phenomenon, the ease with which this crime can be effected in the 21st century means that more cases than ever are being reported. In 1999 there were around 20,000 cases reported in the UK. This rose to a staggering 120,000 by 2004. Now it's running at over 200,000 per year, with an overall cost to the UK economy of over £1.7b.

What is identity crime?

Identity crime is a generic term for creating a false identity, identity theft, or committing identity fraud.

- *False identity* - is a fictitious or invented identity or a real identity altered to create a fictitious one
- *Identity theft* - when sufficient information is obtained to facilitate identity fraud, irrespective of whether the victim is alive or dead
- *Identity fraud* - when a false identity or someone else's identity is used to support unlawful activity or when someone avoids obligation or liability by falsely claiming s/he was the victim of identity fraud.

Why is this crime so easy to perpetrate?

Here are some of the ways criminals obtain personal information to commit a crime.

'Phishing' - this involves incorporating a bank's name, or a variation of it, into a fake website address and sending the link to customers via email. Genuine customers are either requested to reply to the email or follow the link to the website. In every case the crooks are 'phishing' for personal information.

'Pharming' - this is when criminals set up an automatic redirection from a genuine company's real website to a similar looking, but fake, cloned site. Customers attempt to log on to the fake site using their account details and passwords.

What is the impact on economy?

The estimated losses to the following sectors in the UK are as follows:

- Insurance claims £22m
- Losses from plastic cards £504.8m
- Loss to pension schemes £15m
- Building Societies £3.1m
- Retail sector £2.3m
- Unpaid fines £5.9m
- Benefit fraud £20m
- Driving licence fraud and Driving Test fraud £3.62m
- Motor finance fraud £14m
- Indirect taxation £215m
- Direct taxation (including tax credits and child benefit fraud £2.7m)
- Immigration documentation fraud £56.2m
- Local Authorities £28.6m
- Money laundering £395m
- Police service £1.73m
- Telecommunications £372m
- UK Passport service £62.8m

What is the impact on the individual?

It's estimated that it can take an individual between 60 and 400 hours to clean up after the crime, particularly if there is a total 'hijack'. It can also incur a monetary cost too.

What is being done to combat the problem?

CIFAS (the UK's Fraud Prevention Service) holds databases with the identities of repeat offenders. They recommend that access to deceased data would eliminate the possibility of mailing dead people. They could also alert lenders if they receive an application for credit from someone recorded as deceased.

How widespread is the problem?

It is an international problem and a number of initiatives involving identity cards are being undertaken across Europe. According to the UK Fraud Preventin Service (CIFAS) some European countries now have compulsory identity schemes with electronic versions, whilst others have voluntary schemes, but require individuals to register on a population database. Identity crime in Holland carries a 5 year prison sentence.

In the US, however, the problem is much bigger but a lot more progress has been made. Identity theft carries fines of up to $250,000 and allows sentences of up to 15 years imprisonment.

Links:
http://www.cifas.org.uk
http://www.identity-theft.org.uk/

Edited by Heather Weaver, CCLRC, UK

The "Golden Book": Commitments made during the Tunis Phase of the World Summit on the Information Society

The Golden Book - a record of work undertaken to implement the goals of the World Summit on the Information Society (WSIS) and build the future Information Society - was launched on 24 February 2006 during the Consultation Meeting of WSIS Action Lines Facilitators/Moderators, convened by ITU, UNESCO and UNDP in Geneva.

This Golden Book highlights some of the valuable work being done around the world to promote ICTs in projects, large and small, by governments, individuals or team effort, for the benefit of all. It provides illustrative examples of new and innovative projects to build infrastructure, promote ICTs in education, health and governance, ensure fair access and enhance online security.

The Golden Book has been published by the International Telecommunication Union (ITU) as a permanent record of the new commitments pledged by stakeholders during the Tunis Phase of the World Summit on the Information Society. All WSIS stakeholders at the Summit were invited to submit an online questionnaire with details of their activities announced during the Tunis Phase. These activities have been planned or are already being undertaken to implement the WSIS Plan of Action. The Golden Book also serves as a tool helping to coordinate the action taken to implement the 11 Action lines and avoid duplication.

More than 375 submissions were made to the Golden Book by governments, international organizations, NGOs, companies and individuals, describing their work towards promoting ICT activities. ITU estimates that the activities announced during the Tunis Phase to promote WSIS goals represented a total value of at least 3.2 billion Euro. Governments committed to implement projects for some 1.9 billion Euro, representing nearly two-thirds of the estimated total value of all commitments, while international organizations pledged to carry out activities for around half that amount, ie, 0.83 billion Euros. Business entities announced plans to realize projects for around 0.35 billion Euros and civil society projects amount to least 0.13 billion Euros.

The Golden Book including a CD-ROM containing the database is available from the ITU Sales service at a cost of 30 CHF. Access to the database is available free of charge. For more information, see http://www.itu.int/wsis/

First Van Wijngaarden Awards for Lynch and Diaconis

Nancy Lynch and Persi Diaconis.

Computer scientist Nancy Lynch and mathematician Persi Diaconis were awarded the first two Van Wijngaarden Awards during the celebration of CWI's 60th anniversary on 9 February 2006, in Amsterdam. Nancy Lynch (Massachusetts Institute of Technology, USA) is famous for her pioneering and leading work in distributed computing. Persi Diaconis (Stanford University) was praised for his deep insights in mathematics combined with a practical mind. He gave a captivating lecture on the statistics of tossing coins. For the occasion, the Dutch Mondriaan Kwartet played the String Quartet no 1 in C Major, composed by an ALGOL 60 computer program at the Mathematisch Centrum in 1968. The Van Wijngaarden Award is named after Aad van Wijngaarden (1916-1987), one of the founding fathers of computer science in The Netherlands and former director of the Mathematisch Centrum (now CWI). It consists of a bronze sculpture and will be presented every five years. The texts of the laudatios can be found at http://www.cwi.nl/soiree/.

ERCIM – The European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in information technology and applied mathematics. Its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.

ERCIM is the European Host of the World Wide Web Consortium.

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