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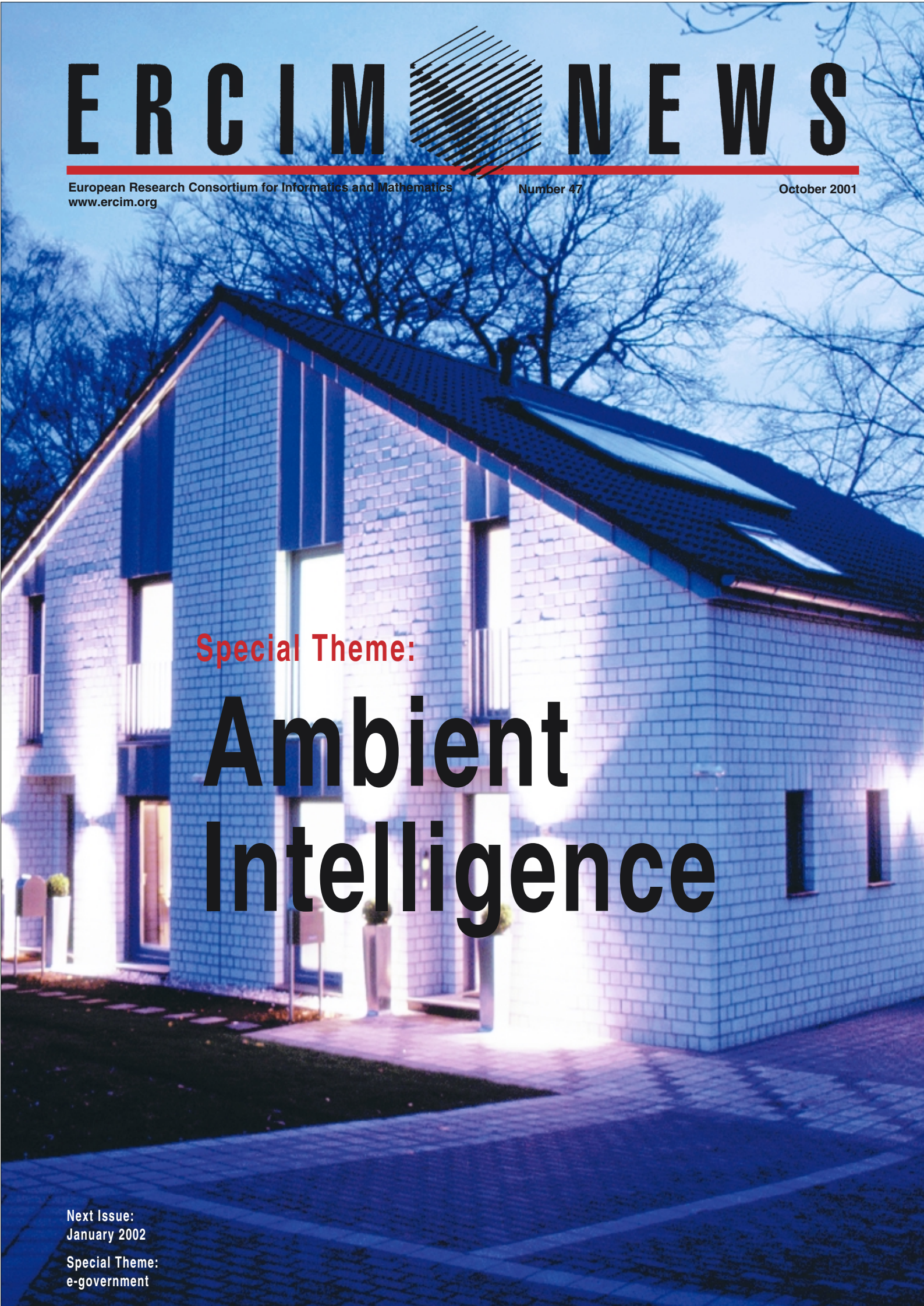

Special Theme:

Ambient Intelligence

Next Issue:
January 2002

Special Theme:
e-government

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Cover image: The Innovation Center for the Intelligent House, a testbed for future forms of living and working. See article on page 17.

Erkki Liikanen
Member of the European Commission, responsible for Enterprise and Information Society

Ambient Intelligence in future EU Research Efforts

The European Commission's proposal for the next Framework Programme (2003-2006) for Research and Development (FP6) was submitted to the Council of ministers and European Parliament in February 2001 and the related Specific programmes in May 2001. Information Society Technologies (IST) are one of the main priorities in the Commission proposal given their fundamental role in realising Europe's objectives for the knowledge society as agreed at the Lisbon European Council of 2000, the Stockholm Council of 2001, and reflected in the e-Europe Action Plan. This renewed effort in RTD in IST is essential to ensure European leadership in the generic and applied technologies at the heart of the knowledge society, to improve European competitiveness and to enable all European citizens to benefit from the knowledge society.

An important challenge for the academic and industrial research community in IST is to maintain the focus on medium to long-term objectives amid changing socio-economic contexts. We know that today only a small part of the world population, between 5 and 10 %, have access to IST applications and services. Costs, complexity, unavailability and unreliability are often preventing the further development and broader deployment of the knowledge and information society and the digital divide is widening. Even in developed countries, only a minor fraction of the possibilities that IST can offer, is actually used despite recent progress in the uptake of internet and mobile technology.

As we start to understand the advantages and limitations of current technologies, research in IST should aim at new avenues that will not only extend the scope, functionality and efficiency of IST applications and services, but that will also make them available, in the most natural and trustful way, to citizens whoever they are, whatever their age is, anywhere and anytime. It must lead to a world where every child has access to personalised learning resources, where every patient can be treated within the comfort of his own home, where every engineer has the power of global computing resources at their fingertips, where every business is plugged into world-wide trading communities; and where every citizen is able to access public services anywhere, anytime.

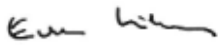
This is the world of 'Ambient Intelligence' that will, gradually but surely, emerge from research in IST. This is the vision that the IST priority in FP6 is following. It puts people at the centre of the development of future IST, ie, 'design technologies for people and not make people adapt to technologies'. It aims at making technology invisible, embedded in our natural surrounding and present whenever we need it (eg, electricity) and at making interaction with the technology simple, effortless and using all our senses. This vision sustains and extends the objectives of the European Commission's eEurope 2002 Action Plan of bringing IST applications and services to everyone, every home, school and to all businesses.

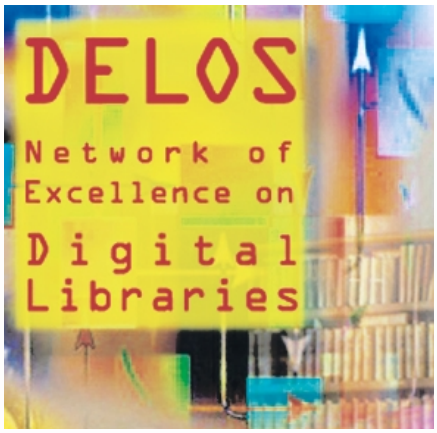
The trend towards an Ambient Intelligence landscape provides a clear opportunity for European industry to build on, and strengthen its leading position in areas such as mobile communications, consumer electronics and home appliances, embedded software and microelectronics. It will help reinforce the competitiveness of all industrial sectors.

Europe can build on pioneering work in the field such as the EU funded initiative on the 'disappearing computer' and on industrial and technological achievements. A main step forward is already brought in mobile/wireless technologies with the 2.5 and 3G mobile systems. These provide anywhere access to applications and services from a non-PC platform and for the normal 'man and woman on the street'. Wearable mobile devices that incorporate interfaces making use of our senses such as speech and gesture are currently under development. Cars already encompass an expanse of IST devices that we use and to which we have access without knowing.

A sustained research effort is needed to accelerate the progress in key areas such as advanced interfaces, broadband mobile, wireless and optical communications, distributed and embedded computing technologies and knowledge handling techniques. It is also required in order to push the limits of miniaturisation and minimise the costs and power consumption of microelectronic components and to explore new materials, such as organic flexible material for displays and sensors so that they can be placed anywhere and take any shape.

Europe can not afford to miss the unique opportunities offered by this next generation of IST, either in social or economic terms. The stake is even higher given the role of IST in all other research and engineering fields and their impact on the realisation of the European Research Area. We hope that the support to IST in FP6 will provide further impetus to the members of ERCIM and the whole research community, from industry and academia, to pull together their effort and build coherent approaches to realise the vision.





This is the second of a series of articles reporting on past and upcoming activities of the DELOS Network of Excellence for Digital Libraries. Further information on the objectives, activities and membership of DELOS can be accessed from the DELOS home page: http://www.ercim.org/delos/

Digital Libraries: Future Research Directions for a European Research Programme

A brainstorming meeting took place on 13-15 June 2001 in San Cassiano (Dolomites), Italy.

The objective of the meeting was to outline the main research directions of a future European research programme in the field of digital libraries. To this end, prominent members of the European research community were invited to participate in and contribute to the definition of this new vision of digital libraries, and to translate it into concrete research actions which will become an integral part of the next 6th FP. Some prominent members from the US research community were also invited, in collaboration with the National Science Foundation. 15 EU and 5 US high-level researchers attended. The meeting was also attended by a representative from the Commission.

The meeting was divided into three sessions. On the first day a plenary session was held where the main objective of the meeting was presented. All participants briefly presented short position statements reflecting their views about the main advances expected over the next few years in their field of activity and expertise, and how these developments can contribute to the generation of new systems and services. The aim of this session was to provide a common background to facilitate the drafting of the final results of the meeting. On the second day three parallel sessions were held to discuss and draft a set of recommendations for a future research agenda relevant to Digital Libraries. A rapporteur was assigned for each group. On the third half-day a final plenary session was held, where the rapporteur of each group presented the proposals and recommendations of his/her group. A discussion was then held to try to consolidate all the proposals in order to draft a report on the outcome of the meeting.

The agenda (including slide presentations), position statements and list of participants are available on the delos web site. A report on the outcome of the meeting providing recommendations on the main research directions of a future European research programme in the field of digital libraries will be available at the site in October 2001.

DELOS / IPI-RAS / IITE Workshop on European-Russian Cooperation in Digital Libraries

A DELOS-Russia Collaboration Workshop took place on 7-8 June 2001 in Moscow, Russia.

The Workshop was organized in the framework of the DELOS 'International Cooperation' Forum according to the DELOS-Russian DL Programme. The objective of the 2001 Workshop in Russia was to organize a meeting between European and Russian representatives of active DL projects to identify areas of common interest and potential cooperation. In May 2001 the list of participating projects from both sides was fixed. The list was based on the European projects that in Luxembourg, at the EU-DL All Projects Coordination meeting in February 2001, had expressed interest in possible cooperation with Russian DL projects. At that time, the UNESCO Institute for Information Technologies in Education (IITE) proposed to host the workshop in Moscow, including in the agenda a UNESCO Expert Meeting on DL in Education.

The following European projects were represented at the Workshop: ARTISTE, SCHOLNET, TEL, MIND, ARION, RENARDUS, ECHO, GLOBAL INFO (now DL-Forum). The following Russian projects from Moscow, St. Petersburg and Novosibirsk were represented at the Workshop: RSL project, Integration of Infosources of RAS, Subject Domain Mediation, GENEEX-PRESS, Cultural heritage network, Cultivate - Russia, Russian Archives Online, AEROSPACE MEDIAT-ECHA, Open Education: Models. The topics discussed helped to identify significant overlap in the interests of European and Russian DL professionals.

After the presentations and discussions, the Workshop formulated and approved several recommendations for concrete actions, including:

- Forming a DELOS-Russia network which, on the one hand, will be a node in the DELOS Network of Excellence and, on the other hand, will be a network of Russian (sub)nodes with activities similar to those of DELOS proper. DELOS-Russia may be analogous to the CULTIVATE-Russia network.
- Improving and intensifying the exchange of research results and development efforts in the area of DL between existing European and Russian projects, building on existing DELOS and UNESCO IITE frameworks to establish cooperation between existing projects or to form

new joint projects within the current and future funding programs.
- Identifying joint activity areas that deserve to be generalized and extended to the level of DELOS working groups. DL frameworks for scientific collection support can be suggested as one such potential direction.

Tutorial on Multilingual Access for Information Systems

A DELOS tutorial on Multilingual Access for Information Systems was held at IFLA2001 (International Federation of Library Associations and Institutions) on 23 August 2001 in Boston, Massachusetts.

40 participants attended the tutorial which provided an overview of the main issues of interest in the following two sectors:
- multiple language recognition, manipulation and display
- multilingual or cross-language search and retrieval.

The topics covered included: the specific requirements of particular languages and scripts, processing of multilingual document collections, multilingual metadata, techniques for cross-language retrieval, presentation issues, system evaluation. The focus of the tutorial was on the needs of the user - whether information seeker, provider, or administrator - and on how today's multilingual retrieval systems can impact on each of these user types. The tutorialists were Páraic Sheridan (Director of MNIS-TextWise Labs, the R&D division of Manning & Napier Information Services based in Syracuse, New York) and Carol Peters (Researcher at the IEI-CNR).

Workshop on Audio-Visual Metadata Modelling

A DELOS workshop on Audio-Visual Metadata Modelling will be held on 23 September 2001 in London, UK in conjunction with the FIAT/IFTA Annual Conference (London, 22-25 September). The workshop will be divided into two sessions. In the first session, research results and on-going standardization activities will be reported. In the second session, a panel of leading representatives from application domains (eg broadcasting, archives, movie industry) will present and discuss real-life experiences with metadata models and editors in order to stimulate a discussion and an exchange of opinions with the audience.

Workshop on Collaboration between DELOS and Non-EU Mediterranean Countries

A DELOS workshop on the Design and Implementation of Digital Libraries will be held at the Alakhawayn University in Ifrane (AUI), Morocco on November 8-9, 2001. This practical workshop aims at bringing together Digital Libraries' researchers from both sides of the Mediterranean to present and discuss their experiences in designing, implementing, and maintaining digital libraries with respect to today's technological and economic environment. The main objective of the workshop is to facilitate an exchange of experiences among researchers involved in technologies of interest to digital libraries, to explore and discuss subjects of common interest for possible international cooperation, and to allow the AUI library to learn from other practical experiences and to have a good and clear idea on how to monitor the design and the implementation of its own digital library.

Setting up of DELOS-NSF Joint Working Groups

DELOS and the NSF have agreed to set up seven joint working groups whose aim is to work together on research areas of important relevance to the digital library community. Each working group will be co-chaired by a prominent member of the European and the US digital library research community, and will consist of approximately 10 members. The joint working groups presently being set up are:
- Spoken-Word Digital Audio Collections
- Information Seeking, Searching and Querying in Digital Libraries
- Personalization and Recommender Systems in Digital Libraries
- Emerging Language Technologies and Cultural Heritage
- Digital Imagery for Significant Cultural and Historical Materials
- Preservation and Archiving
- Evaluation and Test Suites.

NSF / EU DL All Projects Meeting

DELOS is planning to hold a NSF/EU All Projects meeting in Rome, Italy 10-11 January 2002 (tentative date). The European Commission's Information Society Technologies Programme and the National Science Foundation are supporting substantial research concerned with digital libraries. Both expect to develop the enabling technologies as well as principles for DL design and operation, to study the economic and legal issues surrounding electronic distribution of IR, and to better understand the social context - for example, human information needs - in which DLs will operate. By and large, scientists involved in the EU and NSF projects have not had the opportunity to meet regularly. A coordination effort in the DL field can help avoid duplication of effort, prevent the development of fragmented digital systems, and encourage productive interchange of scientific knowledge and scholarly data around the world.

In this context, DELOS is planning to hold the first of a series of annual meetings to bring together scientists involved in European and NSF projects. The objectives are to exchange working experiences and research results in the field of digital libraries, and to establish collaborative links between on-going projects. From the US side, participants will be representatives from the Digital Library Initiative (phase2) projects. From the European side, representatives will be from EU funded Digital Library projects and from DL projects funded by European National Initiatives.

The second DELOS workshop on Personalization and Recommender Systems in Digital Libraries was held on 18-20 June 2001 in Dublin, Ireland (see article on page 44).

The first DELOS International Summer School on Digital Library Technologies was held on 9-13 July 2001 in Pisa, Italy (see article on page 43).

A CLEF 2001 Workshop of the Cross-Language Evaluation Forum was held on 3-4 September 2001 in Darmstadt, Germany (see article on page 45).

The Fifth European Conference on Digital Libraries (ECDL2001) was held in Darmstadt, Germany on 5-7 September 2001. An article on the conference will appear in the next issue of ERCIM News.

The Third DELOS Workshop on Interoperability and Mediation in Heterogeneous Digital Libraries was held on 8-9 September 2001 in Darmstadt, Germany, in conjunction with ECDL2001. An article on the workshop will appear in the next issue of ERCIM News.

The DELOS Network of Excellence on Digital Libraries, funded by the 5th Framework Programme of the European Commission, provides a framework to foster national and international research activities in the Digital Libraries domain and to disseminate the research results in the relevant user communities.

The activities of the DELOS Network of Excellence are organized into five Forums: the Research Forum, the Evaluation Forum, the Standardization Forum, the Technology Transfer Forum and the International Cooperation Forum.

The activities of the DELOS Network of Excellence are open to all those working or interested in DL-related research or applications.

Delos website:
http://www.ercim.org/delos

Please contact:
Costantino Thanos — IEI-CNR
Network Director
Tel: +39 050 315 2910/2912
E-mail: thanos@iei.pi.cnr.it

ERCIM Fellowship Programme 2002/2003 launched

ERCIM offers 18-month fellowships in leading European information technology research centres. This offer is available for PhD holders (or equivalent) from all over the world.

The objective of the Fellowship Programme is to enable bright young scientists from all over the world to work collectively on a challenging problem as fellows of leading European research centers. In addition, an ERCIM fellowship helps widen and intensify the network of personal relations and understanding among scientists. The programme offers the opportunity to ERCIM fellows:

- to improve their knowledge about European research structures and networks
- to familiarize them with working conditions in leading European research centres
- to promote cross-fertilization and cooperation between research groups working in similar areas in different laboratories, through the fellowships.

Conditions

Aside from researchers from academic institutions, scientists working in industry are strongly encouraged to apply. Applicants must:

- have a PhD degree (or equivalent) or be in the last year of the thesis work
- be fluent in English
- be discharged or get deferment from military service
- start the grant before October 2002

Fellowships are of 18 months duration, generally spent in two institutes. For the entire period of 18 months, the fellow will receive a monthly allowance which may vary depending on the country. Costs for travelling to and from the institutes will be paid. In order to encourage the mobility, a member institution will not be eligible to host a candidate of the same nationality.

Deadlines for Application

The Call is divided into two stages with the deadlines:

- 31 October 2001
- 30 April 2002.

How to apply

Applications must be submitted electronically:
http://www.ercim.org/fellowship/

Selection Procedure

Each application is reviewed by one or more senior scientists in each ERCIM institute. ERCIM representatives consider the results and decide to which candidates fellowships should be offered, taking into account:

- the qualification of the applicant
- the overlap of interest between applicant and the hosting institution
- available funding.

Research Infrastructure

At the ERCIM institutes, state-of-the-art computer hardware and software is available to support the major areas of research listed below. Library facilities and access to scientific databases are seen as another key component in the research environment. All ERCIM institutes provide access to excellent library facilities in IT and mathematics. All ERCIM institutes have extensive seminar and research training programmes.

Research Areas of Interest

Fellowships are available in the scientific fields covered by the ERCIM Working Groups the following areas:

- Database Research
- Constraints Technology and Applications
- Control and Systems Theory
- Formal Methods
- Electronic Commerce
- User Interfaces for All
- Environmental Modelling
- Health and Information Technology
- Digital Libraries
- E-Learning
- Matrix Computations and Statistics.

ERCIM institutes covering a broad range of research topics, fellowships are also available in areas not covered by the above topics. ERCIM is particularly interested in candidates with skills in:

- Mathematics and Foundations of Computer Science: combinatorics, graph theory, theoretical computer science, application of number theory to security, computer algebra, stochastics, theory of computation
- Software: real time and high performance programming, software specification, analysis and testing, operating systems, distributed and parallel systems, interactive software and systems
- Computing methodologies: speech, visualisation and virtual reality, image analysis
- Communication technology: communication networks, network architecture and management.

A detailed list of topics in which ERCIM institutes are active is available at http://www.ercim.org/activity/expertise.html

Links:
Detailed description
and online application form:
http://www.ercim.org/fellowhsip/

Please contact:
ERCIM office
Tel: +33 4 92 38 50 10
E-mail: office@ercim.org

Ambient Intelligence

by Jari Ahola

Defined by the EC Information Scociety Technologies Advisory Group in a vision of the Information Society, Ambient Intelligence emphasises on greater user-friendliness, more efficient services support, user-empowerment, and support for human interactions. In this vision, people will be surrounded by intelligent and intuitive interfaces embedded in everyday objects around us and an environment recognising and responding to the presence of individuals in an invisible way by year 2010.

Since the 1999 IST Programme Advisory Group (ISTAG) vision statement for Framework Programme 5 challenging to create an Ambient Intelligence (AmI) landscape for seamless delivery of services and applications in Europe, it rapidly became widely embedded in the work programme for years 2000-2001. AmI is also recognised as one of the key concepts related to Information Society in the Framework Programme 6 and as we can see from the multitude of articles in this issue, ERCIM members are already well on this track. For a more detailed intro, our first contact with AmI is envisioned in a report by ISTAG (ISTAG. Scenarios for Ambient Intelligence in 2010. Final Report, Feb 2001, EC 2001. Available at: http://www.cordis.lu/ ist/istag.htm) using a set of scenarios depicting different potential futures with four fictitious users.

Ambient Intelligence builds on three recent key technologies: Ubiquitous Computing, Ubiquitous Communication and Intelligent User Interfaces – some of these concepts are barely a decade old and this reflects on the focus of current implementations of AmI (more on this later on). Ubiquitous Computing means integration of microprocessors into everyday objects like furniture, clothing, white goods, toys, even paint. Ubiquitous Communication enables these objects to communicate with each other and the user by means of ad-hoc and wireless networking. An Intelligent User Interface enables the inhabitants of the AmI environment to control and interact with the environment in a natural (voice, gestures) and personalised way (preferences, context).

Making AmI real is no easy task: as it commonly takes place with a new technology, soon after high-flying visions we are demonstrated with the first pieces of hardware for the intelligent environment. However, making a door knob able to compute and communicate does not make it intelligent: the key (and challenge) to really adding wit to the environment lies in the way how the system learns and keeps up to date with the needs of the user by itself. A thinking machine, you might conclude – not quite but close: if you rely on the intelligent environment you expect it to operate correctly every time without tedious training or updates and management. You might be willing to do it once but not constantly even in the case of frequent changes of objects, inhabitants or preferences in the environment. A learning machine, I'll say.

The following articles in this special theme issue showcase the various aspects of AmI research in Europe. In addition to background information on AmI related activities within the ERCIM members we have a number of articles on the infrastructure for AmI environments followed with algorithms adding some of the intelligence required to reach our goal for 2010.

Link:
ISTAG; Scenarios for Ambient Intelligence in 2010; Final Report, Feb 2001, EC 2001: http://www.cordis.lu/ist/istag.htm

Please contact:
Jari Ahola — VTT Information Technology
E-mail: jari.ahola@vtt.fi

Articles in this section

Ambient Intelligence: a UK Perspective

by Ronan Sleep

The notion of Ambient Intelligence was developed during a series of ISTAG (Information Societies Technology Advisory Group) and other meetings as a guiding vision to give an overall direction to Europe's Information Societies Technology programme. Ambient Intelligence is essentially an elaboration of Mark Weiser's vision of Ubiquitous - but Calm Computing which stresses the importance of social and human factors as well as developing the base technologies on which aspects of the vision are founded.

The ISTAG meetings culminated in an IPTS (Institute for Prospective Technology Studies) document which develops a number of scenarios illustrating Ambient Intelligence: see http://www.cordis.lu/ist/istag.htm. These scenarios illustrate the breadth possible applications. Some are relatively near term and are based on applying intelligent agent technology via an extension of mobile communications systems, for example to support a busy executive perpetually travelling from meeting to meeting as in the 'Maria, Road Warrior' scenario. In contrast the 'Ambient for Social learning' is much more technologically demanding, assuming for example holographic projection and the ability to manipulate an individual's sound field within a room.

As the scenarios meetings progressed, participants became increasingly concerned with possible impacts of the technology on both individuals and societies. At one extreme, access to the 'ambient intelligence landscape' could be restricted to those engaged in high powered decision making involving much travel and many meetings. At the other extreme, the technology could be used in a much more diluted fashion to make small, but ubiquitous improvements in the lives of most citizens. By no means all uses of an ambient intelligence which are possible are desirable: issues of privacy, choice, and trust of human, organisational and artificial actors become paramount: an ill-considered rush into exploiting the technology before it is both desired and trusted is all too likely to foster the sort of reaction faced by the promoters of GM foods.

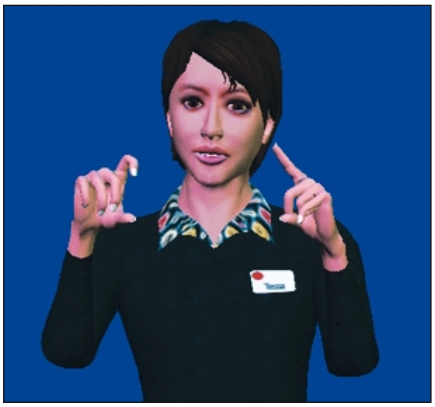
Although Ambient Intelligence covers a large range of concerns, both human and technical, there are some technologies which might be excluded. They are characterised by Mark Weiser's statement about Ubiquitous computing: "Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people.". Seen in this light, Ambient Intelligence is the limit of a process which introduces the technology into people's lives in such a way that the introduction never feels like a conscious learning curve: no special interface is needed because human experience is already a rich 'Manual' of ways of interfacing to changing systems and services. Somehow, we need to create technology that leverages this powerful human resource rather than trying to suppress it by requiring humans to participate in inflexible interaction protocols of the sort supported by current call centre technology.

From this perspective, realising Ambient Intelligence need not wait until we are literally surrounded by the technology: it can begin by studying normal life, using ethnographic and other techniques, and then exploring acceptable ways of using the technology to enhance everyday experience. As people become increasingly empowered, a point is reached where as with the original telephone and its recent mobile offspring it becomes possible to do things that were not possible without the technology. Here at the University of East Anglia in Norwich we have a number of projects exploring this gradualist route to Ambient Intelligence, eg ViSiCAST see http://www.visicast.sys.uea.ac.uk/Publications.html#Presentations.

More generally within the UK the terms pervasive and ubiquitous computing are more prevalent than Ambient Intelligence, but the vision features strongly in a number of recent reports on the future of ICT in the UK. For example, an influential UK government report http://les1.man.ac.uk/cric/dgrc_reports.htm envisages the following developments during the next 5 years:

- UK-based firms taking leading positions in the development of mobile computing, and contributing to new global standards in the area
- A further improvement in the availability of venture capital, and in experimentation with new business models

Towards unobtrusive technology. Here a prototype TESSA system for assisting the hard of hearing is being trialled at a Post Office Counter. Later generations of such technology should merge entirely into the background.



A signing avatar from the prototype TESSA systems.

- Strong UK 'content' companies emerging in fields such as E-education and E-health
- Cheap access combined with demanding consumers for ICT services which creates a population which is also skilled and innovative in ICT innovation
- Government agencies leading the way in releasing the commercial value of under-utilised information through the Internet
- Rapid growth of B2B and B2C e-commerce.

UK Basic and Applied research in ICT is also being increasingly guided by the general vision of Ambient Intelligence: indeed 'Pervasive Computing' is one of five key research challenges identified in a recent report on UK Computing Research (see http://www.cs.ncl.ac.uk/people/cliff.jones/home.formal/UKCRCtoIR.pdf).

Other key challenges identified include System Design, the Information Powered Society, Devices and Theory, and many of the issues covered within these topics have a close match with research issues relevant to Ambient Intelligence.

A flagship UK research activity which has similar motivations to the Ambient Intelligence Vision (although with perhaps more of a Virtual Reality flavour than Mark Weiser would have liked) is the EPSRC funded EQUATOR Interdisciplinary Research Challenge (see http://www.epsrc.ac.uk/documents/about_epsrc/corporate_publications/newsline_journal/newslin16/smarter.htm for a brief description). EQUATOR spans eight sites, including the Universities of Lancaster, Bristol, Nottingham, University College London, Sussex, Glasgow, Southampton and the Royal College of Art, and will involve academics from traditionally disparate disciplines such as computing, sociology and design. To quote Tom Rodden (project leader, now at Nottingham University): "Rather than leap on every small technological step forward, the project will think about how the world might be in five or ten years time, and aim to design and build devices for that moment. We have the opportunity to realise some of the things which technology futurists talk about, but to do it in a very reasoned way. The Equator IRC will investigate all aspects of the development of future devices: the fundamental computational infrastructure required, the theories and concepts that underpin it, the product design that will most enhance the device's function, and the likely ways in which it will be used. We're looking at discovering and meeting future needs: what should be developed and how it might fit with the way people live now, and how they might wish to live in the future. We're looking to see what may or may not be the future." (The author participated in several of the ISTAG meetings which developed the Ambient Intelligence Landscape vision).

Links:
ISTAG: http://www.cordis.lu/ist/istag.htm

VISICAST:
http://www.visicast.sys.uea.ac.uk/Publications.html#Presentations

DGRC Reports:
http://les1.man.ac.uk/cric/dgrc_reports.htm

EQUATOR:
http://www.epsrc.ac.uk/documents/about_epsrc/corporate_publications/newsline_journal/newslin16/smarter.htm

Please contact:
Ronan Sleep — University Of East Anglia, Norwich, UK
Tel: +44 1 603 592 693
E-mail: mrs@sys.uea.ac.uk

Ambient Intelligence in the Context of Universal Access

by Constantine Stephanidis

This article discusses Ambient Intelligence under a Universal Access perspective, as well as the Unified User Interface Development framework as a design and engineering methodology addressing, through a proactive and generic approach, the dimensions of diversity arising in the context of Ambient Intelligence.

The on-going paradigm shift towards a knowledge-intensive Information Society has brought about radical changes in the way people work and interact with each other and with information. Computer-mediated human activities undergo fundamental changes, and new ones appear continuously, as novel, intelligent, distributed, and highly interactive technological environments emerge, making available concurrent access to heterogeneous information sources and interpersonal communication. This dynamic evolution is characterized by several dimensions of diversity that become evident when considering the broad range of user characteristics, the changing nature of human activities, the variety of contexts of use, the increasing availability and diversification of information, knowledge sources and services, the proliferation of diverse technological platforms, etc.

In this context, the 'typical' computer user can no longer be identified: information artifacts are used by diverse user

groups, including people with different cultural, educational, training and employment background, novice and experienced computer users, the very young and the elderly, and people with different types of disabilities. Existing computer-mediated human activities undergo fundamental changes, and a wide variety of new ones appear, such as access to on-line information, e-communication, digital libraries, e-business, on-line health services, e-learning, on-line communities, on-line public and administrative services, e-democracy, telework and tele-presence, on-line entertainment, etc. Similarly, the context of use is changing. The 'traditional' use of computers (ie, scientific use by the specialist, business use for productivity enhancement) is increasingly being complemented by residential and nomadic use, thus penetrating a wider range of human activities in a broader variety of environments, such as the school, the home, the market place, and other civil and social contexts. Finally, technological proliferation contributes with an increased range of systems or devices to facilitate access to the community-wide pool of information resources. These devices include computers, standard telephones, cellular telephones with built-in displays, television sets, information kiosks, information appliances, and various other 'network-attachable' devices.

The notion of Universal Access has become critically important for ensuring social acceptability of the emerging Information Society. Universal access implies the accessibility and usability of Information Society Technologies (IST) by anyone, anywhere, anytime. Its aim is to enable equitable access and active participation of potentially all citizens in existing and emerging computer-mediated human activities. Therefore, it is important to develop universally accessible and usable technological landscapes, capable of accommodating all users in all potential contexts of use, independently of location, user's primary task, target machine, run-time environment, or the current physical conditions of the external environment.

Universal Access is directly related to the emerging concept of Ambient Intelligence, that calls for the development of multi-sensorial interfaces supported by computing and networking technologies present everywhere and embedded in everyday objects. In this context, the technological environment is seen as an all-encompassing computing platform, composed of multiple distributed processing and interactive units, and exhibiting various levels of intelligence. Ambient Intelligence incorporates properties of distributed interactivity (eg, multiple interactive devices, remote interaction capabilities), ubiquitous computing (the 'invisible' computer concept, ie, user - environment direct interaction), and nomadic or mobile computing (eg, location awareness, interface migration). Ambient Intelligence has the potential to provide the user with a virtual space enabling flexible and natural communication with the computing environment or with other users, providing input and perceiving feedback by utilising proportionally all the available senses and communication channels, while optimising human and system resources.

In the context of Universal Access, ambient intelligence is addressed through a proactive and generic approach, which accounts for all dimensions of variation (ie, the abilities, skills, requirements and preferences of users, the characteristics of technological platforms, the relevant aspects of the context of use), and supports intelligent interface run-time adaptation, ie, the capability of automatically adapting to individual users' characteristics and contexts of use through the realization of alternative patterns of interactive behaviour.

The Unified User Interface development framework (see [Stephanidis, C. (Ed.). (2001). User Interfaces for All - Concepts, Methods, and Tools. Mahwah, NJ: Lawrence Erlbaum Associates (ISBN 0-8058-2967-9, 760 pages)]) provides a design and engineering methodology supporting the development of self-adapting interfaces exhibiting both user awareness (ie, the interface is capable of user-adapted behaviour by automatically selecting an interaction patterns appropriate to the particular end-user), and usage context awareness (ie, the interface is capable of usage-context adapted behaviour by automatically selecting interaction patterns appropriate to the particular physical and technological environment). A Unified User Interface comprises a single (unified) interface specification defined by the following key properties:

- it encompasses user- and context-specific information
- it contains alternative dialogue artifacts in an implemented form, each appropriate for different user- and context-specific parameters
- it applies adaptation decisions, activates dialogue artifacts and is capable of interaction monitoring.

Recent and ongoing applications of the Unified User Interface development framework include:

- the AVANTI web browser, providing web-based user-adapted interaction (see article in ERCIM News 41)
- the PALIO platform for anyone and anywhere access to community-oriented services, supporting location awareness and diverse platforms such as PCs, kiosks and mobile phones (see article in ERCIM News 46)
- the 2WEAR platform for migratory interfaces to wearable devices, supporting distributed dynamic I/O control (IST-2000-25286 'A Runtime for Adaptive and ExtensibleWireless Wearables').

Please contact:
Constantine Stephanidis — FORTH-ICS
Tel: +30 81 391741
E-mail: cs@ics.forth.gr

Ambient Intelligence within a Home Environment

by Mária Bieliková and Tibor Krajcovic

EUNICA (Extensible Universal Control of Appliances) is a prototype of an intelligent household system, developed by a team of five students from the Slovak University of Technology in Bratislava. With this system, the team won the fourth price at the annual IEEE Computer Society International Design Competition (CSIDC) World Finals.

Rastislav Habala, Jaroslav Kuruc, Vladimir Marko, Dalibor Rak and Anton Weissensteiner are all undergraduate students at the Slovak University of Technology and worked towards a vision of a household where appliances serve a user according her/his current needs. The students designed and developed a prototype of the system called EUNICA, which is intended to deliver various home-related services to the users. It is sensitive and responsive to the presence of people (the occupants or visitors of a household). The user in the household is surrounded by a multitude of interconnected appliances. The network of appliances is invisible. Appliances serve the user according to her/his customs and preferences. The whole system exhibits some kind of intelligence, eg, it is able to recognize each individual in the household and adapt behaviour according their needs, it is able to recognize specific events (such as time or movement of a user) and act upon various situations.

An important feature of EUNICA is providing mobility: mobile access to appliances on the one side and possible mobile connection of appliances on the other. The wireless technology, namely Bluetooth, which presents the primary way of communication, is granting EUNICA's great features to supersede conventional infrared remote controls. However, EUNICA is not limited to a single set of communication methods or a fixed set of appliances. It uses the open concept of loadable drivers to be ready for future appliances and technologies. The system covers features allowing access to appliances from outside of a user's household via phone lines or the Internet. EUNICA also provides strong appliance management functions that are kept hidden for the standard use. It provides a secure way of appliance installation.

The heart of the EUNICA is the control unit. Any appliance can be connected to the control unit using various types of connections (see Figure 1). Monitoring and controlling appliances are visualized on simple mobile Java based user interface devices connected to the control unit using the Bluetooth wireless communications technology. All kinds of inexpensive, physically compact devices, such as PDAs are allowed. We call these devices 'eurecos' (EUNICA remote controls). They display and allow browsing information received from the control unit (represented in the EUNICA Markup Language that is based on XML) and send user's requests back to the control unit.

To fit the system to a house of any size the access to mobile components of the system in a big house is proposed through a network of access points (realized by Bluetooth modules connected to the control unit). The appliances themselves are not part of EUNICA; however they should include support for EUNICA.

From the user perspective, EUNICA is a system, which enables them to monitor and control appliances in a household by eurecos. Several eurecos can exist in the household. Any user can use any eureco, as each eureco is always adapted to the current user. To make the eureco able to easily and comfortably identify its current user, the eureco prototype is equipped with a fingerprint scanner.

To simplify the monitoring and control of appliances for various individuals and groups (eg, children, adult, elder), the controls have to adapt and customise. The adaptability considers the number of control elements, its layout and appearance. In addition, EUNICA monitors user's actions and adapts to their preferences (eg, EUNICA can detect the level of light brightness the user uses most often and later automatically sets to the observed level).

EUNICA provides sophisticated access rights control. Parents can restrict watching particular TV channel for one child, or forbid switching on the wash machine for all children. EUNICA

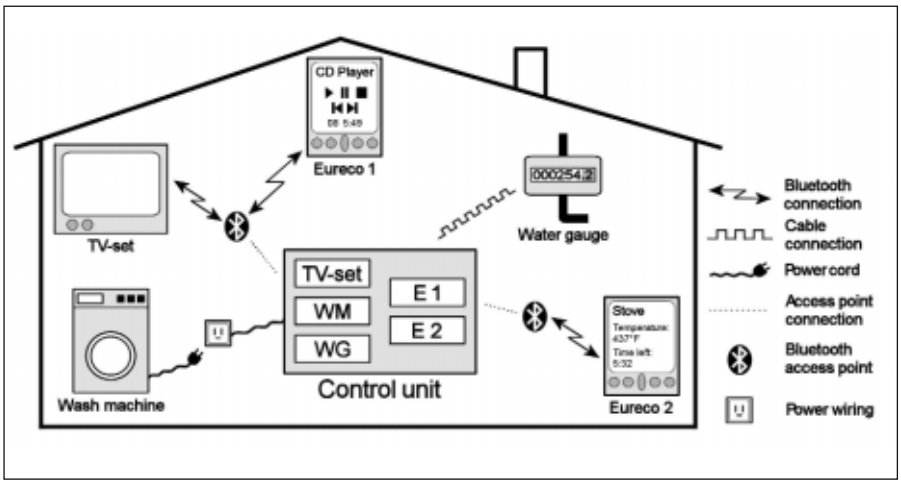


Figure 1: The overview of Eunica.

brings new view to control over appliances. It allows:

- a common way of appliances control (remote control of TV-sets, Hi-Fi)
- to monitor state of appliances (temperature on thermometer, remaining washing time, surveillance camera in the children's room or electronic doorman)
- to control appliances using menus (automatic program selections based on the amount and kind of clothes inserted using the wash-machine menu)
- to program various embedded appliances (heating system, alarm), and help in automatic data acquisition (eg, from various kinds energy meters).

Measured data is sent through the network to the energy providers without a possibility of user intervention, so the user cannot abuse it.

The eurecos can also be used to access Internet resources such as email, weather forecast or electronic newspaper. The system can support wearable computing devices for tracking physiological parameters, locating the users, etc.

In the view of manufacturers EUNICA represents a straightforward extension for appliances they produce. In order to support EUNICA they should extend existing appliances with the Bluetooth or another connection technology (EUNICA provides versatility of appliance connection - by serial or parallel link, by net, AC power lines, or wireless Bluetooth). Manufacturers should develop a driver that will be dynamically added to the control unit. It will enrich the appliance with required logic, which will perform the commands of the control unit and send the state of the appliance to the control unit.

Drivers and appliances are not passive components which only respond to a user requests. A wristlet on a child's hand can monitor her/his temperature and, if it increases, the EUNICA automatically notifies the parents. Drivers and appliances have to satisfy certain requirements for installing and running.

Eureco design of radio control for children

These requirements ensure co-operation between drivers in the control unit, but also security. Finally, manufacturers have to design control pages in EUNICA Markup Language for their appliances.

The control unit is implemented using Sun Java2 JDK 1.3 Standard Edition, because of reducing the platform dependencies and taking advantages of extensibility including security architecture and dynamic loading of new classes into the running code. These features stood in the good stead when outfitting the system with runtime module addition.

The eureco is implemented in Sun Java2 JDK 1.3 Micro Edition (J2ME). It consists of Connected Limited Device Configuration 1.0.2 (CLDC) specification and reference implementation as well as Kilobyte Virtual Machine (KVM) reference implementation for various platforms including Microsoft Windows, which we used. CLDC and KVM implementations are contained in many portable personal appliances such as PDA. Target platform for KVM is devices with low memory (512KB), battery operated and with limited communication capabilities, so it perfectly fits the needs for remote control.

For testing and demonstration purposes two sample appliance prototypes were created:

- radio as an example of appliance with adaptable and adaptive support (as real hardware appliance)
- heating as an example of highly desired appliance according market research provided during the project, see http://eunica.host.sk/ (as an appliance simulated on computer).

EUNICA is designed considering security issues on several levels: security in communication between the control unit and appliances, security in communication among modules inside the control unit and avoiding unconscious and conscious misuse of EUNICA and appliances.

Acknowledgement

We would like to thank our undergraduate students Rastislav Habala, Jaroslav Kuruc, Vladimir Marko, Dalibor Rak and Anton Weissensteiner for their excellent project work and presentation at the CSIDC World Finals in Washington, DC, and to ALEF, s.r.o. and APIS, s.r.o. for providing us with fingerprint scanner hardware and software development kit. The work reported here was partially supported by Slovak Science Grant Agency, grant No. G1/7611/20 and by IEEE Computer Society via Computer Society Design International Competition (CSIDC) 2001.

Links:
SUT CSIDC web page
http://www.dcs.elf.stuba.sk/csidc
CS-IEEE CSIDC web page
http://www.computer.org/csidc

Please contact:
Maria Bielikova — Slovak University of Technology / SRCIM
Tel: +421 2 602 91 473
E-mail: bielik@elf.stuba.sk

A Flood of Intelligence - the Living Room Project

by Jukka Vanhala

The Living Room project studies the smart home environment. The project is unique in its approach of developing user interface paradigms and communication techniques for large collections of intelligent small objects.

Today we are able to add intelligence into an object with about 20 Euros. We are interested in what happens when the cost is eventually closer to 20 cents. The research is conducted at the Institute of Electronics of the Tampere University of Technology in Finland by a research group called Personal Electronics Group, PEG. The project started in summer 1999 and is continuing.

Let's get Physical

The concept of digital convergence is expanding. We share the vision that the ambient intelligence arises from the convergence of three key technologies: Ubiquitous Computing, Ubiquitous communication, and Intelligent User Friendly Interfaces. But there is also the fourth component, which is the real world physical objects.

The boundary between real world and the information world will vanish. Traditionally things have existed on their own sides. Food and tools clearly are material, books and email are mostly information. The new technology will connect the two worlds. A new car has dozens of micro controllers and a computer and a mobile phone are primarily information appliances. It becomes possible to control the real world trough the network and make use of information contents by manipulating real world objects.

In addition to information processing, communication, and contents the everyday living environment gets a digital form. Eg imagine a tee shirt suitable for children's games. There would be a computer with a game contents downloaded from the network and sensors measuring the actions of the player. The shirt communicates with the other players' shirts. Clearly the tee shirt is a real physical object, which has been augmented with digital contents.

The everyday environment at the home or at the office will still be a real physical environment. The physical objects will get new digital content and functions, but they still have their traditional functions. How people will see the effect of the Moore's law is not in the high-end computers doing spectacular things, but rather in the very small processors embedded in every imaginable object forming a very fine grain parallel multicomputer with a user interface spread across the whole environment.

the Living Room project studies the smart home as a place where intelligence is embedded in practically all physical objects ranging from kitchen appliances to toothpicks. A home of the future might have thousands of active smart objects. Today the cost of embedding some simple sensors, a microcontroller, a short-range radio link, and a battery into an object is about 20 euros. The size of the device is about the size of a matchbox. In about ten years it is possible to integrate all electronics onto a single chip and the cost and the size will drop dramatically. We reach an interesting point when the intelligence adds less than 20 cents to the cost of the product. Then it is possible to have smart things costing about 2 euros total, a price tag on a say toothbrush or on a cone of ice cream.

Natural and Control Interfaces

A smart object has a natural user interface and a control user interface, which can be physically separated. All objects have a physical appearance and functionality that represents its natural

The interior of the Living Room showing spotlights, the floor with pressure sensors, and the smart flowerpot.

purpose. Tools have handles and a refrigerator has a door and shelves. We call this the natural user interface. The design of it has traditionally been the job of the industrial designers and the mechanical engineers. Now they too have to learn new skills, as the embedded electronics will give new functionality to old objects. The enhanced natural user interfaces utilizes sensors to measure the user action and the object reacts with actuators typical to each object.

As electronics is embedded into objects, they will get also information content and ability to process information. The information is in symbolic form and therefore a smart object needs also an interface capable to represent and input symbols. Without the communication capability each of the objects would need its own small control interface with probably a few buttons and a couple of text lines on an LCD-display. It is difficult to design a good interface with such a limited set of controls. It is also clear that most of these interfaces would have different logic and different appearance. Thus the user must learn to use dozens of badly designed interfaces.

When the ability to communicate with the home network is an integral part of the devices the situation improves. All control interfaces can be detached from the actual device much in the same manner as a TV has a remote controller. Here we run into another well-known problem. It is no better to have dozens of loose remote controllers instead of the control interfaces on each device. The solution is to have a universal remote controller, which can control all possible devices. There are already such devices on the market although they are pretty limited in their design. A future control device, the universal information appliance, UIA, should have a large screen, a pointing device, speech input and a standard method to describe the appearance and functionality of the interface, which can be eg loaded from the web page of the appliance manufacturer. Designing sets of 'skins' to control interfaces for smart objects could become a new value added service. Service provider could be independent of appliance manufacturers and provide matching designs for all devices. There will also be a need for different kinds of terminals, thus the interfaces must scale to meet the abilities of the underlying hardware.

The Living Room

Living Room is besides the name of the projects also the name of the actual laboratory where the new systems can be evaluated. The 40 square meter laboratory resembles a flat with a living room and a bar kitchen. During the summer 2002 a new laboratory will be opened with a two room fully equipped flat including a full kitchen and a sauna.

At the moment the infrastructure is ready comprising of a short range RF-network, the design for the controller to be embedded into smart objects, the master control computer and the prototype system software with a control user interface. There are also a number of smart objects including a flowerpot, a door with locks, an array of spotlights, shades, refrigerator, pressure sensitive floor, and even a smart wine bottle rack.

Communication is done wirelessly with a narrow band control network, which has been designed just for this purpose. It is based on the Nordic VLSI transceiver chip, which operates on the license-free 433 MHz IMS band. The throughput is 10 kbits/s and the reliable range is over 30 meters, which is enough for the normal rooms at home. Of course it is not possible to transmit images or speech over the control network. For that purpose there is the IEEE 802.11 wireless LAN connecting the control computer and the user interface terminals, which are both PC-class computers.

Many legacy products such as TVs and audio equipment use infra red transmission for communication. Since those devices will be in use for at least another twenty years, there must be a way of controlling them. An IR-receiver/transmitter is connected to the control computer via a serial link so that the same unified user interface as is used to control devices via the RF-network can be used.

The controller to be embedded into smart objects consists of an Atmel AVR-series microcontroller, sensor interface electronics, the RF-link, and a battery. Software is easily customizable for different requirements. The size of the controller is about 2 times 4 times 6 centimeters.

At the moment we are using a normal office-PC with the Windows-98 operating system as the control computer. Eventually the controller will be a home gateway type standalone computer but the prototyping work is much easier with the good development tools available for Windows-98. The user control interface is implemented on an industrial PC with a touch screen. The computer is embedded into the surface of a coffee table. Similar control terminals can be installed on walls and other surfaces.

Conclusions and Future Development

Traditional user interface research has concentrated on the design of the control interface. When all objects in a smart space can be used to collect and distribute information the collection of the natural user interfaces will dominate the behavior. We call the collection of the natural user interfaces a collective user interface. There is not much empirical knowledge or experience on this because it would require a full implementation of a smart home, which has not yet been built anywhere. The Living Room –project is working towards implementing a prototype environment of a collective user interface. Our approach is very practical. We are interested both in the overall architectural design and in the implementation details. Real world experiments and prototype installations are used to test all designs.

Link:
http://www.ele.tut.fi/research/personalelectronics/

Please contact:
Jukka Vanhala — Tampere University of Technology, Institute of Electronics, Finland
Tel: +358 3 365 3383
E-mail: jukka.vanhala@tut.fi

Ambient Intelligence and Home Networking for Wellness Management and Home Automation

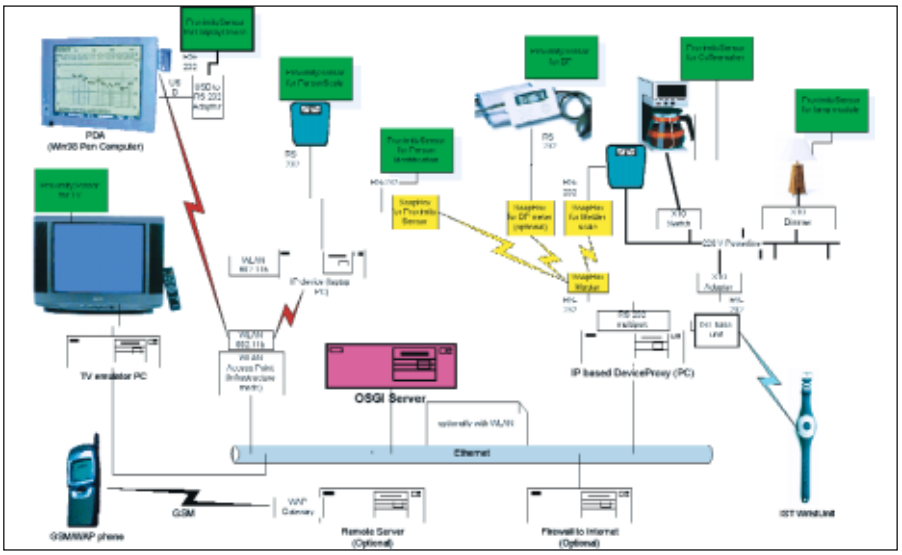
by Ilkka Korhonen

Different ambient intelligence based services at home using the same infrastructure are within the scope of the the Wireless Wellness Monitor project carried out at VTT Information Technology.

Self-monitoring is an efficient tool in personal health management. Self-monitoring of eg weight means daily measurements of weight, storage of the results, and using the recorded weight history to follow up possible changes in weight. This would allow the user to learn about the behavioural factors affecting the weight, and thereby to manage his/her weight. This is called behavioural feedback model (see ERCIM News No 46, pp. 60-61; http://www.ercim.org/publication/Ercim_News/enw46/parkaa.html). Efficient self-monitoring requires daily actions (weighing, storing of the result, browsing the feedback), which should require minimal efforts by the user for it to be successfully applied in the long-term. Ideally, the measurements should be able to be made wherever and whenever convenient (mobility), the storage of the results should occur automatically (wireless communications, automatic user identification, existence of ambient database services), and the user should be able to get the personalised feedback right when needed, independent of time, place or user interface s/he has at hand (persolisation, adaptation of user interfaces, etc.). This implies application of ambient intelligence (or, home networking, ubiquitous computing).

The first part of the Wireless Wellness Monitor project (WWM I) was carried out between 1.8.1999 and 31.12.2000 (see ERCIM News No 46, pp. 60-61; http://www.ercim.org/publication/Ercim_News/enw46/parkaa.html). In that part a behavioural feedback model for health management was presented, and a lab-prototype of ambient intelligence based weight management was developed and demonstrated. In the current continuation project (WWM II) we extent the concept to include home automation and other functionalities. This is done in order to demonstrate that different ambient intelligence based services at home should be running as different services on the same infrastructure, including a home network, a home gateway, and different user interfaces such as personal digital assistant, mobile phone, or TV. Especially the project studies how simple devices (such as a personal scale or coffee maker) may be networked at home and how smart health management and home automation applications may actually be implemented in the home networking infrastructure. The project will produce two kinds of results: 1) a home networking and ambient intelligence concept, and 2) a demonstration system, in which the concept is implemented, including the infrastructure and wellness management and home automation applications.

Actual ambient intelligence enabled home requires two levels of implementation. The first level provides the infrastructure and makes the technology ambient, communicative. The second level builds the actual smart applications; the intelligence. One goal of the project is to study and demonstrate this two-layered application structure in case of health management and home automation. A schematic illustration of the physical network to be built in the project is illustrated in the figure. The main characteristics of the demonstration system are: 1) the intelligence is mostly located at a home server (OSGi server); 2) from the service point of view, the home network is IP-based; however, simple non-IP devices are represented by a proxy to the network thus allowing heterogenous physical connections to the network. The demonstration system is to be completed by the end of 2001, and user trials are to be carried out early 2002. Partners: VTT Information Technology, VTT Electronics, Nokia Research Center, IST Oy, Celotron Oy and the National Technology Agency of Finland (TEKES).



Physical network of the Wireless Wellness Monitor II demonstration system. The architecture is based on home server (OSGi server) and IP-based networking. Simple non-IP devices, such as health monitors or coffee machine, join the network physically by eg RS232 and are represented as IP-devices by a device proxy.

Link:
http://www.vtt.fi/tte/samba/projects/wwm/

Contact:
Ilkka Korhonen — VTT Information Technology
Tel: +358 3 316 3352
E-mail: ilkka.korhonen@vtt.fi

Wired and Smart: from the Fridge to the Bathtub

by Franz Miller

There's a smart wired house in Duisburg; even the car and the garden are integrated in the network. The 'Innovation Center for the Intelligent House' will be used by researchers and industrial firms as a workshop and testing ground for future forms of living and working.

On the Internet, you can even take a look at the far side of the moon whenever you like, but you can't look to see whether you've left the hot plate switched on in the kitchen at home. The Internet and mobile communications have penetrated every last remote spot of the globe, but strangely enough, the places closest to our daily lives, our homes, are still cut off from the communication networks. Household appliances and domestic systems are isolated from one another, silently dumb. Wouldn't it be a good idea to enable all of these appliances to communicate, and link them together in an 'intelligent house'? If we set up a network to connect heating systems, security alarms, TVs, fridges, thermostats, movement sensors, lighting and window shutters, we would be able to create completely new functions and save money too. The wired, partially automated and remotely controlled home, the 'smart house', is one of the biggest innovation projects of this decade.

The residential half of inHaus is fully furnished and equipped, enabling the present state of the art to be tested. © Fraunhofer IMS / Axel Struwe.

Controlling inHaus from the car. © Fraunhofer IMS / Axel Struwe; Volkswagen AG.

The inHaus complex integrates all of the functions of an experimental, networked dwelling house and a workshop of the future. Practically all of the installations are hidden behind the walls and tiles © Fraunhofer IMS / Axel Struwe.

The aim of smart-house technology is to save energy, increase security and comfort, and to provide the basis for a range of new services. Researchers all over the world are working on the vision of the 'intelligent house' – experimental houses are already in operation in the USA, Japan, Holland, Sweden and Switzerland. But a great number of questions still remain open: Which data transmission standards are likely to be most widely used? How can we make the best use of what is technically feasible? And above all: What do people want in their homes?

Now Germany, too, can join the ranks of the innovators, with its own large-scale experimental project. The Innovation Center for the Intelligent House, or 'inHaus' for short, opened in April in Duisburg. In a project initially scheduled to run for five years, this otherwise ordinary semi-detached house will be used to develop, test and demonstrate many of the ways in which modern progress in information technology and communications can be integrated into our everyday private and working lives. Two features make inHaus stand out from other similar projects: It is both an experimental laboratory for living and a workshop for innovation, and will therefore continue to change in the light of new developments. And it is an open system, ready to accommodate all suppliers and concepts. This innovation center for future forms of living and working in a 'smart environment' is being supported by a broadly based consortium of firms, headed by the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg, who have all chosen to coordinate their components so that they work together.

The beginnings of inHaus date back five years, to the time when the first concepts for data networks in domestic buildings were formed. So far, such networks have not made the breakthrough to the mass market, because there were no standards or integration concepts. The existing solutions tend to be isolated projects. Over the next five years, the Duisburg

innovation center hopes to pave the way to series production.

The inHaus complex is housed in a pair of connected buildings. One is an authentic home, with the laboratory for living and a home office, supplemented by a car (the connect-Passat) and an intelligent garden. The other is a research and development workshop, containing a bathroom laboratory, a kitchen laboratory, the future craftsman's workshop, the central building utilities room and a planning and advice office, which also handles teleservices.

Klaus Scherer of the IMS, initiator of the project and now project manager for strategy and marketing, defines the objectives as follows: "On the one hand we want to find out how various appliances, components and infra-structures, which often operate on the basis of extremely different standards applicable in different professional fields, can be made to work together in a single system, in a useful and efficient way. In other words: find ways for technologies to understand each other better. And on the other hand we want to find ways for technology and people to understand each other better. The aim is to provide people with genuine support in their living environment, in their world of work, in communications and in mobility. This means, for instance, that the technology must as simple as possible to operate."

The operators of inHaus are testing several networks simultaneously, both cabled and wireless. The system integration solutions are largely based on Internet technology. The IMS has embedded this technology in the appliances and system components ('embedded Internet'). The multimedia home cabling system HomeWay links TVs, telephones and personal computers, and provides any required service in any room of the house. Hometronic and EIB networks use wireless and cable connections to control all electrical elements, including heating – fully automatically or by manual keypads, via remote control or telephone and Internet. To allow the Internet messages to leave the house, the IMS and its partners have developed a Residential Gateway, as the central element linking the external and internal data networks. It works both ways, so inHaus residents can connect with the appliances in their home while they are at work – to check their status or issue remote-control commands. Another major element, providing links with services in the outside world, is 'Smart Home', a novel Internet service platform that is connected to the Hometronic wireless network in the inHaus complex. Special emphasis has been placed on new functions for saving energy: Sensors in the rooms measure the temperature, humidity and air quality, and automatically open and close the motor-driven windows. If a thunderstorm approaches, the house automatically makes sure that everything is weatherproof. When the occupants leave the house, the heating switches itself down to economy level.

"In ten years or so," predicts Klaus Scherer, "the intelligent house will have become a normal part of everybody's life." Already today, it is possible to catch a glimpse of the way of life and working to come.

The inHaus partners are: Ackermann, BurgWächter/Secu, Deutsche Telekom/ T-Systems, Fraunhofer IMS, Geberit, Grothe, Henkel, Honeywell, Kaldewei, Liebherr, Merten, Miele, Siedle, Sony, Stadtwerke Duisburg, Viessmann, Volkswagen, Winkhaus and ca. 60 component suppliers and sponsors

Links:
http://www.inhaus-nrw.de
http://www.ims.fhg.de/englisch/index.htm

Please contact:
Klaus Scherer — Fraunhofer Institute
for Microelectronic Circuits and Systems
Tel: +49 203 3783 2 11
E-mail: scherer@ims.fhg.de

Enabling Ambient Intelligence Research with SoapBox Platform

by Esa Tuulari

One approach for ambient intelligence research is to study what happens as sensing, computing and wireless communication capabilities are added to everyday objects. At VTT Electronics scientists have designed and implemented SoapBox, Sensing, Operating and Activating Peripheral Box, which makes this approach possible.

SoapBox is put together from commercial components. It possesses small size, low power consumption, RF-communication in unlicenced radio-band and a set of in-built sensors. It also has IO capabilities to connect to user devices. As user devices we use mainly PDA's which nowadays offer decent support for application development. However, using a PC or laptop is also possible.

By installing SoapBoxes in everyday objects we really can have computers everywhere. With the wireless communication link all these computers are continuously connected to the user device, enhancing user-real world communication to entirely new level compared to situation with no such system or systems based solely on existing commercial devices (see Figure 2).

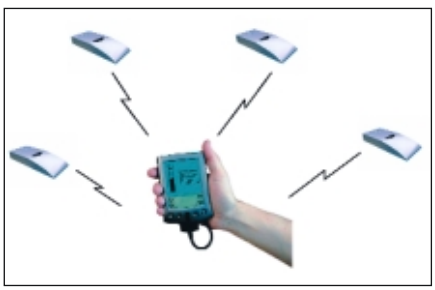


Figure 1. SoapBox architecture consisting of one central Box attached to the user device (in the back of the Palm, not shown) and several remote Boxes locating in the environment.

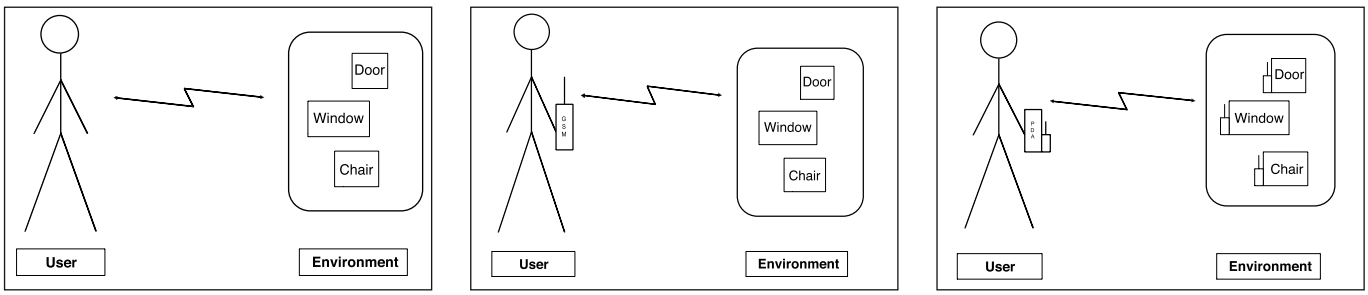


Figure 2: Enhancing user - real world interaction. Left: Original situation. Centre: Cellular phone alone doesn't help much. Right: Adding SoapBoxes in both ends solves the problem.

From the devices point-of-view also the user is part of the environment. In the SoapBox architecture we can easily instrument the user with SoapBoxes. For example measuring and recognicing user activity and user behaviour is much easier if the sensors are distributed in the limbs than concentrated in the belt or back, as is the situation with many wearable computers.

Application Examples

In general it is very easy to invent and implement new applications based on SoapBoxes. For example sensing if doors are open or closed, if someones chair has moved lately, or if there are lot of traffic in the corridor offer a basic set of applications that can be implemented with SoapBoxes.

By installing a SoapBox in the ceiling of a mailbox we can use the proximity sensor for detecting letters (or anything similar) inserted in the mailbox. The SoapBox then transmits an RF-message indicating "new mail available". If the owner of the mailbox is nearby with his PDA and central SoapBox attached to it, the message is received and the user is informed about new mail. In a factory or a store the possibility to monitor the usage of for example fork-lifts could provide valuable information. With the SoapBox this can be done without installing any tags or cameras in the building. Instrumenting the moving object is enough to start with.

Technology

Short range wireless communication is one of the key features of the SoapBox. The challenge has been to combine low power consumption and such performance parameters as communication range, bit rate and message delay. Luckily in many applications high bit rate is not needed since only short messages are used and time between messages is rather long. SoapBox electronics consists of two printed circuit boards (see Figure 3), one containing the sensors and the other containing all the other electronics. This makes it easy to develop further versions in a modular fashion.

SoapBox software has been implemented mainly in C language. A few lines of assembly language has been used mainly in timing critical parts. All the application software can be written in C, utilizing the API offering services for RF- ans RS-communication as well as for reading sensors. A single channel 868 MHz radio is used for two way, half duplex wireless communication. A small helical antenna fits inside the SoapBox encapsulation. Maximum data rate is 10 kbps and maximum transmit power is 1 mW. A real-time clock and calendar circuit is also included. It can be utilized for example for timing control functions and for recording timestamps for detected events. The sensor board of SoapBox ver. 1.0 includes four different kinds of sensors:

- Three axis acceleration sensors. These sensors can be used to measure acceleration or tilt of the device
- Illumination sensor. The intensity of visible light can be measured. The dynamic range of the sensor enables both indoor and outdoor measurements
- Electronic compass can be used for sensing the direction of the Box and also for detecting magnetic objects
- Optical proximity sensor for measuring relative distances. This sensor is based on sending IR pulses and measuring the intensity of reflected light.

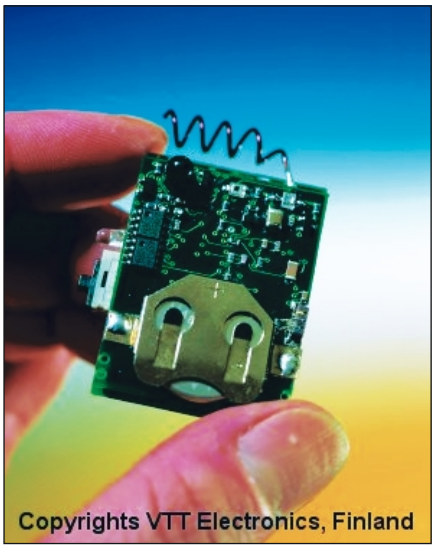


Figure 3: Picture of SoapBox boards, illustrating the size and shape of the electronics.

Acknowledgement

This work has been partially conducted in European joint research project 'Beyond the GUI' under ITEA cluster project of the EUREKA network, and financially supported by TEKES (Technology Development Centre Finland), to which organisations the author wish to express his gratitude.

Link:
http://www.ele.vtt.fi/projects/iie/

Please contact:
Esa Tuulari — VTT Electronics
Tel: +358 8 551 2334
E-mail: esa.tuulari@vtt.fi

Designing for Ludic Aspects of Everyday Life

by Bill Gaver

Researchers at Royal College of Art, UK, are developing design-driven techniques to explore people's lives, create evocative design proposals, and develop prototypes of new systems that focus on emotional and sociocultural effects.

If technology is to become 'ambient' in the sense of surrounding us throughout our lives, the question is not only what form it should take – web pages, ubiquitous computing, tangible media, information appliances, etc. – but what roles it might play in our lives. What is technology good for? How can it support our values, individually, socially, and culturally?

There is a danger that as technology moves from the office into our homes, it will bring along with it workplace values such as efficiency and productivity at the expense of other possibilities. People do not just pursue tasks and solve problems, they also explore, wonder, love, worship, and waste time. These activities, captured by the notion of 'Homo Ludens,' or people defined as playful creatures, are meaningful and valuable, but difficult to handle from traditional perspectives on Human Computer Interaction. Thus we are developing design-driven techniques to explore people's lives, create evocative design proposals, and develop prototypes of new systems that focus on the emotional and sociocultural effects.

What sort of technologies might be appropriate for Homo Ludens? One exploration took the form of a palette of design proposals called Alternatives. Over a period of about three months, we conceptualised about 20 products in the domains of home, street, intimacy, and wonder (see Figure 1). Presenting each using collages that suggested but did not specify their forms, and short descriptions that contextualised them and explained how they might be experienced, these proposals were meant to spur the imagination and open new spaces for design. The Data Lamp, for instance, is about the size of a floor lamp and allows images to be displayed on its façade or released to paint surfaces in a room. Dawn Chorus is an artificially intelligent bird feeder that trains local birds one's favourite songs. The Intimate View camera allows separated lovers to transmit close-up pictures of their surroundings for moments of intense shared focus, while the Telegotchi is a virtual creature with no controls, allowing people to practice their psychic powers as they enter into a relationship with it. These proposals are what Tony Dunne has termed 'value fictions,' exploring unusual values using plausible technologies in order to question the restricted scope currently assumed.In order to develop possibilities for ludic technologies further, we are currently engaged in a long-term research programme called Equator in collaboration with eight UK academic institutions. The Equator Project is focusing on merging the virtual with the real in situations such as performance, play, museums, and cities. Our group is focusing on technologies for the home, seeking to explore the values people have in their lives away from work. To do this, we are expanding the Cultural Probes method originally developed for another project. Having recruited about 20 households through advertisements in the popular press and on shop windows, we have distributed 'Domestic Probe' packages, with a variety of rovocative tasks to which they are asked to respond (see Figure 2). These materials include disposable cameras with requests for pictures (eg 'the most uncomfortable place in your home,' 'the view from your kitchen window,' 'something red'), a device for recording a vivid

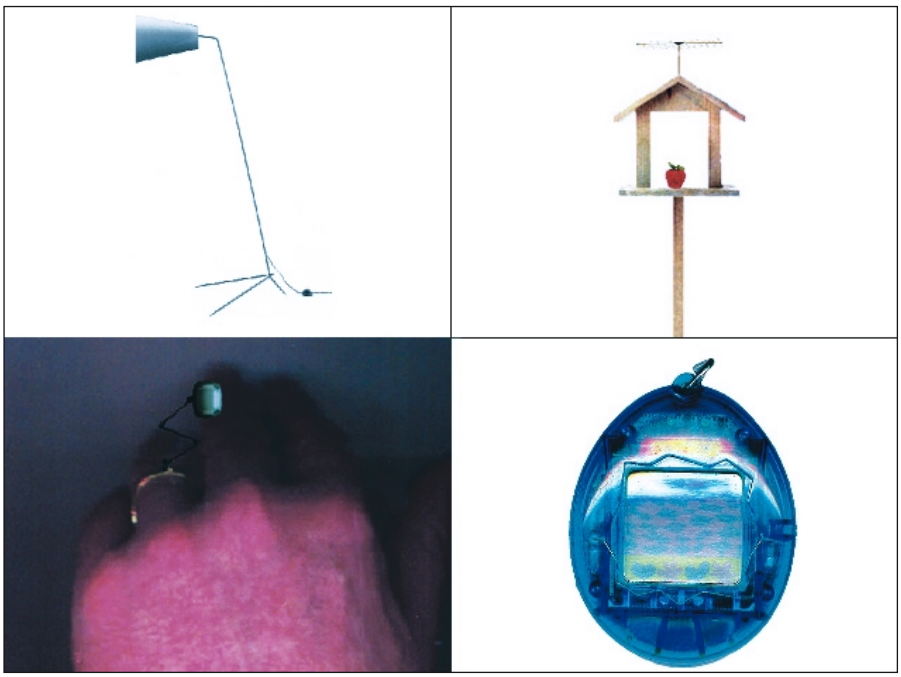


Figure 1: Alternatives proposals: Data Lamp, Dawn Chorus, Telegotchi and Intimate View camera.

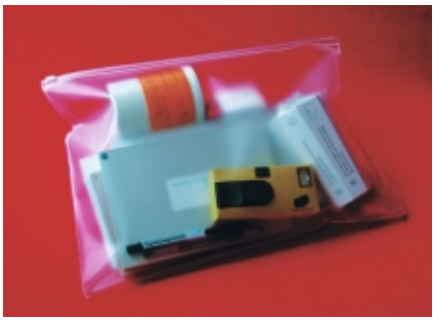


Figure 2: Domestic Probe package.

dream when they awake, a glass for listening to interesting sounds around their home, and a collection of bizarre news articles for them to annotate. The Probes are, in some ways, like the projective tests used by psychoanalysts: suggestive but ambiguous, they elicit revealing fragments from participants which inform and inspire our designs.

With most of the Probe returns in, we are beginning to develop new product concepts based on the replies. For instance, one woman revealed rigid notions of a properly ordered house, shows a strong interest in horoscopes and fortune-telling, and seeks 'positive energy' in her life. For her, we are developing a system of distributed sensors so that the state of her home can be translated into prophecies and prognoses. One man enjoys gazing at his tank of tropical fish and identifies a certain chair as the most uncomfortable spot in his home, so we are thinking about transforming the chair into a control centre from which he can guide a small telerobotic camera to watch his fish from within the tank. Finally, a musician who lives in a penthouse flat may be offered a system in which sounds transmitted to his home from wireless microphones are sampled and ordered rhythmically to allow him to make music from the noises in his environment. These proposals are in their early stages, and no doubt will develop and change before implementation, but they capture some of the possibilities we see for technology aimed at supporting people's domestic lives. They may seem whimsical, but it would be a mistake to dismiss them on that ground: for unless we start to respect the full range of values that make us human, the technologies we build are likely to be dull and uninteresting at best, and de-humanising at worst.

Link:
http://www.crd.rca.ac.uk

Please contact:
Bill Gaver — Royal College of Art, UK
Tel: +44 20 7590 4296
E-mail: w.gaver@rca.ac.uk

Ubiquitous Service Environments

by Carl Gustaf Jansson and Peter Lönnqvist

The FUSE (Future Ubiquitous Service Environments) group focuses on transparently accessible configurations of services made available on assemblies of personal / public / mobile / stationary devices that melt into the periphery. FUSE is affiliated with KTH in Stockholm and funded by both national and EU sources, eg the IST FET Disappearing Computer project FEEL (2001-2003).

Service Environments are dynamic configurations of services available in physical spaces for both collaborative and individual use. An important objective is to achieve service environments that are open, transparent, adaptive and degrade gracefully with respect to capabilities of the interactive devices available in the room. The term ubiquitous refers to the objective that device technology preferably should be designed in such a way that it melts into the periphery when not needed (ambient or calm technology).

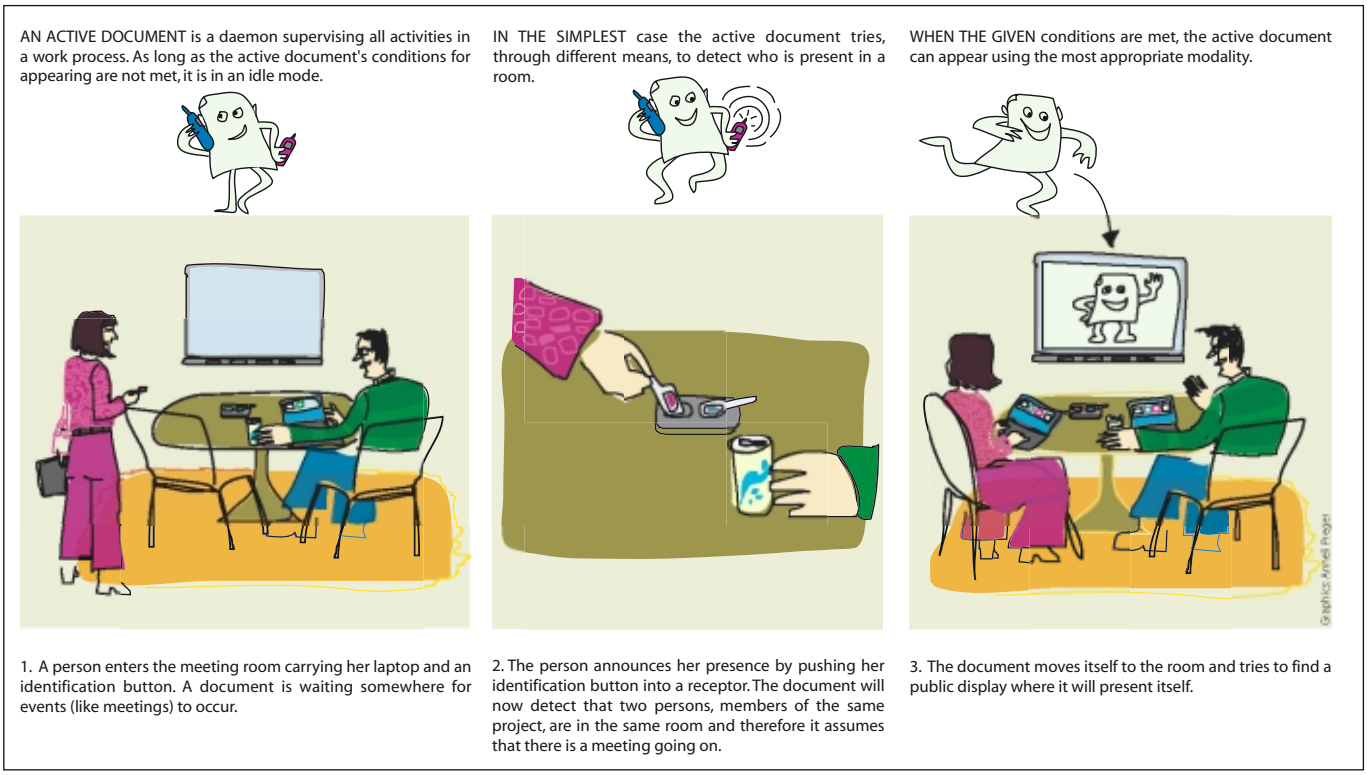
Inhibiting factors for the realisation of ubiquitous service environments are device technologies of today characterised by heavy, bulky, focus demanding devices, weak integration between IT- non IT devices, strong division between private and public devices, weak local communication among devices, too many wires for energy and communication and static individual behaviours and configurations of devices.

The situation of today can be remedied in two ways:

- Establishing a richer set of channels for interaction, by disassembling interactive devices (order of 10 ->100) accommodating non-conventional appearance of interactive devices, mix the use of private and public devices, the use of mobile and stationary devices as well as the use of several modalities (sound, visual and tactile modalities)
- Enforcing synchronised behaviour of services and devices, by configuring devices in a wireless, dynamic and ad-hoc fashion, creating adequate mechanisms for context sensitivity both for physical and organisational contexts and finally allowing for collaboration and communication between services.

The FUSE group focuses on the following issues:

- design of software architectures for ubiquitous service environments
- development and test of prototypes of interactive services that support distributed as well as local work
- design of ubiquitous hardware environments with the two foci above, to diversify and to synchronise
- HMI issues such as design of interfaces for small devices, tangible interfaces, multi-modal transparency, adaptability as well as properties of conscious/non conscious interactions
- AI issues like negotiation mechanisms for intelligent software agents for synchronisation of services and implementation of autonomous and proactive services in a form called 'active documents'
- Software Security and privacy issues focussed on client authentication and access control in dynamic and ad-hoc environment
- systems complexity issues, like problems raised by scaling up in terms of number of devices, modalities and services as well as emergent behaviours in the system.



Active documents supporting teamwork.

Current FUSE projects include:

- FEEL, an EU IST FET Disappearing Computer Program project, aiming at mechanisms that ensures less intrusions on collaborative work from parallel electronic individual and distributed work. The project attacks the problem by employing a number of the above mentioned principles. The work involves both prototype design and simulations.
- I-space, funded by the Swedish Wallenberg Foundation, aiming at interactive spaces where the 'technology level' can be easily adjusted and where specific 'working modes' can be easily restored. In a collaborative project with CS dept. at Stanford University, project based courses at both locations will utilise co-designed interactive spaces. A substantial grant has also been received for establishing an interactive space with ambient characteristics in the educational facilities at KTH in Kista.
- MEETPCC, a project funded by the Swedish Foundation for strategic research (SSF. The project focuses on active documents that supports work processes and which are context sensitive and able to detect specific events as well as these active documents strategies for materialising themselves on the technology available in the space where the event occurs. This project involves both aspects of human machine interaction, computer security and artificial intelligence (see figure).
- Agent Based Technology, a project funded by the Swedish funding agencies NUTEK/VINNOVA, focussing on negotiation mechanisms for software agents. Negotiation among software agents is used as the primary mechanism for synchronisation of services. Both rationalistic, market-based and social paradigms for negotiation have been utilised.

Future extensions of the work as outlined in current project proposals include:

- handling mobile robots as active participants in the interactive spaces
- handling seamless and graceful degradation of functionality of services when moving between interactive spaces with different characteristics
- exploring social paradigms for negotiation among multiple services.

FUSE is a research group at the Dept. for Computer and Systems Sciences at KTH in Stockholm, Sweden. FUSE is also affiliated with the new centre for Wireless Systems at KTH. FUSE co-operates directly with SICS and the University of Southampton within the FEEL project and more loosely with ERCIM members such as GMD and INRIA through related projects within the Disappearing Computer Initiative.

Link:
http://www.dsv.su.se/fuse/

Please contact:
Carl Gustaf Jansson — Royal Institute of Technology (KTH), Sweden.
Tel: +46 8 16 1605
E-mail: Calle@dsv.su.se

Offering a Consumer-Oriented Ambient Intelligence Environment

by Valerie Issarny

OZONE is an IST project that aims at specifying and implementing a generic framework that will support the effective use and acceptance of ambient intelligence in the consumer domain. Nine INRIA research teams are contributing to OZONE, focusing mainly on the service enabling and software environment layers of the OZONE framework.

The objective of the OZONE project is to develop novel concepts, techniques and tools to provide invisible computing for the domestic and nomadic personal use of information technology. The developed concepts aim at improving the acceptability and usability for the average customer. One of the important concepts is the application of advanced technologies to support the user centric retrieval and consumption of information compared to the, current practice, computer centric approach. This requires special emphasis on natural interfaces that put the user in the foreground, and the system in the background. Security and privacy are prerequisites for consumer acceptance of these systems and are covered in the project's objectives. A final objective deals with the provision of a strong technology base, enabling powerful, but energy-efficient, computing.

The OZONE project targets the provisioning of a generic framework that is not tailored to a specific environment but that is rather able to integrate new technologies as they appear. The framework architecture is based on a layered approach ranging from 'service enabling' functionality over the 'software environment' towards the underlying 'platform architecture'. An incremental approach of specification, design and prototype implementation will be applied to arrive at enabling technologies, providing a generic invisible computing framework driven by demonstrator scenarios from the extended home environment area.

The main focus of INRIA in OZONE is on the service enabling and software environment layers. INRIA also contributes to some specific aspects of the platform architecture layer, relating to silicon compilation technology and resource management. INRIA will further develop a demonstrator of a new transportation system based on fully automated vehicles. The OZONE research will concern the human interface with the transportation system: reservation and call of vehicles, on-board control and information, city information, etc. The information support will be based on fixed terminals (home or office or city) as well as portable and on-board devices.

The service enabling layer comprises enabling technologies for seamless service discovery based on the user's location and context, and for multimodal and secure access to available and personalized services. Core of the work will focus on the design and implementation of a linguistic knowledge management support environment to supply the situation sensitive information to the services operating in the framework, so that they can adapt to the context in a dynamic way. Next to this functionality, functionalities will be developed to support the application of multimodal user interfaces from the services as well as measures to protect the privacy of the user. For the multimodal interfaces, the combination of speech input with pointing devices will be the starting point; the application of vision will be investigated as an extension to this idea.

The software environment layer provides the necessary support for achieving service delivery, independent of connectivity, device in use and power supply means. Component-oriented software development methodology, and currently available tooling to help the development and deployment of distributed software systems will be taken as a starting point for the design of the software environment. However, these technologies are not sufficient to seamlessly offer services to users from the existing services that are available worldwide. Any requested service should be deployed dynamically in a way that guarantees both the functional and the non-functional properties that are expected from the service by the end-user. The approach undertaken to meet the aforementioned requirements lies in the combination of two technologies:

- mobile agent technology will be exploited for the specification of the complex services to be deployed dynamically with respect to both the base services to be used and the user environment
- component-based technology will be exploited for the integration of existing services, hence enabling their use by mobile agents.

The OZONE IST project will start in November 2001. The project will first investigate the specification of the generic OZONE framework, based on requirements elicitation and extensive inventory of the relevant technology domains. The project will then elaborate the generic framework enabling consumer-oriented ambient intelligence applications, which will be assessed using applications from the extended home environment area. The INRIA research teams contributing to OZONE are: Langue & Dialogue, Maia and Parole at INRIA-Lorraine, Cosi and Temics at INRIA-Rennes, Sirac at INRIA-Rhone Alpes, and Imara, Moscova, and Solidor at INRIA-Rocquencourt, The other partners of OZONE are: Philips (Project coordinator, The Netherlands), Interuniversity Micro Electronics Center (Belgium), Laboratoire d'Electronique de Philips (France), EPICTOID (The Netherlands), Technical University Eindhoven (The Netherlands), and Thomson Multimedia (France).

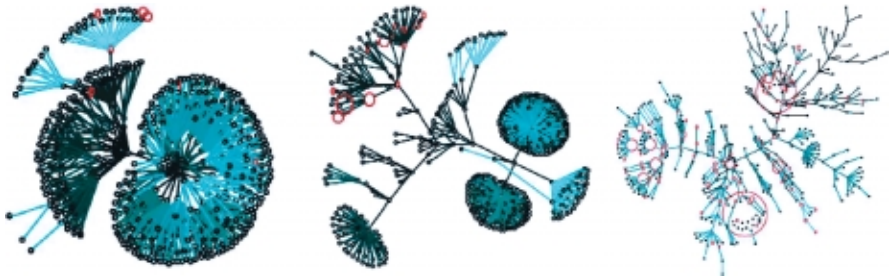
Please contact:
Valerie Issarny — INRIA
Tel: +33 1 39 63 57 17
E-mail: Valerie.Issarny@inria.fr

Global Ambient Intelligence: The Hostess Concept

by András Lörincz

The Neural Information Processing Group of the Eötvös Loránd University, Budapest, launched a project 24 months ago to develop a general methodology for distributed collaborating goal-oriented experts (including humans) without using any assumption on synchronization. The expert community will have adaptive means for distributed computing, editing, and decision-making. Medical applications and home monitoring are in focus.

The research has originated by noticing the need for adaptive asynchronous information collection and control methods for distributed decision-making. Several experiences (see, eg http://www.eds.com/case_studies/case_arkansas.shtml) point towards this direction. Our model example is the complex case of Parkinson disease patients (PDPs) using Deep Brain Stimulators (DBS). Simpler systems can be derived as analogies of this case.



Crawlers:
Left: breadth first crawler, middle CF crawler of the NEC Institute, right: ELU NIPG crawler. The diameter of the red circles is proportional to the number of hits at a given site. The color of lines shows recency of the search. Dark blue: early part of the search. Light blue: recent part of the search. The size of travel is inversely proportional to the line thickness.

For PDPs, histories of individual patients show that sporadic experiences at different hospitals need to be collected to improve evaluation. Remote setting of the DBS, augmented reality with information collection and data management together, could form global ambient intelligence (GAI) for full support of the patients. Data management should meet constraints derived from Good Clinical Practice and could be seen as an extension of drug administration procedures. GAI can serve the patient, can help the doctor and can estimate risk. Adaptive tools for such (safety critical) applications have become available by our latest achievements in reinforcement learning (RL). Optimization of decisions on continuing data collection or executing an action can be termed as optimization of perception-action loops. Such challenging optimizations concern partially observed environments, being in the focus of RL research. We are not aware of any similar global approach on the field.

The project aims at defining the 'hostess', 'who' is a goal-oriented agent with possibly adaptive and distributed subsystems. The hostess 'serves' someone, eg a patient, a visitor, the owner of a home, or groups of those. For the interactions with people served, the hostess makes use of signals that are important for efficient human communication, including facial expressions, prosody, body talk, and behavioral patterns. In case of Parkinson disease patients global ambient intelligence needs to exploit:

- the medical history of the patient (available locally or over the internet)
- the medical history of other patients
- mobile communication outside of safe environments (PDPs with DBS often engage in activities outdoor)
- optimization of the neural prosthetic device, the DBS, with option for remote control
- visual, acoustic and haptic augmented reality tools
- distributed data editing
- (provisional) access control
- decision-making in this safety critical situation.

A particular aspect of the project is that decision is achieved by combining the assessments of experts who may be located at different sites and may have different roles. The access to (medical) data may improve the decisions at the expense of real time, communication time, and computational costs. Risk-sensitive decision-making needs to consider pipeline operations, both in communication and in computation tasks. The project is 'just-in-time-research'. We develop components under the assumption that Quality of Service will be available for internet networks in about two years.

State-of-the-art techniques have been adapted, developed, and are ready to use on the following fields: connectionist parallel algorithms, reinforcement learning for partially observable environments, parallel techniques for satisfiability problems, adaptive and robust control methods, tracking and probabilistic inference methods, internet technologies. The components are developed in a modular fashion. Some of the components are in use or are ready to use. Examples include text clustering and classification tools for search on the internet and other databases, tree validation, clustering and classification tools for XML documents, time series recognition and time series prediction tools, internet crawler and hostess technology in JAVA.

At each stage, the technologies we have adopted or developed undergo functional testing. For example, our internet crawler has been under testing. Medical

doctors will help to improve graphical user interfaces. Two other components close to testing are:

- connectionist knowledge representation (CFR) for individual (human) experts which/who are not present during decision-making
- facial expression recognition software.

Results on these components will be available in six months. CFR will be tested by its distributed editing capabilities for expert teams. We see no bottleneck for global ambient intelligence. Today, all essential technology components are within reach, including:

- JavaSpaces, the flexible message-ware between available/existing software components at various sites
- XML access control (XACL) for provisional authorization
- reconfigurable hardware components.

Sub-components of the project have potentials for other immediate applications.

Individual sub-projects have been and are supported by:

- EOARD of US Air Force, London (Structure based identification of XML documents)
- Honda Future Technology Research, Germany (image processing for humanoid robots)
- Panasonic, Osaka (Software-hardware co-synthesis with pipeline operation using intelligent properties).

The figure is about our internet crawler that combines support vector machine and RL. Three graphs show the search patterns of the traditional breadth first crawler, the state-of-the-art context focussed (CF) crawler (NEC Institute), and our crawler. It can be seen that our crawler travels further and collects more information (given by the red circles). The efficiency of our crawler is almost an order of magnitude better than that of the state-of-the-art NEC crawler.

Link:
http://www.inf.elte.hu/~lorincz

Please contact:
András Lörincz — Eötvös Loránd University, Hungary
Tel: +36 1 463 3515
E-mail: lorincz@inf.elte.hu

Ubiquitous Computing Infrastructures

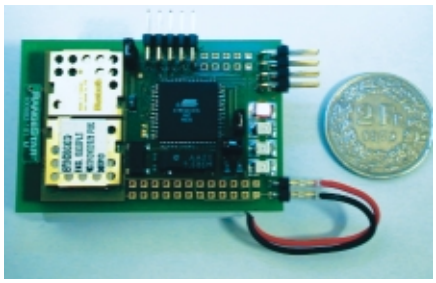
by Friedemann Mattern

Incorporation of computing power into everyday objects gives rise to 'smart things'. To enable communication and cooperation among such smart objects, new information infrastructures are required. The Distributed Systems Group at ETH Zurich addresses the challenges of designing and implementing such infrastructures.

Ubiquitous computing aims at making computers available throughout the environment, while rendering them effectively invisible. Real-world objects that contain embedded processors and sensors provide novel ways of accessing information, but they may also react to their environment and they may provide new emergent functionality when interacting with other smart things.

This vision of smart objects in particular and ubiquitous computing in general is grounded in the belief that microprocessors and advanced sensors will soon become so small and inexpensive that they can be embedded in almost everything. It is expected that billions of such objects will be interwoven and connected together by wireless networks, forming a world-wide distributed system several orders of magnitude larger than today's Internet. Infrastructures for cooperating smart objects have to cope with a highly dynamic environment and should, among other things, provide location information to mobile objects, represent context information, and enable reliable and scalable service creation.

One of the major ubiquitous computing projects at ETH Zurich is the Smart-Its project. It is one of 16 projects conducted under the European Union's Disappearing Computer initiative within the Future and Emerging Technologies programme. Its goal is to develop unobtrusive, deeply interconnected smart devices (so-called 'Smart-Its') that can be attached to everyday items in order to support new functionality, novel interaction patterns, and intelligent collaborative behavior. Eventually, Smart-Its should be as cheap and as small as state-of-the-art radio tags (RFIDs), but in addition they will also be able to communicate with peers, and they will be customizable in their behavior. In order to facilitate a meaningful integration in their environment, Smart-Its are equipped with various sensors providing context information.



One of the first Smart-Its prototypes, based on an Atmel microcontroller. Bluetooth modules allow communication between different devices.

Smart-Its only develop their inherent potential when acting in a collaborative environment together with other Smart-Its providing different sensor information and services. They require a background infrastructure in order to access distributed services, connect to remote devices, or exchange application-specific information. Among others, such services include location and security services as well as services for the propagation of context information.

The Smart-Its project is conducted in cooperation with the Perceptual

Computing and Computer Vision Group (ETH Zurich), the Cooperative Systems Engineering Group (Lancaster University, U.K.), TecO (University of Karlsruhe, Germany), PLAY (Viktoria Institute, Sweden), and VTT. The research areas being addressed include: embedded device development, perceptual computing methods for collective perception, infrastructures for smart devices, architectures for context-awareness, and evaluation of application scenarios.

At ETH Zurich, we are engaged in developing and evaluating appropriate communication schemes and adequate infrastructures for cooperating Smart-Its. However, we also interested in security and privacy issues, since this will be of prime concern in a world of highly interconnected, autonomous smart devices that will eventually permeate our everyday lives, effectively placing us under constant surveillance.

Furthermore, we cooperate with the University of St. Gallen in the M-Lab project to identify and create business applications for smart things in the area of business-to-business. The goal of the M-Lab is to build up a critical mass of highly qualified researchers and practitioners in the field of applied ubiquitous computing.

Ubiquitous computing is also part of our teaching activity. Besides teaching fundamentals of distributed systems, distributed algorithms, and Internet technology, our graduate level curriculum focuses on state-of-the-art research in ubiquitous computing. In our ubiquitous computing laboratory, students can devise and build their own smart environments using handheld devices (eg, mobile phones or pen-based computers), ID systems (eg, smart cards or RFID tags), and wireless communication equipment such as Bluetooth or WLAN.

Links:
http://www.inf.ethz.ch/vs/
http://www.inf.ethz.ch/vs/res/ubicomp.html
http://www.inf.ethz.ch/vs/res/proj/smartits.html
http://www.m-lab.ch/

Please contact:
Friedemann Mattern — SARIT/ETH Zurich
Tel: +41 1 632 05 36
E-mail: mattern@inf.ethz.ch

Ubiquitous Computing and Embedded Operating Systems Design

by Michel Banâtre

A research activity at INRIA concerns the impact of Ubiquitous Computing on operating system design, particularly the aspects related to Java for appliances, Spontaneous Information Systems and context awareness.

One of the main purposes of an operating system is to provide the basic mechanisms to manage hardware resources available on architectures in order to run applications in an efficient way. Obviously, its purpose is not limited to hardware resources management, it provides all facilities for their virtualization to make resources accesses easier.

Resource management is always the problem that operating systems researchers have to solve. Obviously solutions provided ten years ago, need to be strongly reconsidered, mainly due to the evolution of the hardware architectures and also to new application domains. Some of these application domains have already been carefully considered. For example a lot of research has been carried out concerning multimedia applications. Here, one of the main problems is to guarantee a 'quality of service' (QoS) which can be defined in terms of security, availability or efficiency: Today, the growing interest for mobile devices (PDA, cell phones, Car Information Systems, etc.) requires advanced researches in the emergence of 'Ubiquitous Computing'. Intuitively it can be defined as making computer systems pervasive, enhancing user interaction with the environment, as seamlessly as possible. Obviously context awareness plays a major role in this area. The Ubiquitous Computing research area is not new, Marc Weiser identified it ten years ago. However, at that time the need of specific equipment in term of communication facilities or terminals made difficult to imagine what kind of applications could benefit from the new research area. Today, the situation is totally different with the development of wireless communication facilities (eg GSM), the new generation of mobile phones and PDA, the short distance wireless technology (wavelan, bluetooth, etc.). Some research projects are running, but they are mainly concerned with the definition of user interfaces or interaction scenarios between the user and its PDA, which leads to the notion of 'wearable computers'. A great deal of research remains to be done about operating systems to support Ubiquitous Computing. Reasons for this are:

- these systems could be considered as embedded systems as they have to ensure some minimal running facilities in a strictly autonomous way during a mission for which we do not know, a priori, the tasks which will be run
- these systems may have to ensure soft real time constraints due to possible multimedia applications
- these systems have to take into account the specificity of some kind of resources, in particular the energy, the physical context and the mobility of the user, and the limited amount of some resources such as memory or CPU
- these systems have to be designed taking into account the instability of cellular networks (bandwidth, connection, etc).

To summarize, we can advocate that operating systems have to be reconsidered taking into account constraints related to the physical environment at large. To do that, we need to examine the impact of ubiquitous computing in areas such that resource allocation, load balancing techniques, scheduling algorithms, etc. It is clear that a lot of results exist concerning these activities, but the challenge is to provide global solutions, which take into account simultaneously, for example, soft

real time requirements, energy consumption and short distance wireless connection.

Our research theme is devoted to the design of such operating systems, through three main activities. One is related to the design and the implementation of a Java Development Environment that allows the development of Java multimedia application targeted appliances, the other one concerns spontaneous information systems based on 'Short Distance Wireless' (SDW) technologies, and the last one is about location awareness.

Java Development Environment for PDA

The main goal of this activity is to envision the use of wireless appliances that allow the user to perform actions such as Internet accesses, application downloading, and phone calls. However, the actual provision of the aforementioned environment on the wireless appliance is far from straightforward; hardware and software solutions still need to be devised. Our research concerns software solutions design. A wireless software environment must meet the following requirements:

- maximize efficiency so as to support efficient execution of applications, possibly run concurrently
- minimize power consumption so as to provide users with highly autonomous, small-sized appliances
- maximize availability so that users can benefit from their appliances despite the occurrence of failures
- support multimedia applications, which have 'soft' real-time constraints
- support dynamic downloading of applications (eg through Internet).

A Java environment achieves the latter requirement. Furthermore, the de facto standard status of Java leads to a significant amount of available software, which will continue to grow. However, providing a Java environment for appliances that both supports multimedia applications and exploits the underlying hardware, which could be a multiprocessor, is an open issue and constitutes the main core of our current research. A Java runtime environment has been designed that allows the development of Java multimedia applications, targeted for appliances. Such an environment supports:

- concurrent execution of multimedia applications, by handling associated timeliness requirements
- efficient execution of applications by exploiting the underlying architecture
- parallelism together with minimal power consumption, through the provision of complementary scheduling and load balancing policies.

Currently, the research is devoted to taking the benefit of the underlying hardware in order to improve the efficiency of our environment.

Spontaneous Information Systems

A spontaneous information system is a system composed of computing devices that are carried by people and that communicate by a Short Distances Wireless (SDW) interface. Devices can only communicate with each other when they are within a relatively short distance. Since devices are mobile, a device may leave a network at any time – simply by being moved out of communication range of other devices. Spontaneous networks are analogous to human groupings: people can only directly communicate when they are close, strangers that meet may exchange information, and this exchange may lead to further exchanges (notably of more sensitive information) as the relationship develops. A person can find himself in a network at any time, and the network around him or her varies over time. It is very easy to imagine relevant applications of this paradigm: medical domain, e-commerce, PDA-to-PDA information exchange, games, etc.

Among all the challenges we have identified, we have selected some which demonstrate the real need for new research. One is coming from the fact that the network composition is dynamic and localized. Devices can only communicate with devices in their neighbourhood, and once a device leaves the range of communication, it no longer forms part of that network. A device can only use the information available on its current network. The second one is autonomy. For instance, many spontaneous systems are formed mainly by PDAs, which are programmable devices. On the one hand, this makes the range of possible applications large. On the other hand, it introduces extra complexity since devices may interact in unforeseen ways. For example, a device may use a protocol that other devices are unaware of.

The last important feature of spontaneous systems is that the value of the information can be highly localized in time and place. For instance, information about a traffic jam can be useful to a person in a car who is one kilometer from the jam, but the information is useless one day later or to anyone who is not in a car. Information in a spontaneous network is highly contextual and situational.

All of these problems combined are particular to spontaneous information systems and suggest a new form of building and operating systems as the user's physical mobility has to be taken into account at the resource management level (energy, CPU, etc). Currently we are involved in two main directions, one related to the proposal of predictive scheme in order to estimate the communication time depending on users' mobility. The other is concerned with data location and accesses. In order to integrate all these results a demonstrator is under construction.

Location Awareness

Location awareness is the last important aspect to consider: ubiquitous computing enables the system to fade into the environment, by its potential to guess the context of the users without requiring explicit interactions from them. Up to now, most localization services were used to build applications related to navigation (helping the user to locate himself or other entities in the environment, like GPS car navigation system). We believe that a lot of research still has to be done for a true context-aware system, which uses localization as a part of the context representation (along with time), to go further than a navigation application. Currently we have designed an original solution based on SDW technologies to dynamically sense the relevant context aspects of a mobile user.

Acknowledgements

Java Development Environment for PDA activity is supported by Texas-Instruments and the Spontaneous Information Systems activity is supported by Alcatel R&D

Please contact:
Michel Banâtre — INRIA
Tel: +33 2 99 84 72 85
E-mail: banatre@irisa.fr

Ambient Interfaces for Distributed Work Groups

by Tom Gross

The Computer-Supported Cooperative Work group of the Fraunhofer Institute for Applied IT develops ambient interfaces bridging the gap between the physical and the electronic world and supporting distributed work groups with a shared environment of mutual information and orientation providing a basis for smooth coordination.

Knowledge workers typically work in both the physical world with physical artefacts and in the electronic world with electronic artefacts. At the same time they work at various places and cooperate with colleagues at the same or at a distant places. So, as the knowledge workers' activities and plans span across media, locations and work groups, they need to spend a considerable amount of time and energy for orientation and coordination.

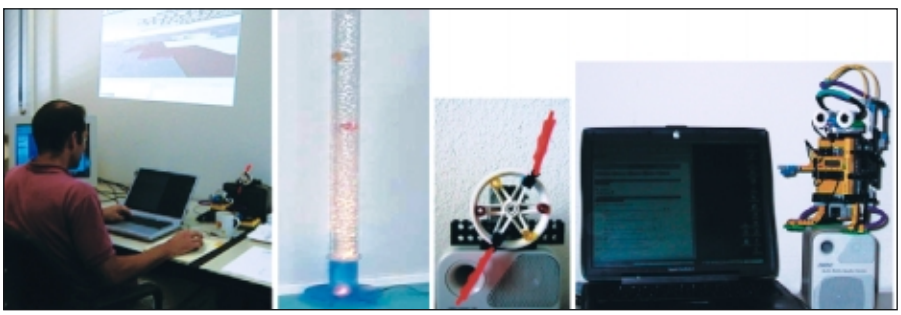
We are developing a hybrid setting that bridges the gap between physical and electronic worlds and provides a framework for orientation in both worlds. In this hybrid setting, ambient interfaces are the basis for a shared environment of mutual information fostering intuitive and adequate behaviour of distributed participants in a cooperative setting. The ambient interfaces act as sensors in the physical world and capture various types of information such as the position and orientation of a user, noise in a coffee room or movement in the hallway. On the other hand they act as indicators presenting digital information in the physical environment of the user by means of projections of digital information on the wall and physical artefacts such as fish tanks, propellers, or robots (see Figure).

In a first generation of ambient interfaces the sensors were mainly developed based on existing technology. The MOVY system was used to capture the position and orientation of a user (see ERCIM News No. 36, January 1999); a WebCam with microphones and standard software was used to capture noise; and the 'Vision Command' from LEGO was used to capture movement. Some simple binary ambient interfaces, which can be switched on and off, were developed to present the information. Relaisboards with eight relais allowed to control eight binary ambient interfaces. For instance, the fish tank starts releasing bubbles, or a propeller starts blowing air into the user's face when certain events occur. Depending on the frequency of the releases of the bubbles, the bubbling starts to aggregate, ie, when interesting events occur in high frequency, there are still bubbles from the former releases and the bubbling on a whole gets rougher indicating that a lot is going on. Additionally, the release of the bubbles produces subtle sounds of the motor and the bubbles. Thus the user can capture the information visually and acoustically. The propeller addresses the haptic sense of the user by blowing air in a subtle way into the user's face.

This first generation was deployed in users' offices and in a public coffee room. From the users' feedback three mayor requirements for the second generation of ambient interfaces were derived: customisability (ie, the developers and users should be able to easily and rapidly build and adapt ambient interfaces); aesthetics (ie, the users should like and appreciate the presence of ambient interfaces); and low cost (ie, it should be possible to deploy big numbers of ambient interfaces to individual offices and public places in office buildings).

In the second generation we developed AwareBots, ambient interfaces presenting awareness information with the gestalt of robots. Based on LEGO's Mindstorms Robotics Invention System, a broad variety of AwareBots were designed and created by project members. For instance, the AwareBot in the right picture of the figure can indicate the login of a colleague by lifting its hat and the manipulation of a document by rotating its body. In order to log into the system and to set the status to 'Available', the user simply presses the arm of the AwareBot. Other AwareBots can roll their eyes when the user's Web pages are accessed and capture movement outside of the owner's office. Additionally, a WAP interface was developed that allows mobile users to query for information and enter information manually while on the move.

For the design of the third generation the existing designs will be evaluated and possibly consolidated. As an overall output we plan to come up with basic guidelines for the design of ambient interfaces capturing and presenting information in the user's physical environment in order to provide shared guidance. The ambient interfaces described are based on the TOWER system and its event and notification infrastructure (cf. ERCIM News No. 42, July 2000). They are being developed in the IST-10846 project TOWER, partly funded by the EU, with the partners Aixonix, blaxxun interactive AG, FhG, UCL, and WS Atkins.



User with TOWER world; fish tank; propeller; AwareBot.

Links:
http://tower.gmd.de/
http://orgwis.gmd.de/~gross/

Please contact:
Tom Gross — Fraunhofer Institute
for Applied Information Technology
Tel: +49 2241 14 2091
E-mail: tom.gross@fit.fraunhofer.de

GeoNotes: Social Enhancement of Physical Space

by Per Persson and Fredrik Espinoza

Positioning technology is often associated with locating people in geographical space. The GeoNotes system, however, positions pieces of information. GeoNotes allows all users to annotate physical locations with virtual 'notes', which are then pushed to or accessed by other users when in the vicinity.

GeoNotes started in the summer of 2000 and is an ongoing project at the HUMLE-lab at Swedish Institute of Computer Science. Although the final application will rely on systems that handle automatic positioning of mobile devices, the primary workload so far has been on the application side. Today GeoNotes is a Java application that allows a user to add content, a GeoNotes place label, sender information, and access restrictions. The user then chooses a lat-long to define the place of the GeoNote, either through a map interface or 'here'.

The base server handles transactions of notes for all clients (see Figure 1). It performs requests from clients to insert notes, retrieve notes from a location, and to update a single note. It stores the actual note data (its contents), be it text, audio, or video, as an entry in the Wherehoo database (http://wherehoo.media.mit.edu/). Wherehoo is a service for storing location dependent data in a client independent manner. It stores data coupled to a field that describes the physical location of the data as a latitude/longitude position. To retrieve data, one specifies the location and a radius and the service returns all entries in that area. The server stores meta information about the usage of the note, such as the number of times it has been read, when it was last read, and so on, as data in a MySQL database.

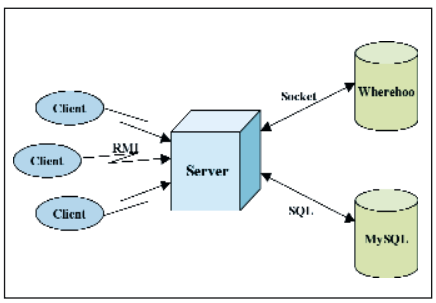


Figure 1: The GeoNote System Architecture. Clients connect to the server using RMI. The server uses a socket connection to store content data about notes in the Wherehoo database and SQL commands to store meta data about the usage of notes in the MySQL database.

GeoNotes is an open and mass-scale annotation system, allowing not only commercial or organizational annotators to add to the information space, but all users. In this way it is more similar to graffiti, toilet scribbles, sticky notes and posters than to commercial marketing channels.

As a mass-scale annotation system we can expect public and private spaces to be cluttered with GeoNotes. These traces of other people create a nice social overlay over geographical space, and thus support social awareness and processes in those spaces. At the same time, however, information overload will become a problem, making navigation support and filtering the core foci of GeoNotes.

Users can browse a map for GeoNotes or use the at-a-glance overview displayed in Figure 2, which provides GeoNotes of the immediate surroundings. The size of the circle represents the number of GeoNotes at this particular place. The pie-chart represents different sorts of GeoNotes, for instance notes specifically directed to the user or relating to some content. At the right hand side of the interface, there is a scrollable list of all GeoNotes at this specific place. Once clicked, the user accesses the individual GeoNote. The next step in the implementation is to provide a search engine for GeoNotes (perhaps in combination with a map interface).

GeoNotes pushed to the user will be filtered with social recommendation and collaborative filtering techniques. Information about users putting up notes, reading notes, rejecting notes or even

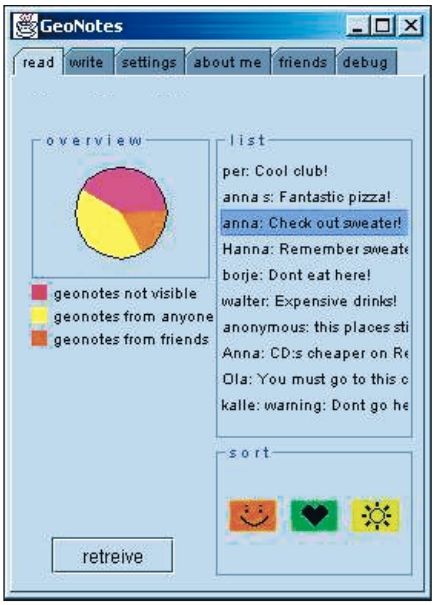


Figure 2: The pie-chart circle provides an 'at-a-glance' overview of the immediate GeoNote information space. On the right hand side of the screen is the list of the titles of individual GeoNotes.

rejecting GeoNotes senders (MacDonald's advertisements, for instance), provide valuable information to profile the user and to cluster those profiles with other users'. In this way only those GeoNotes that are shared within such a cluster of similarity will be pushed to the user. Such filtering techniques can also be complemented with traditional word-based search engines: 'only push GeoNotes that contain the words ONE-ROOM APPARTMENT or CAR FOR SALE'. Future activities of the project involve deploying the GeoNotes service on some positioning enabled PDA and conducting user evaluation.

Links:
http://www.sics.se/humle/projects/GeoNotes/

Please contact:
Per Persson — SICS
Tel: +46 70 600 1805
E-mail: perp@sics.se

Contextualisation in Nomadic Computing

by Markus Eisenhauer and Roland Klemke

Contextualised information presentation and interaction gives Nomadic Computing its backing. At the Fraunhofer Institute for Applied Information Technology (FIT), prototypes and services are currently being developed in the framework of the project 'Situation Awareness in Motion' (SAiMotion), a cooperation between FIT and other Fraunhofer Institutes that concentrates on context modeling and Human-Computer Interaction.

The baseline for the acceptance of information and communication systems is a simplified information presentation adapted to situation, task and user. On the one hand, simplified means a reduction of information by adapting the information presentation to the context (a task, situation and user adapted choice of information) but on the other hand, it means driving at an intuitive interaction with the SAiMotion-system itself. This article will concentrate on the first aspect of information adaptation. In SAiMotion, simplified information presentation is achieved through automatic proactive selection of information and context-sensitive presentation of the contents with explicit consideration of important environment variables, like daytime, noise, and the situation of communication.

Context in Nomadic Computing

For context adapted information presentation and interaction the development of a suitable context and process model is vital determining the individual information needs on the basis of location, environment, situation, user, task and activation features. In most context definitions four dimensions of context are considered (Klemke, 2000; Schilit, 1994): the location of the user in either electronic (eg an URL) or physical space, the identity of the user implying a user model with information about the user's interests, preferences and knowledge, the time (day/night time working hours, weekend, etc) and the environment (the task or activity in a current situation; other users). Approaches that take context into their account usually focus one or only few aspects like the users current position in physical space to adapt the information selection and presentation. Beyond to these approaches SAiMotion aims to provide an exhaustive situation model identifying and using all relevant situative parameters for proactive information supply and user interaction.

Contextualisation

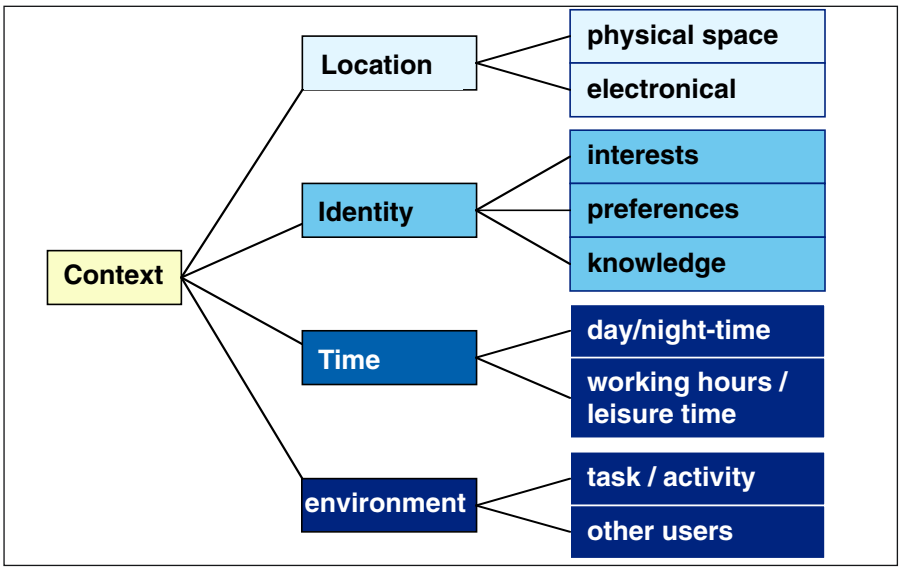
The process of information contextualisation requires filtering, annotating and aggregation of information contents. The identification of the relevant situative parameters in agreement with the above described context dimensions help to solve this task. The information need of the user is determined by the primary task as well as his present location. The objective is to assist the user by a proactive supply of actually relevant information (and functionality) so that the search and selection of information does not distract him from the primary task. Information and communication systems thus are being used to enrich the professional and personal weekday with useful additional information.

Information Selection and Anticipation

Context adapted services are dependent on the reception of the situation of the user implying the physical environment (location, objects in the vicinity, light intensity, volume) actual tasks and targets of the user, the current state of affairs in the processing of the task, the characteristics of the device – concerning in- and output of information, as well as the user's profile of interests and preferences. Depending on the present situation the probable current information need is narrowed down – and is possibly predictable, so that the information needed could be anticipated by the system.

Additionally the emerging contexts create a framework for user coordination at different locations allowing an implicit coordination of location independent communication and cooperation of users. As already mentioned the problem of privacy is to be taken into account since users are not always willing to disclose their situation or parts of their situation (eg their location) to the SAiMotion-system or other users.

In contrast to location and situation independent information access deter-



Context Typology

mining the paradigm of 'anything, anytime, anywhere' it is vital for the above described activities to provide information dependent on the present location and situation and to support suitable methods of user interaction and information presentation: The SAiMotion-system provides support for the completion of a task, by providing navigation help, information about nearby local resources that are useful for the completion of the task, selecting information adapted to the particular situation, task and user preferences, monitoring the current goals and sub goals including a warning of possible conflicts and adapting the interaction with the SAiMotion-system to the modality appropriate for the context. Moreover the SAiMotion-system is capable pursuing multiple tasks: at the counter it reminds the user of an overdue cash transfer and presents the current balance, at the supermarket it provides the shopping list and the current special offers, in an exhibition it provides a tour or information about the exhibits, on a journey it provides useful information about the city, including map, hotel information, transportation, current events, sightseeing, and culture etc.

The most important advance will be anticipated information supply: Relevant information will be proactively selected for the present task sequence or interest of the user. With the help of user, situation and task monitoring it will be possible to reduce the information explosion to information that match the interest and needs of the user to anticipate the next interaction with the SAiMotion-system and the possible content of the next request. The SAiMotion-system proactively scans for useful information and has it ready for the next request.

Conclusion

SAiMotion will lead to a great improvement in the efficacy of the user interaction with the system. Time saving and information focusing contribute to a greatly improved interaction and to greater contentment of the user. Moreover multimodal interaction and pro-active presentation mechanisms that adapt to environmental variables like daytime, noise, situation of communication will lead to context sensitive interaction. The SAiMotion-system on its own will meet a situation- and user-adapted interaction. Several partners are involved in the activities like Fraunhofer-Institut für Graphische Datenverarbeitung IGD), Fraunhofer-Institut für Arbeitswirtschaft und Organisation (IAO), Fraunhofer Institut für Zuverlässigkeit und Mikro-integration (IZM), Fraunhofer Institut für Integrierte Schaltungen (IIS); Fraunhofer Institut für Publikations- und Informationssysteme (IPSI).

Link:
http://fit.gmd.de/projects/saimotion/

Please contact:
Markus Eisenhauer — Fraunhofer Institute for Applied Information Technology
Tel: +49 2241 14 28 59
E-mail: markus.eisenhauer@fit.fhg.de

Scene Interpretation for Video Communication

by Monique Thonnat

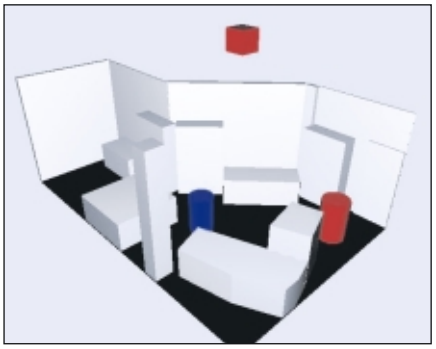
Based on Scene Interpretation, a Video Communication System can improve permanent and informal communication between distant individuals. Such a system has been realized by the Orion team at Inria Sophia Antipolis from 1999 to 2000.

By Scene Interpretation, we mean detecting and tracking several individuals in a scene (eg an office) and recognizing their behavior (eg 'two persons are meeting near the blackboard'). The concept of video communication is dedicated to allow permanent and informal Communication and group awareness between spatially separated individuals (including video-conference). Current video communication (VC) systems rise two problems. First, the static nature of the cameras interferes with the real word activity; ie the VC system should automatically follow and zoom at the main individual in the office. Second, the level of availability (protection of privacy) has to be set up automatically, if not, the studies show that VC systems will be less accepted.

For these reasons, we propose to use an interpretation system to be a part of the global VC system to automate these tasks.

Given image sequences of everyday office life, our proposed interpretation system is able to analyze the behavior of individuals. This system is composed of three modules. First, from images the detection and classification module detects moving regions by subtraction to a background image and it classifies moving regions into mobile objects adding a label giving its type, such as individual or noise. Second, the tracking module associates the mobile objects with already tracked targets that correspond to real individuals. Third, the scenarios recognition module recognizes the scenarios relative to the behavior of tracked individuals. Finally, thanks to the scenario analysis, the VC system can decide what to send to the network, a zoomed sub-image of the camera or a filtered (blur) image. For example, if the system recognizes a work meeting situation, the VC system can automatically broadcast a blurred image to protect visitor's privacy. Moreover, if the scenario 'the user is writing on the blackboard' is recognized, the system can broadcast an image zoomed on the blackboard area.

In this article, we focus (1) on the tracking module and (2) on the behavior recognition module. The tracking problem is a central issue in scene interpretation as the lost of a tracked object prevents from analyzing its behavior. We have developed a tracking method, based on a 3D model of the scene



The left image illustrates the tracking results, whereas the right image comes from a 3D animation illustrating the behavior recognition. Colored cylinders represent the individual identifiers detected and tracked in the office. Each person has it's own color.

(including 3D geometric and semantic information), on explicit models of individuals (including the 3D size of the mobile objects and the presence of skin areas) and of individual's trajectories and on the computation of several possible paths for each individual (using a time delay to improve the robustness of the algorithm). Resulting algorithm is able to cope with severe occlusions, merging/splitting individuals, errors in detection and in classification. For the behavior recognition module, we have developed a description language, close to natural language, which enable users to specify the behaviors they want to be recognized. By this way, the users can configure their own VC System and setup a desired level of their privacy.

This interpretation system has been tested on several office sequences. The longest sequence is 15 minutes time long. Some of these sequences are available on the web, at http://www-sop.inria.fr/orion/personnel/Alberto.Avanzi. These sequences show people entering the office together, crossing and overlapping each other. An example of scenario recognition "two people are meeting in the office" is illustrated by the figure. This scenario illustrates the case when guests are visiting the office and when the availability level should decrease (we don't want to broadcast guest pictures). Guests can be recognized according to the place where they sit. On a 3D animation, a flag (cube), showing the availability level, changes its color following the number of people in the office: green (nobody in the office, maximum of availability), orange (low probability of guests in the office, medium level of availability) and red (high probability of guests in the office, meeting situation, no availability). Currently, the two main limitations of the system are the mix of individual identifiers in difficult cases (eg long crossings) and to handle situations where individuals are mixed with mobile objects corresponding to noise (eg a chair moved by a person).

The first results of this Video Communication System based on Scene Interpretation are encouraging. We are planning to model more sophisticated scenarios and to complete the scene model to include 3D scene objects that are able to move (like chairs and doors). This new model will prevent paths to be mixed with mobile objects corresponding to the motion of these scene objects. This work has been done in collaboration with the IIHM and PRIMA teams from the University Joseph Fourrier in Grenoble.

Link:
http://www-sop.inria.fr/orion/

Please contact:
Monique Thonnat — INRIA
Tel: +33 4 92 38 78 67
E-mail: Monique.Thonnat@sophia.inria.fr

Mining Multimedia Documents by Visual Content

by Nozha Boujemaa and Marin Ferecatu

The IMEDIA research group at INRIA develops content-based image indexing techniques and interactive search and retrieval methods for browsing large multimedia databases by content.

Everyday, the average person with a computer faces a growing flow of multimedia information, particularly via the internet. But this ocean of information would be useless without the ability to manipulate, classify, archive and access them quickly and selectively. However multimedia is dominated by images, with respect to bandwidth and complexity.

The IMEDIA team achieves research, collaborations, and technology transfer on the complex issue of intelligent access to multimedia data streams. The prototype software IKONA illustrates this research lead at IMEDIA.

Specific and Generic Image Signatures

Visual appearance is automatically measured by numerical signature of image features such as color, texture, shape, or most often a combination of them. More specific image signatures have to be developed for special content and situations. For designing an effective image retrieval system, we find it convenient to divide image databases in two categories:

- The first category concerns specific image databases for which a ground truth is available. When indexing the database, the designer will consider these ground truths and tune the models or range of parameters accordingly, maximising the system efficiency. We have developped specific signature for face recognition and detection and fingerprint identification.

Figure 1: Generic image database. Left: Selecting a query image in IKONA; the red border indicates the selected image. Right: Query results for the selected image.

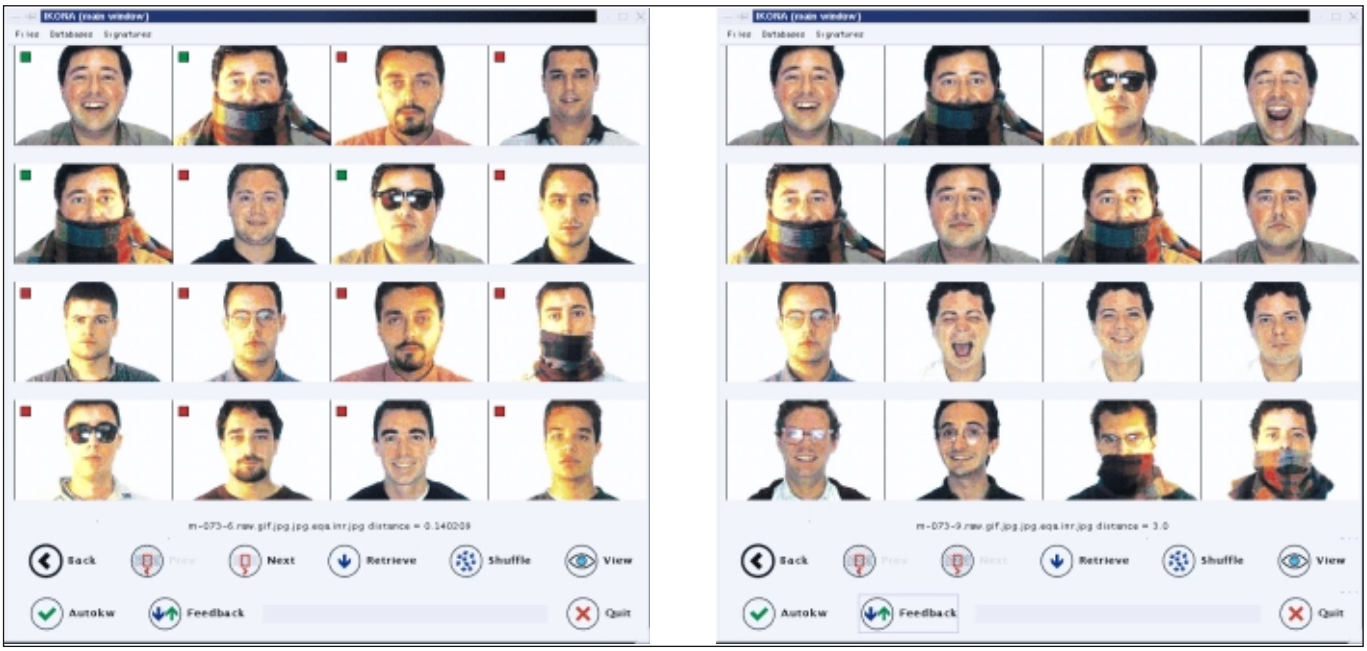


Figure 2: Specific Image database. Left: Selecting a query image with relevance feedback mecanism in IKONA. Right: Query results for the selected image. For more results on face retrieval, see http://www-rocq.inria.fr/~sahbi/Web/ercim.html

- The second category includes databases with heterogeneous images where no ground truth is available or obvious. Examples include stock photography and the World Wide Web. The user should be assumed to be an average user (not an expert). In this context, generic image signatures are computed in order to describe general visual appearance such as color and texture.

IKONA System Architecture

Our CBIR software IKONA, is based on a client-server architecture and aims to be flexible, easily extensible, easy to use, intuitive, and does not enforce special knowledge or training.

The server needs to be fast and is written in C++. It includes image feature extraction algorithms (signatures), user interaction policies (retrieve by visual similarity mode, relevant feedback mode, partial query mode, points of interest mode, etc...) and a network module to communicate with the clients.

The client needs to be portable and is written in Java; it normally should run on every computer architecture that supports Java Runtime Environment (JRE). It presents the user with an easy to use Graphical User Interface (GUI), sets the query mode for the server and display the search results.

The communication protocol is modular and extensible, ie it is easy to add new functionality (new feature extraction algorithms, searching methods, security access restrictions, etc) without disturbing the overall architecture (implementation). By default, IKONA does a 'retrieve by visual similarity' in response to a query, which means that it search all images in all databases and returns a list of the most visually similar images to the query image.

Interactive Search

In order to deal with generic databases, Ikona includes a relevance feedback technique which enables the user to refine their query by specifying over time a set of relevant and a set of non-relevant images. Relevance feedback interaction methods try to use the information the user supplies to the system in an attempt to 'guess' what are his intentions, thus making it easier to find what he wants. IKONA has a RF mode for category search in image databases, which means it can help the user to find more rapidly certain categories of images in large databases with browsing and user profiling methods. This interaction allow to compensate the 'semantic gap' in such image search system.

Region based queries are being integrated into IKONA. In this mode, the user can select a part of an image and the system will search images (or parts of images) that are visually similar to the selected part. This ineteraction allow to the user to precise to the system what part or particular object is interesting in the image. In this case, since the query is focused, the system response is enhaced with regards to the user target since the background image signature is not considered. We have developed segmentation based methods as well as point of interest methods to achive partial queries.

Hybrid Image and Text Indexing

While text indexing is ubiquitous, it is often limited, tedious and subjective for describing image content. Visual content image signatures are objective but has no semantic range. Combining both text and image features for indexing and retieval is very promising area of interest of IMEDIA team. We first work on a way to do keyword propagation based on visual similarity. For example, if an image database has been partially annotated with keywords, IKONA can use these keywords for very fast retrieval. Based on the indexed visual features and the keywords index, IKONA can suggest a number of keywords for a non annotated image and their weight. Further research on keyword propagation, semantic concept search and hybrid text-image retrieval mode are being carried on.

Short Term Involvement and Event

Several industrial partenership are going on: Judicial Policy for pedophilia problems, TF1 French Chanel with more efficency in TV journal preparation, France Telecom R&D, Thalès and Thomson Multimedia. IMEDIA has organized a first workshop of a series on multimedia content access management topic sponsored by NSF Digital Library Initiative with IBM (Watson research center) and Berkeley University. This workshop was attended by approximately 35 distinguished researchers from both academia and industry and from both Europe and United States. It provide a forum for active researchers in this area to exchange ideas on the most recent research progress and challenges in the area of multimedia content browsing, indexing and retrieval.

Links:
http://www-rocq.inria.fr/imedia/

Please contact:
Nozha Boujemaa — INRIA
Tel : +33 1 39 63 51 54
E-mail: Nozha.Boujemaa@inria.fr

How can I be sure that my DVD player understands my TV?

by Wan Fokkink, Izak van Langevelde, Bas Luttik and Yaroslav Usenko

In the context of the ERCIM Working Group on Formal Methods for Industrial Critical Systems, protocols within HAVi (Home Audio Video Interoperability) and FireWire were analysed using a combination of state-of-the-art methods and tools for verification and testing.

A young trend in consumer electronics is the ubiquitous, transparent and intelligent integration of audio, video, communication and information services that have become so widely used in the 20th century. One of the key features of this integration is the ability of digital equipment to communicate reliably in a flexible fashion, which typically includes the plug-and-play ease of use. The look and feel of ambient intelligence, however, can be instantly destroyed by a single crude error message.

HAVi and the IEEE 1394 high-speed serial bus, better known as FireWire, target a dynamic interconnection of different pieces of equipment in the home environment. HAVi is a common, openly-licensable specification for networking digital home entertainment products that has been developed by eight multinationals. Devices connected in a HAVi network can inter-operate, using each other's resources and functionality. HAVi is built on FireWire, which is designed to carry all forms of multiple digital audio and video streams quickly, reliably and inexpensively. Its architecture is scalable and a user can add or remove systems and peripherals easily at any time. FireWire has rapidly become the de-facto standard in the interconnection of digital devices.

Although intelligent household goods are mostly not safety-critical, validation of their correctness is an important issue. The financial implications of errors or bad performance can be enormous,

CWI conducts verification of embedded systems. Illustration: I.A. van Langevelde (2001).

because of their mass replication and damage to consumer interests. The high complexity of the protocols underlying such products (specifications typically require several hundreds of pages) turn their verification into a major challenge. A number of protocols within HAVi and FireWire have been analysed successfully using formal methods.

One notable study involved the analysis of the so-called HAVi leader election protocol, which was carried out at CWI. In HAVi, controllers, acting as hosts for digital devices, elect among themselves a leader with the best capabilities to supervise their controlling tasks. Each time when a change in the network of the underlying FireWire interface occurs, the controllers need to re-elect a leader. The HAVi leader election protocol was specified in the specification languages LOTOS, Promela and µCRL. The resulting models were analysed using model checking techniques, which facilitate the automated verification of behavioural properties. This analysis revealed that the leader election protocol does not meet some critical safety properties and that there are situations in which the protocol does not converge to the election of a leader. These errors were due to a lack of detail in the HAVi specification. They occur when communication between devices is faster than communication between components within one device. These aspects were taken into account in a subsequent specification of the HAVi leader election protocol.

A second study targeted the Link layer of FireWire using the language µCRL and the associated tool set, both developed at CWI. FireWire describes the serial bus in three layers: the Transaction layer offers an interface of high-level instructions, such as reading and writing of data, the Link layer transforms these instructions into packets of bits, and the Physical layer is concerned with the actual sending and receiving of the bits. The analysis brought to light a serious case of underspecification: when the Link layer receives a packet from the Physical layer, the handling of a request from the Transaction layer is left unspecified. Different solutions were proposed independently at CWI and at the University of Kiel. At INRIA Rhône-Alpes a model checking analysis revealed a deadlock, due to a flaw in the communication scheme between Link and Transaction layer. The shortest execution trace leading to this deadlock consists of fifty consecutive transitions, which indicates that it would be very difficult to discover this deadlock by means of testing.

Third, the FireWire tree identify protocol for spanning a tree in the network topology was tackled at the University of Nijmegen. This tree identification fails if the network topology contains a loop, which is signalled using a time-out mechanism. With the timed model checker UPPAAL it was detected that the timing constraints of FireWire are too lenient: they allow for scenarios in which there is a time-out but no loop in the topology. Furthermore, the FireWire root contention protocol was studied, which comes into play in the finale of the tree identify protocol where two nodes compete to become the root of the tree.

Correctness of this root contention protocol was established by a number of case studies using a combination of UPPAAL and probabilistic I/O automata. In collaboration with the University of Aalborg, precise timing constraints were derived. A young initiative is the analysis of the IEEE 1394.1 standard for Bus Bridges, being developed to connect FireWire networks through so-called `bridges'. The initial modelling of the standard in Promela at CWI and the University of Nijmegen has already revealed a number of bugs in the draft specification, in the algorithm that updates routing tables. Some of these discoveries have been taken into account in the latest draft of the standard. The aim is to conclude this verification before the standard is finalised, thus contributing further to the standardisation process. Envisioned extensions of this project include the analysis of stochastic aspects at the University of Twente.

Concluding, these case studies bring home the point that communication between for example a DVD player and a TV can benefit from the analysis of the underlying protocols by means of formal methods.

Links:
http://www.cwi.nl/sen2/
http://www.inrialpes.fr/vasy/fmics/
http://www.cs.stir.ac.uk/firewire-workshop/

Please contact:
Wan Fokkink — CWI
Tel: +31 20 592 4104
E-mail: wan@cwi.nl

Fault Diagnosis in Wireless Sensor Networks

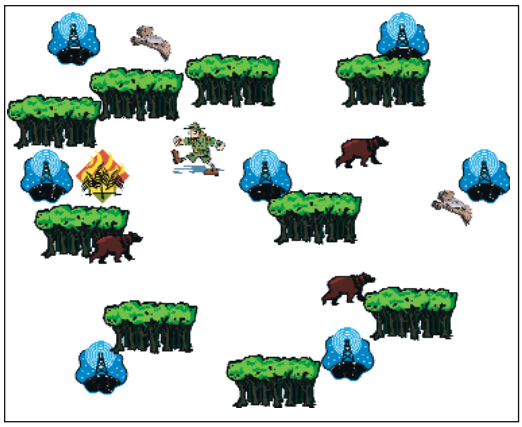
by Stefano Chessa and Paolo Santi

Scientists at CNR address the problem of identifying faulty mobiles in ad hoc wireless networks and propose an energy efficient silent fault diagnosis protocol.

Wireless sensor networks are receiving increasing attention due to their ability to monitor a wide variety of environments, ranging from remote geographical regions to industrial plants, from office buildings to toxic urban locations. A wireless sensor network is usually composed of hundreds or thousands of sensors equipped with computation, sensing and communication devices, which are coordinated in a distributed mode in order to collect information on their surroundings. During the lifetime of the network, the information collected by the sensors is periodically transmitted to sink nodes, which can be either mobile or base stations. Sink nodes are used by external operators to retrieve the information gathered by the network.

Due to the limited energy supply of sensors, protocols for sensor networks should be designed with the goal of minimizing energy consumption. For this reason, energy-efficient information dissemination protocols for sensor networks have been recently proposed in the literature. These protocols exploit network redundancy to achieve fault tolerance: when a sensor crashes (either because of battery depletion or due to a catastrophic event), neighboring sensors can cover, at least partially, its sensing task. However, none of these protocols provide explicit knowledge regarding the state (faulty or fault-free) of the sensors in the network. In our opinion, the extraction of explicit diagnostic information from the network could be important in those situations in which sensors repair/ reconfiguration is feasible.

In order to motivate this hypothesis, consider the following example. A sensor network is used to help rangers to monitor a vast natural park. The sensors, which have limited energy supplies and are mostly static, provide information about the presence of animals, tourists, fire, flooding and so on. Rangers, who are equipped with mobile stations, move around the park for control and maintenance. Mobile stations are connected to the sensor network through the nearest sensor. This way, the rangers can be alerted of abnormal events, and they can quickly intervene where needed. However, if there is no provision for sensor maintenance, eventually the batteries will be depleted and crash. As a consequence, the number of non-operating sensors in the system will increase until the system gets disconnected, and is no longer functional. In such a scenario, sensors should provide diagnostic information along with sensor data, thus enabling rangers to maintain network functionality by replacing faulty sensors or by recharging depleted batteries. For this purpose, sensors in the network should execute a distributed diagnosis protocol, either periodically or on-demand.



A park monitoring scenario.

However, existing distributed diagnosis protocols have been designed either for multiprocessor computers or for wired computer networks. As a consequence, all the protocols proposed so far assume that units communicate according to the one-to-one paradigm typical of wired networks. This means that, if applied to sensor networks, these models are unable to take advantage of the shared nature of communication, and are thus not feasible or at best extremely energy consuming.

For this reason, we have developed a distributed silent fault diagnosis protocol explicitly designed for wireless sensor networks. The protocol takes advantage of the shared nature of communications and aims at minimizing the total number of bits exchanged for the purpose of diagnosis, thus reducing the energy consumption entailed by the protocol execution. The protocol first constructs a spanning tree of the graph representing the network topology, then exchanges diagnostic information only along the edges of the tree. This allows a significant reduction in the number of messages to be sent for the purpose of diagnosis. We have shown that the protocol exchanges the minimum number of bits required by any diagnosis algorithm for wireless sensor networks, thus proving its optimality.

We have also studied the problem of identifying soft-faulted mobiles in ad hoc networks. Contrary to the case of silent faults, soft-faulted nodes can continue to communicate with other units, although with altered behavior. We have proposed a new comparison-based diagnostic model based on the one-to-many communication paradigm. We show that using this strategy the ability to diagnose soft faults in the presence of mobility is significantly reduced with respect to the stationary case, meaning that a somewhat weaker notion of diagnosis should be considered under this scenario. We have also designed a distributed soft faults diagnosis protocol for stationary ad hoc networks based on the new model. The analysis of the time and communication complexity of the protocol shows that efficient soft faults diagnosis in this scenario is possible.

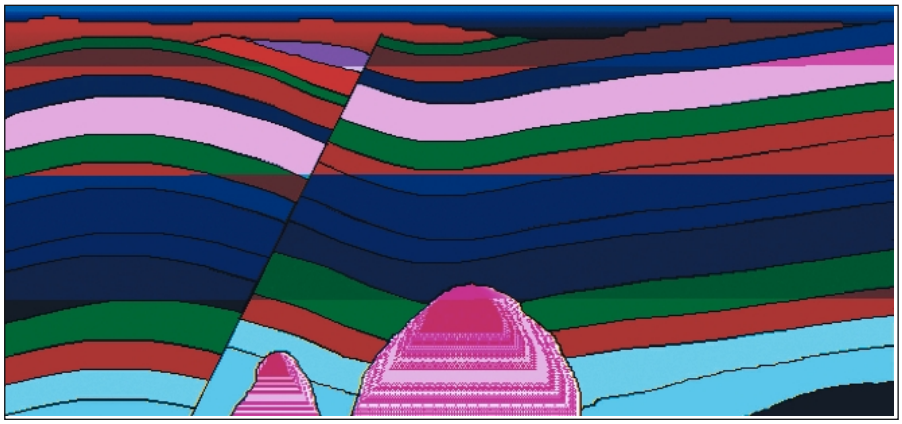
Please contact:
Stefano Chessa — IEI-CNR/Pisa University
Tel: +39 050 2212 736
E-mail: ste@di.unipi.it
or Paolo Santi — IMC-CNR
Tel: +39 050 3152411
E-mail: santi@imc.pi.cnr.it

Domain Specific Languages

by Arie van Deursen and Jan Heering

CWI is developing tools and methods to support the effective use of domain specific languages in real life software engineering projects.

The challenge of software engineering is to create flexible, reliable, scalable and maintainable systems. To achieve this, the software engineer must apply a wide variety of tools and techniques. One of these is to take advantage of the underlying application domain, by means of a domain-specific language (DSL), which provides a notation that can be used to compose applications from a set of concepts tailored towards a specific application domain. Details of the underlying implementation platform are captured by knowledge built into the DSL compiler. This compiler can translate the DSL into, for example, executable code, calls to library routines, database transactions, or HTML forms.



Seismic modelling and other computational modelling software benefits from the Sophus approach to software construction which is being developed at CWI in cooperation with the University of Bergen, Norway.

The Risla language is a case in point. It was developed by CAP Gemini and MeesPierson, in cooperation with CWI. Given a description of the essential ingredients of an interest rate product (loan, swap, financial future, ...), the Risla compiler can generate data structures in VSAM format, data entry screens in CICS format, and COBOL routines for registering modifications in the product or for yielding management information. A DSL compiler relieves the user from unnecessary details and machine dependencies.

As a result, changes in the ICT infrastructure have to be accommodated only once in the DSL compiler. After re-compilation of all DSL programs, the desired infrastructure-related changes have been effectuated without making a single change to the DSL programs themselves. Contrast this with the traditional situation that domain-related knowledge and infrastructure-related knowledge are intermixed in the program code. The use of DSLs thus leads to greater flexibility and less maintenance.

The DSL project is carried out under the auspices of the Telematics Institute (TI) and has as goals to develop methods for selecting suitable DSL domains, and for capturing domain knowledge into a DSL and its compiler; to develop meta-tools for the rapid prototyping of domain-specific languages; and to gain more experience, via case studies, with the use of domain-specific languages in a commercial setting. Legacy applications are often a valuable (but hard to exploit) source of domain knowledge. Therefore, the DSL project takes legacy systems and software understanding tools as one of its point of departure. So far, we have gained experience with a variety of analysis and renovation problems, including documentation generation for (mostly COBOL-based) legacy systems (in cooperation with the Software Improvement Group, ABN AMRO, Roccade and others), and analysis of C and and SDL systems, both in cooperation with Lucent, partner in the national Telematics Institute (TI). In addition, we gained experience with a variety of DSLs: RISLA for the financial domain (in cooperation with TI-partner Cap Gemini), Sophus for writing partial differential equation solvers (in cooperation with University of Bergen, Norway), used for instance in the area of seismic modeling for oil exploration, and a router description language (in cooperation with TI-partner Lucent). Last but not least, major progress has been made with the development of tools and meta-tools as incorporated in the ASF+SDF Meta-Environment. Results of the project can be found at www.cwi.nl/projects/dsl/

Links:
DSL project:
http://www.cwi.nl/projects/dsl/
Interactive Software Development and Renovation at CWI:
http://www.cwi.nl/sen1/

Please contact
Arie van Deursen and Jan Heering — CWI
Tel: +31 592 4075 / 4130
E-mail: Arie.van.Deursen@cwi.nl, Jan.Heering@cwi.nl

QuantifiCare: A new INRIA spin-off in Medical Image Processing

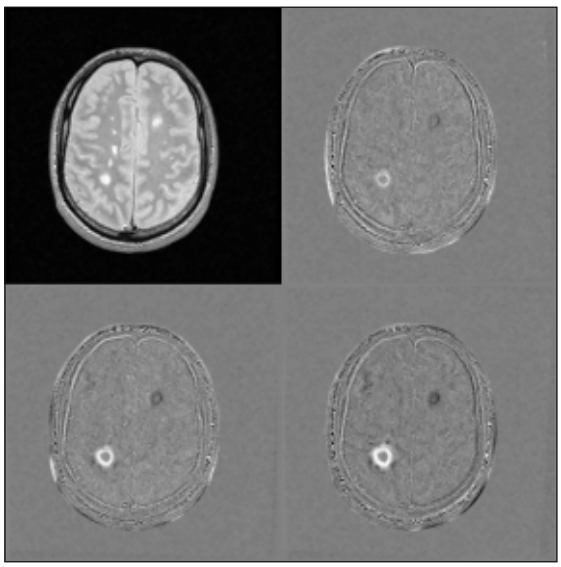
by Jean-Philippe Thirion

QuantifiCare is a newly created spin-off of INRIA, located in Sophia-Antipolis and dedicated to Medical Image Processing applications. Its first target is the quantification of disease evolution for the objective measurement of drug efficacy.

Created by several former researchers of INRIA in March 2001, QuantifiCare S.A. is a French company, located in Sophia-Antipolis and dedicated to the applications of Medical Image Processing. The first phase of its activity is to design specific protocols for the follow-up of disease evolution such as ischemia, arrhythmia, osteoporosis, lesions or tumors volumes. Amongst the studied pathologies are Coronary Artery Disease, Multiple Sclerosis, Stroke and Cancer. QuantifiCare's techniques take as input volumetric images such as Magnetic Resonance Images (MRI), cat-scans, Nuclear Medicine images (SPECT, PET∑), 3D ultrasound and provide quantitative measurements of physical parameters.

QuantifiCare is relying upon a unique expertise in 3D image matching in order to track very precisely subtle changes along time. Inter-patients image matching is also used to relate the information of different individuals and allow for population model analysis or data mining applications. An important technology transfer, relying on a large number of general-purpose libraries, as well as on dedicated matching methods, including three patents, has been signed between QuantifiCare and INRIA in June 2001. This technology has been developed over the years by an INRIA research team called EPIDAURE, created in 1989 by Nicholas Ayache. Jean-Philippe Thirion, the Chief Executive Officer of QuantifiCare as well as several other co-founders of the company, are former senior researcher of EPIDAURE.

Two product lines have already been developed by QuantifiCare and are currently improved: MPS-Quant, based on the analysis of Myocardial Perfusion Scintigraphy (MPS) studies for Coronary Artery Disease (CAD) and MS-Quant for the follow-up of Multiple Sclerosis (MS).



Evolution of multiple sclerosis plaques measured using QuantifiCare's technology. Top left is a baseline image slice, extracted from a complete MR scan of the head. Top right, bottom left and bottom right are successive exams of the same subject, acquired with a 3 weeks interval each, and matched and subtracted with the baseline image. Growing lesions appear as white annuli and shrinking lesion as black annuli. Other techniques are used to quantify more precisely different attributes of MS plaque evolutions such as the 'mass effect'.

According to the American Heart Association, more than 7 million Americans have a history of Coronary Artery Disease and 600,000 people are dying each year in the US, due to this disease. Two current treatments are proposed, which are bypass grafting (600,000 operations per year) and angioplasty (500,000 operations per year). As these operations are costly and invasive, many alternative treatments are currently being developed, such as angiogenesis, laser revascularization, thrombolitics, radiation therapy. MPS-Quant is currently used in two retrospective drug trial studies, one for Angiogenesis, involving 60 patients and one for laser revascularization, with 260 patients.

Multiple Sclerosis corresponds to fewer, but younger patients: about 350,000 patients are identified in the US and 450,000 in Europe. These patients are generally aged between 20 and 40 years. Some drugs have already been approved for a subset of MS patients, who are presenting the 'relapsing-remitting' form of the disease. It has been shown, from MRI measurements, that the number of relapses was decreasing when beta-interferon is used. However, no long term beneficial effects have been demonstrated and many alternative treatments are currently under evaluation, for which QuantifiCare's technology is providing highly accurate evaluation of changes, not only with respect to the number of plaques, but also with respect to hidden effects of the pathology such as 'mass effects', that is, local volume variations within the brain or brain atrophies. QuantifiCare owns the right on a patented technology, which has allowed, for the first time, to quantify such effects.

The first customers are pharmaceutical companies. QuantifiCare is designing dedicated measurement to quantify drug efficacy and takes care of all aspects related to imagery in Phase II or Phase III drug trials. The proposed services are including the centralization of image data coming from multiple clinical centers, the archiving and remote processing of the image data and also original image-based data mining capacities. The results of QuantifiCare's computation can be used directly to support evidence of efficacy for the registration of a new drug or a new treatment.

The current effort of the company is to establish a set of research contracts and

drug trial participation with pharmaceutical companies. It is currently recruiting Marketing and Sales persons from the pharmaceutical field. A mid-term objective is to establish formal collaborations with other academic research teams in image processing, within or outside INRIA, to keep the technology of the company updated. Each percent gained in sensitivity for the measurement of disease evolution can lead to gains of several orders of magnitude in the statistical results of a trial involving hundreds or thousands of patients and can decide upon the registration or rejection of the new drug. The stakes are high and QuantifiCare,s ambition is to maintain its technology to the up most level, to increase the chances to measure the slightest effect of a drug, when medical imaging is used to monitor the evolution of patients.

Link:
http://www.quantificare.com

Please contact:
Jean-Philippe Thirion — QuantifiCare S.A., France
Tel: +33 4 93 00 60 86
E-mail: info@quantificare.com

MIA — Querying Multimedia Databases

by Arjen de Vries

The Multimedia Information & Analysis (MIA) project investigates the problem of access to multimedial collections.

Finding textual information on the ever growing Web is already quite a challenge, let alone searching the forthcoming wealth of multimedia documents. This research provides the basis for a new generation of search engines on a multimedia Web, and supports digital archiving in large companies. It is carried out by CWI and seven partners (universities as well as companies) with funds allocated to the Amsterdam Science and Technology Centre (WTCW).

Digital multimedia documents are best stored centrally and distributed through broadband Internet, allowing remote access from anywhere anytime; shortly, even from your mobile phone. And, digital data are easily exchanged, also enabling the reuse of existing material. Furthermore, people at home create ever more digitized data: making your own compact discs with music has become extremely popular, and digital photo- and film-cameras become increasingly common. Technology developed in MIA focuses therefore on retrieving 'that song with that nice little melody', or 'that picture of our sailing, with the Boston skyline; when the weather was nice, was it 1997, or 1998?'

MIA's database team at CWI focuses on two themes: scalability and query formulation. The target in the first theme is processing queries in a collection exceeding one million pictures. Common approaches based on the colour distribution of an example image break down for collections of this size, because often either all objects or none are found. Moreover, some 'back of the envelope' calculations show that the required time per iteration of the search process yields unacceptable response times as soon as the collection grows beyond several thousands of pictures. Yet, the toughest problem in searching picture archives with current systems, is that query results are hard to understand even for their software developers. The end-user cannot be expected to comprehend why an example picture of a sunset at sea results in (however beautiful) pictures of African savannas. Such inaccurate answers are an unwanted side-effect of the uncertainty inherent to posing the question, exposing the wide gap between our high-level perception and the (necessarily) much simpler methods for image analysis.

We seek to reduce this gap with better formulated search requests, based on two different but complementary approaches. On the one hand, we assist the user with automatic query formulation; in our opinion, many improvements can be achieved by collecting more information about the user's interest in a carefully crafted, interactive query process. On the other hand, we attempt to give users more insight into the query process inside the system itself, enabling them to intervene in that process and eventually adjust it (query articulation). An interesting challenge in our research is to find the correct balance between these two approaches.

Initial query results (upper row) from a photo collection can be improved by feedback from the user (lower row) (Illustration: CWI).

Links:
http://www.cwi.nl/WTCW/MIA/
http://www.cwi.nl/ins1

Please contact:
Arjen de Vries — CWI
Tel: +31 592 4306
E-mail: Arjen.de.Vries@cwi.nl

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Sixth ERCIM FMICS International Workshop

by Hubert Garavel

FMICS is the ERCIM Working Group on Formal Methods for Industrially Critical Systems. Launched in 1996 by Diego Latella and Stefania Gnesi (CNR Pisa), the FMICS working group is currently chaired by Hubert Garavel (INRIA Rhone-Alpes).

The 6th ERCIM FMICS workshop was held in Paris on July 16-17, 2001. The program committee was chaired by Stefania Gnesi (IEI-CNR) and Ulrich Ultes-Nitsche (University of Southampton). The workshop was held in the LIAFA laboratory (University Paris-7) and the local organization chair was Mihaela Sighireanu.

The meeting was attended by 38 persons, both from academia and industry In particular, it is worth mentioning that companies such as Ericsson, Giesecke & Devrient GmbH, IBM, Instrumentointi Oy, Motorola, NASA, Simtech, and TransEDA were present at the 6th ERCIM FMICS workshop.

The opening talk of the workshop was given by Jean-Eric Pin, Scientific Director of ERCIM. During the two days, fifteen talks were presented, carefully selected by the Program Committee with a rejection rate of 50%. Also, two invited talks were given, the first one by Cindy Eisner ('Automatic Detection of Vacuity in Temporal Logic') and the second one by Joseph Sifakis ('Modeling Real-time Systems').

A special issue of the scientific journal 'Formal Methods in System Design' will gather the best papers presented during the workshop.

The 6th FMICS workshop benefited from the financial support of INRIA Rhone-Alpes and ERCIM. The workshop proceedings (240 pages) have been published by INRIA.

Links:
FMICS Working Group web page :
http://www.inrialpes.fr/vasy/fmics/
6th FMICS Workshop web page:
http://www.dsse.ecs.soton.ac.uk/FMICS2001

Please contact:
Hubert Garavel — INRIA
Tel: +33 4 76 61 52 24
E-mail: hubert.garavel@inria.fr

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IEA/AIE-2001 Conference Report

by László Monostori and József Váncza

IEA/AIE-2001 — The Fourteenth International Conference on Industrial & Engineering Applications of Artificial Intelligence & Expert Systems was held during 4-7 June 2001, in Budapest, Hungary. The conference that covered all main research areas and many application domains of AI was supported in part by ERCIM.

The success of engineering depends on the recognition and use of several synergic factors. While the analytic approach is the key in solving some well-defined subproblems, creativity helps us to get free of prejudices and in finding useful analogies. Moreover, critical thinking opens up the way of argumentation with inexact premises and rules. While engineering is based on such complex mental features, it is perhaps more transparent than some other human activities: its world is of man-made artifacts that should be useful in a broad sense of the word.

This resulted in the opinion that by considering the advancements in engineering of intelligent systems, one may have a proper view of the state of research in the whole area of Artificial Intelligence (AI). Knowledge gleaned here is valid not only in this particular application area but provides valuable hints to the perspectives in the theory of AI and in its potential for solving other problems as well.

Having recognized the above features of engineering problem solving, the International Society of Applied Intelligence (ISAI), more than a decade ago, initiated a series of conferences named Industrial & Engineering Applications of Artificial Intelligence & Expert Systems (IEA/AIE). The Hungarian AI community was honored by the invitation of the ISAI to host the IEA/AIE-2001 conference (June 4-7, 2001, Budapest, Hungary), which was the fourteenth in the series. General chair of IEA/AIE-2001 was Moonis Ali, program chair and co-chair were László Monostori and Soundar Kumara, respectively. The conference was organized by SZTAKI in co-operation with a number of international scientific societies as AAAI, ACM/SIGART, ECCAI, ERCIM to name but a few ones. The main sponsoring institutions of the event were ISAI, ERCIM, the Hungarian Academy of Sciences, and the Hungarian Ministry of Education.

The Call for Papers announcement attracted many researchers and engineers from all over the world. A total of 104 papers — representing 21 countries and all continents — were selected for presentation. The accepted papers covered all the main research areas of AI and many different application domains.

The plenary talk of the conference was delivered by Tibor Vámos (SZTAKI) on 'Triple R: Representation, Retrieval, Reasoning'. The technical presentations were held in 2-3 parallel tracks in sessions on search, knowledge representation, model-based reasoning, machine learning, data mining, soft computing, evolutionary algorithms, distributed problem solving, expert systems, pattern and speech recognition, vision, language processing, planning and scheduling, robotics, autonomous agents, design, control, manufacturing systems, finance and business, software engineering, and tutoring.

Proceedings of IEA/AIE-2001 were published by Springer Verlag under the title 'Engineering of Intelligent Systems' in the series of Lecture Notes in Artificial Intelligence (LNAI 2070). Electronic access to the papers of the volume is possible (see links). The extended versions of some selected papers are considered for publication in the International Journal of Applied Intelligence.

Links:
Conference:
http://www.sztaki.hu/conferences/ieaaie2001/
Proceedings:
http://link.springer.de/link/service/series/0558/tocs/t2070.htm

Please contact:
László Monostori, József Váncza — SZTAKI
Tel: +36 1 466 5644
E-mail: {laszlo.monostori;vancza}@sztaki.hu

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Workshop on User Interfaces to Data Intensive Systems

by Epaminondas Kapetanios

The second international workshop on User Interfaces to Data Intensive Systems (UIDIS) took place at the Swiss Federal Institute of Technology, in Zurich, Switzerland, 31 May - 1 June 2001. The two-days workshop has been attended by 24 participants.

The mission of the workshop was to continue the tradition of previous workshops in Interfaces to Database Systems (IDS 1992, IDS 1994, IDS 1996) and the 1st UIDIS 1999. The emphasis, however, has been put to a human-centered way of human-computer interaction, especially, when data intensive systems are concerned. The workshop tried to find solutions to problems such as interaction with high-dimensional spaces, accessing large and semantically difficult to interpret database schemas, understandability of data and user/system interactions, through a variety of 12 accepted papers which have been selected out of 17 submitted papers by the program committee.

In particular, the workshop brought together researchers practitioners in information management systems, computer-human interaction, knowledge based methodologies and visualization. The papers were organized in three sessions which mainly addressed:

- context aware data querying and information retrieval techniques in order to restrict the navigational space and increase understandability of domain knowledge and data in semantically difficult to interpret databases. The presentations were related to context aware query languages as well as to information retrieval techniques
- designing effective user interfaces for interactive systems in terms of embedding user/system interaction issues into conceptual design (UML), constraints based specification of user interface patterns, considering of possible outcomes in a user/system interaction environment, as well as the semi-automatical derivation of user interfaces by using XML
- providing comprehensive visualization techniques which enable the recognition of interesting information patterns as well as the presentation of information.

The two invited talks addressed the accessing and organizing large information spaces. The first talk put the emphasis on the semantics based (ontological) approach, on the example of contents management for business-to-businsess electronic commerce, while the second talk discussed the use of the parallel coordinates approach as a visualization technique for high-dimensional information spaces. The workshop has been considered a success by the participants and organizers alike. A number of sponsors have contributed to its successful organization: ERCIM; the Association of Computing Machinery (ACM - Special Interest Group Computer-Human Interaction (SIGCHI); the Swiss Federal Institute of Technology (ETH), Zurich; the GlaxoSmithKline pharmaceutical company, and the University of Zurich.

Please contact:
Epaminondas Kapetanios — ETH Zurich
Tel: +41 1 632 7261
E-mail: kapetani@inf.ethz.ch

1st International Conference on Universal Access in Human-Computer Interaction

by Constantine Stephanidis

The 1st International Conference on Universal Access in Human-Computer Interaction (UAHCI 2001) took place in New Orleans, Louisiana, USA, 5-10 August 2001, jointly with the Ninth International Conference on Human-Computer Interaction (HCI International 2001), the Symposium on Human Interface (Japan) 2001, and the 4th International Conference on Engineering Psychology and Cognitive Ergonomics.

The establishment of this new international conference is largely due to the dedicated work of the ERCIM Working Group 'User Interfaces for All', which, since its institution in 1995, has carried out a variety of activities bringing together researchers and teams who share common interests and aspirations, and contribute to the endeavours towards making the emerging Information Society equally accessible to all citizens.

The UAHCI 2001 conference has attracted strong international interest, with 228 papers presented, covering a wide range of topics in the area of Universal Access in Human-Computer Interaction, such as Universal Design, Adaptive and Intelligent Interfaces, Architectures and Tools, Multimodal, Continuous and Ubiquitous Interaction, User Diversity and User Participation, Human Factors, Ergonomics, Guidelines and Standards, Access to Information, Applications, Assistive Technologies, and Cultural, Social, Ethical and Legal Issues. The Proceedings of UAHCI 2001 have been published by Lawrence Erlbaum Associates (ISBN 0-8058-3609-8).

The Second International Conference on Universal Access in Human-Computer Interaction will be held in Crete, Greece, 22-27 June 2003, jointly with the Tenth International Conference on Human-Computer Interaction (HCI International 2003, http://hcii2003.ics.forth.gr), the Symposium on Human Interface (Japan) 2003, and the 5th International Conference on Engineering Psychology and Cognitive Ergonomics.

Links:
Conference website:
http://hcii2001.engr.wisc.edu/
Working Group 'User Interfaces for All':
http://ui4all.ics.forth.gr/

Please contact:
Constantine Stephanidis — FORTH
Tel: +30 81 391741
E-mail: cs@ics.forth.gr

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ECOOP 2001 - 15th European Conference on Object-Oriented Programming

by László Kozma

ECOOP 2001 took place at Eötvös Loránd University, Budapest, Hungary from 18 to 22 June 2001. It was organized under the auspices of AITO (Association internationale pour les technologies objects), with sponsorship from IQSOFT, the Hungarian Ministry of Education, NOKIA, GRAPHISOFT, Microsoft Research, ERCIM, ERICSSON, VT-SOFT, SZÁMALK and SZÁMITÁSTECHNIKA. About four hundred people participated in the events.

The conference was chaired by Gerti Kappel from Johannes Kepler University, Linz and László Varga from Eötvös Loránd University, Budapest. The Programme Committee was chaired by Jørgen Lindskov Knudsen from University of Aarhus, Denmark.

The first two days (Monday 18 and Tuesday 19) were dedicated to workshops and tutorials. During the last three days of the week (20-22), the main conference took place together with an exhibition, demos and poster sessions.

22 workshops and 21 tutorials were selected out of respectively 30 and 48 high quality proposals. The opening keynote address was given by Charles Simonyi from Microsoft Research. His paper entitled 'Languages, Objects, and Intentionality', was a very impressive discussion on 'intentionality' as an important aspect of natural language, and the uses of intentionality in computer languages and in object-oriented programming. Erik Meijer, Microsoft gave the second invited talk entitled 'Scripting .NET Using Mondrian'. He spoke about Mondrian, a functional scripting language designed especially for the new Microsoft .NET platform. Mondrian is useful for functional programmers who would like to be able to inter-work more closely with other languages that target the .NET Common Language Runtime and for object-oriented programmers who would like to explore being able to write and access objects written in functional languages.

Alistair Cocburn, Humans and Technology gave the third invited talk

entitled 'People and the Limits of Methodology'. He spoke about that people had a nasty habit of running neatly drown up methodologies. It is not that they intend to do, it just that people are packed as 'individuals' while methodologies are packed in 'roles'.

Eighteen technical papers out of the 108 submitted papers were selected for presentation and covered a broad range of topics related to the object-oriented paradigm including sharing and encapsulation, type inference and static analysis, language design, implementation techniques, reflection and concurrency, testing and design.

From an organizer's point of view, the conference was very successful. The technical presentations, tutorials and workshops were of high quality. We were successful in attracting many young researchers whose enthusiasm and fresh ideas greatly contributed to the success of the event. The conference proceedings were published by Springer - Verlag, Berlin - Heidelberg in Germany.

Please contact:
László Kozma — Eötvös Loránd University, Hungary
Tel: +36 1 209 0555
E-mail: kozma@ludens.elte.hu

First DELOS Summer School on Digital Library Technologies

by Maristella Agosti and Vittore Casarosa

The First DELOS International Summer School on Digital Library Technologies (ISDL 2001) was held in Pisa, Italy, from 9-13 July 2001, under the direction of Maristella Agosti, University of Padua, Italy.

Being the first Summer School organised by the DELOS Network of Excellence, it was decided to have a broad programme covering most of the fundamental issues underlying the multidisciplinary area of Digital Libraries. Future editions of the DELOS Summer School may focus on specific issues and technologies of interest in the area of the Digital Libraries, providing more in depth coverage of the topics selected.

The ISDL programme was organised in nine half-day lectures, having as invited lecturers leading researchers in the digital library field, both from the US and Europe. Each lecture was devoted to a fundamental topic of Digital Libraries, addressing both the methodological aspects and the presentation of the results of some of the most innovative and significant Digital Library projects. The School was divided into two parts: the first part, from Monday to Wednesday morning, devoted to more general topics, and the second part, from Thursday to Friday, addressing more specific topics. On Wednesday afternoon there was an invited talk, a short demo and the social programme (a guided tour of Lucca and a social dinner in an old villa outside of Pisa). Most of the participants and lecturers resided at the conference centre for the duration of the School, allowing ample opportunities for getting to know each other and for an informal exchange of ideas. The programme of the school included:

- 'Introduction to Multimedia Digital Collections' by Carl Lagoze, Cornell University, USA
- 'New Models for Scholarly Dissemination' by Robert Wilensky, University of California, Berkeley, USA
- 'Architectures and Open Access to Digital Libraries' by William Y. Arms, Cornell University, USA
- 'Information Retrieval Models and Methods, Metadata, and Evaluation' by Norbert Fuhr, University of Dortmund, Germany
- 'Online Information Access from Handheld Devices' by Andreas Paepcke, Stanford University, USA
- an invited talk on 'Public Access to Digital Materials' by Brewster Kahle, Internet Archive, USA
- a short demo by Rui Amaral, INESC ID, Portugal
- 'Cross-language Retrieval' by Carol Peters, CNR-IEI, Italy
- 'Text Categorization and Information Filtering' by Fabrizio Sebastiani, CNR-IEI, Italy
- 'Video Digital Libraries' by Howard Wactlar, Carnegie Mellon University, USA
- 'Libraries in the Digital World' by Elizabeth Lyon, UKOLN, UK.

The School was attended by 52 students from 16 different countries (Australia, Denmark, France, Germany, Greece, India, Ireland, Israel, Italy, Korea, Poland, Portugal, Spain, Switzerland, The Netherlands, UK). 36 students were from universities and research institutions, and the remaining 16 were from libraries and archives. DELOS was able to partially fund the participation of 24 students by covering their enrolment fees.

An evaluation form was distributed at the end of the course asking students to rate different aspects of the school on a scale from 1 to 5 (bad to good). About 75% of the students filled in the form with 86% of the students giving a rating of between 4 and 5 for the school overall, 85% giving a rating of between 4 and 5 for the social events overall, and 87% giving a rating of between 4 and 5 for support overall. Lectures were rated individually, with 70% of the ratings falling between a score of 4 and 5. A section of the evaluation form provided space for comments and suggestions which will be considered when planning the next Summer School in June 2002. All in all, the school can be judged to have been a success, with many students expressing interest in attending ISDL2002.

Please contact:
Vittore Casarosa — IEI-CNR
Tel: +39 050 315 3115
E-mail: casarosa@iei.pi.cnr.it

Joint DELOS-NSF Workshop on Personalisation and Recommender Systems in Digital Libraries

by Alan Smeaton and Jamie Callan

The Joint DELOS-NSF Workshop on Personalisation and Recommender Systems in Digital Libraries held at Dublin City University June 18-20, 2001, brought together 57 researchers and practitioners from 14 countries to discuss the development of personalisation and recommender systems and techniques, particularly as they apply to digital libraries.

The concept of personalisation is about making systems different for individual people or groups of people and one type of personalisation that is growing in use is recommender systems. These take input directly or indirectly from users and based on user needs, preferences and usage patterns, they make personalised recommendations of products or services. These vary from recommending books to buy or TV programs to watch, to suggesting web pages to visit. The ultimate goal of such recommender systems is to reduce the amount of explicit user input and to operate, effectively, based on usage patterns alone, thus giving users what they want without them having to ask.

Within the digital library environment, personalisation and recommender systems may have different characteristics because individual user behavior and traffic patterns may differ significantly from those of Web and E-commerce environments. For example, few digital libraries will see millions of transactions within a short period of time, digital library resources may be structured and more stable as compared with commercial sites, and digital library characteristics and usage patterns may provide opportunities for types of long-term learning that would be difficult or impractical in other environments.

Fifteen papers and three invited talks were presented at the workshop, while moderated discussion sessions at the end of each day provided an opportunity for participants to reflect on the day's talks and to address recurring themes and issues. Although the workshop included talks on software architectures, several deployed systems, and a user study, most of the presentations focused on algorithms for making recommendations. In spite of this emphasis the papers were generally consistent with past research in this area, which has been adaptation of existing technologies, mostly from Information Retrieval or Machine Learning, often combined with creative methods of acquiring training data. This suggests that the area is not yet mature enough to have spawned its own specific and tailored techniques, or the theoretical models that would support them, which is a sign that there is much more work yet to be done.

Workshop participants naturally felt that personalisation is an important research area, and that it will receive greater attention in the coming years but there was less agreement on how it will be applied in the context of digital libraries. Most of the 'success' stories are systems that encourage additional consumption, for example of movies and books but it is harder to find systems that provide other types of improvements that might be more applicable in a digital library environment.

As is often the case, research has been influenced strongly by the data available and movie recommender systems are a popular research vehicle because movie databases are freely available on the Web. Some researchers have access to more interesting datasets, but these are often proprietary, which makes research results difficult to evaluate and reproduce, and which raises a barrier to entry by new researchers. Workshop participants agreed that there is a strong need for a more diverse set of generally-available data resources for personalisation research, and encourage the funding community to consider this in their funding decisions.

Evaluation is a related problem. Most of the systems discussed in the workshop were evaluated in some manner, but few of the evaluations could be called rigorous. It might be clear how to evaluate a movie recommender system, but it is less clear how to evaluate more complex systems. Researchers in this area need to begin considering a broad approach to evaluation that embraces not just quantitative evaluation, but also methods and tools from disciplines such as sociology. While recognising the importance of evaluation, we worry that an overemphasis on evaluation will stifle new ideas in this fledgling field. Finding the right balance between creative development of new ideas and scientific evaluation remains an issue.

Finally, prior research on personalisation and recommender systems has focused on relatively short periods of time. Systems are beginning to be deployed that are intended for daily use over long periods of time (two were discussed in this workshop), but little is known about how such systems and their users might evolve over time. It is important to begin studying long-term personalisation issues, for example following a particular group of users over a several year period. Workshop participants felt that funding bodies need to give greater attention to longer-term projects.

The complete workshop proceedings are available at http://www.ercim.org/ publication/ws-proceedings/DelNoe02/.

Please contact:
Alan Smeaton — Dublin City University, Ireland
E-mail: asmeaton@compapp.dcu.ie

Jamie Callan — Carnegie Mellon University, USA
E-mail: callan@cs.cmu.edu

CLEF2001: Workshop of the Cross-Language Evaluation Forum

by Carol Peters

The results of the second evaluation campaign of the Cross-Language Evaluation Forum were presented at a Workshop held on 3-4 September, immediately before ECDL2001 in Darmstadt, Germany.

Cross-Language Evaluation Forum provides an infrastructure for the testing and tuning of mono- and cross-language information retrieval systems working with European languages. The main focus of the activity is to stimulate the development of multilingual information retrieval systems, ie systems capable of matching a query in one language against document collections in many languages.

As a result of the success of the CLEF2000 campaign, it was decided to extend the test suite provided for this year's participants. In particular, the multilingual corpus was increased to nearly one million documents in six languages instead of four languages: Dutch and Spanish were added to the English, French, German and Italian collections. The main task of CLEF2001 thus required participants to search a document collection in five languages, extracting their queries from a topic set offered in twelve different languages (nine European and three Asian languages). The same topic set could be used in the bilingual retrieval task to search either a Dutch or an English target collection. Tasks testing monolingual, domain-specific, and interactive text retrieval systems were also offered. Thirty four groups participated in one or more of the tracks – fourteen more than in 2000.

The results of the CLEF2001 experiments were presented in a two-day Workshop held in Darmstadt at the beginning of September. The Workshop was attended by nearly fifty researchers and system developers from both academia and industry.

In the opening session, one of the organizers, Martin Braschler of Eurospider Information Technology, Zürich, gave an overview of the campaign and summarised the main trends that emerged this year. All the traditional approaches to the cross-language task had been employed but many innovational strategies were also tested. It was notable that many groups had built on results reported in CLEF 2000. The rest of the first day was dedicated to descriptions of the experiments and discussions on a number of the key issues affecting cross-language systems. These included the problem of merging the results of a search over a number of document bases in different languages in a meaningful way, and a comparison between methods used for indexing texts in multiple languages.

On the second day, ideas for new activities were presented. Julio Gonzalo (UNED, Madrid) and Douglas Oard (University of Maryland) first reported the results of the experimental interactive track that was focussed on the end user and the document selection task. The aim was to investigate how the results of a cross-language system can best be presented to users who have no knowledge of the target language(s) in order to facilitate their selection of those documents that do contain relevant information and merit further examination. Marcello Federico of itc-IRST, Trento, then illustrated a proposal for the design of a track for a preliminary testing of systems for cross-language spoken document retrieval, thus moving CLEF towards an investigation of multilingual multimedia systems.

In the following session, Donna Harman from the US National Institute for Standards and Technology (NIST) and Noriko Kando (National Institute of Informatics, Japan) reported on the activities of the TREC and NTCIR evaluation campaigns for cross-language systems (for Arabic and Asian languages, respectively) . In their next campaign, NTCIR intends to adopt the CLEF model for evaluating multingual retrieval systems operating on Chinese, Japanese, Korean and English. The session concluded with an invited talk by Ellen Voorhees (NIST) on the philosophy of IR evaluation in which she outlined the methodology that has been studied for TREC and adopted by CLEF. In the afternoon, the criteria adopted by CLEF to create the topic sets and produce the relevance assessments were described by Christa Womser-Hacker (Univ. Hildesheim, Germany) and Djoerd Hiemstra (Univ. Twente, Netherlands).

In the final session of the Workshop, the preliminary programme for CLEF 2002 was outlined. While the multilingual task will remain unaltered, the bilingual task has been considerably strengthened. Groups will be able to test their systems choosing from target document collections in at least five European languages and perhaps more. Investigations are currently underway as to the feasibility of adding both Finnish and Swedish. Monolingual system testing will again be offered and the interactive track will be extended to become an official CLEF task in 2002.

Copies of the Workshop presentations are available on-line on the CLEF Web site. The proceedings will be published for the second year running by Springer in their Lecture Notes for Computer Science series. CLEF is a collaboration between the US National Institute for Standards and Technology and the European Commission. CLEF2000 and 2001 were supported by the DELOS Network of Excellence for Digital Libraries. CLEF 2002 will be funded independently under the 5th Framework IST programme of the Commission.

Link:
http://www.clef-campaign.org/

Please contact:
Carol Peters – IEI-CNR
CLEF Coordinator
Tel: +39 050 315 2897
E-mail: carol@iei.pi.cnr.it

ERCIM NEWS

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Director: Bernard Larrouturou
Central Editor:
Peter Kunz
E-mail: peter.kunz@ercim.org
Tel: +33 1 3963 5040
Local Editors:
CLRC: Martin Prime
E-mail: M.J.Prime@rl.ac.uk
Tel: +44 1235 44 6555
CRCIM: Michal Haindl
E-mail: haindl@utia.cas.cz
Tel: +420 2 6605 2350
CWI: Henk Nieland
E-mail: Henk.Nieland@cwi.nl
Tel: +31 20 592 4092
CNR: Carol Peters
E-mail: carol@iei.pi.cnr.it
Tel: +39 050 315 2897
FORTH: Constantine Stephanidis
E-mail: cs@csi.forth.gr
Tel: +30 81 39 17 41
FhG: Dietrich Stobik
E-mail: stobik@gmd.de
Tel: +49 2241 14 2509
INRIA: Bernard Hidoine
E-mail: bernard.hidoine@inria.fr
Tel: +33 1 3963 5484
SARIT: Harry Rudin
Tel: +41 1 720 3707
E-mail: hrudin@smile.ch
SICS: Kersti Hedman
E-mail: kersti@sics.se
Tel: +46 8633 1508
SRCIM: Gabriela Andrejkova
E-mail: andrejk@kosice.upjs.sk
Tel: +421 95 622 1128
SZTAKI: Erzsébet Csuhaj-Varjú
E-mail: csuhaj@sztaki.hu
Tel: +36 1 209 6990
TCD: Carol O'Sullivan
E-mail: Carol.OSullivan@cs.tcd.ie
Tel: +353 1 60 812 20
VTT: Pia-Maria Linden-Linna
E-mail: pia-maria.linden-linna@vtt.fi
Tel: +358 9 456 4501

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CALL FOR PARTICIPATION

MMM 2001 — 8th International Conference on Multimedia Modeling

Amsterdam, 5-7 November 2001

MMM 2001 will continue the Multimedia Modeling series' exploration of models and abstractions for multimedia creation, representation, storage, delivery, processing, presentation and final interface. This year's foci will be on authoring and creation, standards, intelligent delivery and presentation, and the recent (re-)introduction in the field of semantic models for multimedia and for the Web.

Topics concentrate on mulitimedia authoring; aspects of information presentation; multimedia standards and models; semantic models for multimedia and for the Web; multimedia modeling of real world scenarios; model-based graphics, video, vision and virtual reality; formal methods and multimedia information; Multimedia databases.

More information:
http://www.cwi.nl/conferences/MMM01/

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CONCUR 2002 — 13th International Conference on Concurrency Theory

Brno, Czech Republic, 20-23 August 2002

The purpose of the CONCUR conferences is to bring together researchers, developers and students in order to advance the theory of concurrency, and promote its applications. Interest in this topic is continuously growing, as a consequence of the importance and ubiquity of concurrent systems and their applications, and of the scientific relevance of their foundations. Submissions are solicited in all areas of semantics, logics and verification techniques for concurrent systems.

Principal topics include (but are not limited to) concurrency related aspects of: models of computation and semantic domains, process algebras, Petri nets, event structures, real-time systems, hybrid systems, decidability, model-checking, verification techniques, refinement techniques, term and graph rewriting, distributed programming, logic constraint programming, object-oriented program-ming, typing systems and algorithms, case studies, tools and environments for programming and verification.

More information:
http://www.fi.muni.cz/concur2002

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ISSTA — International Symposium on Software Testing and Analysis

Rome, 22-24 July 2002

ISSTA is a leading research conference in software testing and analysis, bringing together academics, industrial researchers, and practitioners to exchange new ideas, problems, and experiences. The ISSTA programme will include research papers, panels, and invited presentations.

Call for Papers

Authors are invited to submit papers describing original research in testing or analysis of computer software. Papers describing theoretical or empirical research, new techniques and tools, and in-depth case studies of software testing and analysis methods and tools are welcome.

As ISSTA 2002 will be colocated with the Workshop on Software Performance, papers on software testing, analysis, and verification techniques targeting software peformance issues are particularly sought.

More information:
http://www.iei.pi.cnr.it/ISSTA2002/

CALL FOR PAPERS

Pervasive 2002 — International Conference on Pervasive Computing

Zurich, Switzerland, 26-28, 2002August

The objective of the International Conference on Pervasive Computing will be to present, discuss, and explore latest technical developments in the emerging field of pervasive computing as well as potential future directions and issues. Leaving aside low-level hardware and transmission technology topics as well as peripheral socio-economic aspects, the conference will focus on technical infrastructure and application issues.

Relentless progress in basic Information Technologies (IT) - microprocessors, memory chips, integrated sensors, storage devices, and wireless communication systems - continues to bring ever smaller, lighter, and faster systems-on-a-chip. As a result, beyond large hosts, PCs, and laptop computers, IT systems are now invading every aspect of life to the point that they are disappearing inside all sorts of appliances or can be worn unobtrusively as part of clothing and jewelry. This explosive spread of IT can be compared to the spread of electric motors over the past century but promises to revolutionize life much more profoundly than elevators or electric car windows ever did. At the same time, pervasive computing poses profound challenges including technical, safety, social, legal, political, and economic issues.

The objective of this conference will be to present, discuss, and explore latest technical developments in the emerging field of pervasive computing as well as potential future directions and issues. Leaving aside low-level hardware and transmission technology topics as well as peripheral socio-economic aspects, the conference will focus on technical infrastructure and application issues. It will include presentations, panel discussions, poster sessions, and demos on subjects like:

- System architectures and platforms for pervasive computing
- Middleware and pervasive computing infrastructures
- Mobile, wireless, and wearable technologies
- Innovative small computing and intelligent devices
- Emerging applications and mobile business issues
- Scenarios for information appliances
- Service discovery protocols
- Content distribution and delivery
- User interfaces for invisible and embedded computing
- Context awareness
- Security and privacy issues.

More information:
http://www.pervasive2002.org/

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STACS — 19th International Symposium on Theoretical Aspects of Computer Science

Antibes Juan-les-Pins, France, March 14-16 2002

Topics presented at STACS include (but are not limited to):

- Algorithms and data structures, including: parallel and distributed algorithms, computational geometry, cryptography, algorithmic learning theory
- Automata and formal languages
- Computational and structural complexity
- Logic in computer science, including: semantics, specification, and verification of programs, rewriting and deduction
- Current challenges, for example: theory, models, and algorithms for biological computing, quantum computing, mobile and net computing.

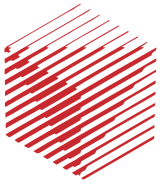
More information:
http://www-sop.inria.fr/stacs2002/

INRIA — Claude Castelluccia, reseach fellow at INRIA is the winner of the 2001 Communication & Systems Award. Intended to reward young researchers who bring significant innovations to important applications, the CS 2001 scientific price was awarded to Claude Castelluccia for his work on mobility in the future Internet protocol IPV6. Detailed information at http://www.inrialpes.fr/planete/

INRIA — **Olivier Faugeras** is recipient of the '2001 World technology Award' in the category 'Information Technology - Software'. The Award recognises the programmes and capabilities of which information technology hardware makes use. It includes traditional software applications using innovative or enhanced techniques, as well as more comprehensive subjects such as virtual reality or artificial intelligence. http://www-sop.inria.fr/robotvis/robotvis-eng.html

CLRC — **Professor John Wood** succeeded Gordon Walker as CCLRC's

Chief Executive. He took up his post on 1 April 2001 and his appointment is for four years. John Wood was appointed Professor of Materials Engineering and Head of Department at the University of Nottingham in 1989 and subsequently became Dean of Engineering in 1998. He is Chairman of the Office of Science and Technology's Foresight Panel on Materials, having been appointed in 1997. Professor Wood has held a number of directorships and consultancies with industry and has acted as an adviser on materials issues to governments. He is a Fellow of the Royal Academy of Engineering and has been awarded both the Grunfeld and Ivor Jenkins Prizes of the Institute of Materials. Professor Wood received the Citizen of Honour of Cluj-Napaca in Romania for his 'help in restructuring materials engineering education in Romania'.



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Central Laboratory of the Research Councils
Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, United Kingdom
Tel: +44 1235 82 1900, Fax: +44 1235 44 5385
http://www.cclrc.ac.uk/

Consiglio Nazionale delle Ricerche, IEI-CNR
Area della Ricerca CNR di Pisa, Via G. Moruzzi 1, 56124 Pisa, Italy
Tel: +39 050 315 2878, Fax: +39 050 315 2810
http://www.iei.pi.cnr.it/

Czech Research Consortium for Informatics and Mathematics
FI MU, Botanicka 68a, CZ-602 00 Brno, Czech Republic
Tel: +420 2 688 4669, Fax: +420 2 688 4903
http://www.utia.cas.cz/CRCIM/home.html

Centrum voor Wiskunde en Informatica
Kruislaan 413, NL-1098 SJ Amsterdam, The Netherlands
Tel: +31 20 592 9333, Fax: +31 20 592 4199
http://www.cwi.nl/

Foundation for Research and Technology – Hellas
Institute of Computer Science, P.O. Box 1385, GR-71110 Heraklion, Crete, Greece
Tel: +30 81 39 16 00, Fax: +30 81 39 16 01
http://www.ics.forth.gr/

Fraunhofer Gesellschaft
Schloß Birlinghoven, D-53754 Sankt Augustin, Germany
Tel: +49 2241 14 0, Fax: +49 2241 14 2889
http://www.fhg.de/

Institut National de Recherche en Informatique et en Automatique
B.P. 105, F-78153 Le Chesnay, France
Tel: +33 1 3963 5511, Fax: +33 1 3963 5330
http://www.inria.fr/

Swedish Institute of Computer Science
Box 1263, SE-164 29 Kista, Sweden
Tel: +46 8 633 1500, Fax: +46 8 751 72 30
http://www.sics.se/

Swiss Association for Research in Information Technology
Dept. Informatik, ETH-Zentrum, CH-8092 Zürich, Switzerland
Tel: +41 1 632 72 41, Fax: +41 1 632 11 72
http://www.sarit.ch/

Slovak Research Consortium for Informatics and Mathematics
Dept.of Computer Science, Comenius University, Mlynska Dolina M SK-84248 Bratislava, Slovakia
Tel: +421 7 726635, Fax: +421 7 727041
http://www.srcim.sk

Magyar Tudományos Akadémia – Számítástechnikai és Automatizálási Kutató Intézete
P.O. Box 63, H-1518 Budapest, Hungary
Tel: +36 1 4665644, Fax: + 36 1 466 7503
http://www.sztaki.hu/

Trinity College, Department of Computer Science,
Dublin 2, Ireland
Tel: +353 1 608 1765, Fax: 353 1 677 2204
http://www.cs.tcd.ie/ERCIM

Technical Research Centre of Finland
VTT Information Technology, P.O. Box 1200, FIN-02044 VTT, Finland
Tel:+358 9 456 6041, Fax :+358 9 456 6027
http://www.vtt.fi/