Imaging for the Information Society

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Abstract

As part of the 5th Framework Programme, the European Commission supports research and development activities in the field of digital imaging, in particular within the Information Society Technologies (IST) specific Programme. This paper briefly introduces the IST Programme and gives an overview of collaborative projects most relevant to imaging research. The EU's 6th Framework Programme is also briefly discussed and orientations for the integration of imaging research are proposed.

The Image Society

Information society technologies (IST) are transforming the economy and society and have far reaching implications on our everyday life. They provide solutions to major societal challenges such as healthcare, environment, safety, mobility and employment. The IST sector is now one of the most important of the European economy. The European Commission supports R&D in this sector through the IST Programme. A full description is available under Ref. 1. IST Calls for Proposals are published regularly, several times a year. They specify particular areas of activity that are relevant to a particular Call. More information on rules for participation is available from Ref. 2.

Research in the IST Programme focuses on the future generation of technologies in which computers and networks will be integrated into the everyday environment, rendering accessible a multitude of services and applications through easy-to-use human interfaces. This vision of "ambient intelligence" places the user, the individual, at the centre of future developments for an inclusive knowledge-based society for all. Realisation of the vision presents many technical challenges and imaging technologies are an essential element.

In today's society, the power of images is already ubiquitous. We are constantly exposed to a flow of pictures from television, magazines, computer screens or outdoor advertising boards. Images are increasingly sophisticated, integrating and mixing animated computer graphics and high-resolution images of the real world. Consequently, they are increasingly attractive and exciting, enabling us to see things that will never exist in the real world.

But this is only the beginning of the image revolution. Looking back in a few years from now, we will probably find today's streamed video appallingly blocky, modern video conferencing barely realistic and 2001's digital still picture cameras ludicrously low resolution. Imaging technologies will contribute to the next step of development of the information infrastructure as we know it today and provide us with highly visual and interactive systems much like those common in games today.

Imaging Research in IST

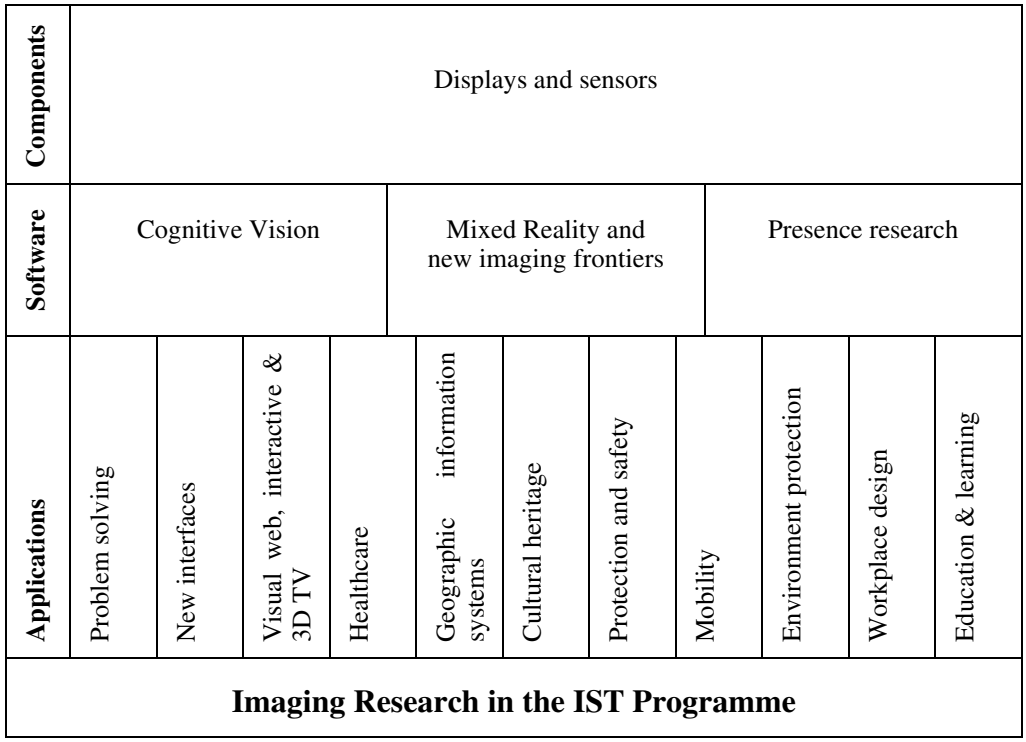
Imaging research has an impact on systems enabling access for all in the information society, such as intelligent systems to support health professionals and provide patients with personalised healthcare and information. It is also key to the enhancement of personal and property protection and to securing and safeguarding civil infrastructures. In the area of mobility, imaging provides solutions to safety issues and to logistics, infomobility and location based services. Imaging also plays a role in environment protection by enabling knowledge-based systems for natural resource management, for risk prevention and crisis management. For cultural heritage, it is essential for dynamic access and preservation of tangible and intangible cultural and scientific resources. Imaging also impacts research addressing work and business challenges, it transforms workplace design, improves learning, provides new solutions to electronic and mobile commerce. Imaging is also a cornerstone of complex problem-solving in science, engineering, businesses and for society. Finally, imaging is the essence of intelligent surfaces and interfaces that will provide more effective ways of accessing ubiquitous information and easy and natural interaction modes with dynamic knowledge through next generation information appliances.

The table below summarizes the main research areas concerned with imaging within the IST Programme. Relevant applications are also included for completeness. More details on the most relevant groups of projects follow.

Devices and Displays

This area addresses multimodal interface devices able to capture user commands and deliver enriched audio-visual content for nomadic, wearable and stationary terminals. It aims to overcome the usability problems of portable systems limited by the performance and size of their display and sensory interface and take advantage of limited system size by on-board integration of processing and sensing/actuating functions. The objective is to demonstrate new technologies able to bring high quality displays to the mass consumer market especially for large area or low power. The current focus (workplan 2001) is on innovative concepts for the disappearing display, high resolution immersive devices, holographic and 3D rendering. It is also on adding value to existing

display technologies through customisation, performance improvement based on innovative key components and system integration, manufacturing cost reduction based on new processes and equipment, and reuse for other applications. The line also addresses multi-sensor/ actuator optimisation and integration to interface systems with user senses, posture and environment. See Ref. 3 for the details of running projects.



Cognitive Vision

The objective is to develop robust cognitive vision systems acquiring and using knowledge for decision making. The focus is on adaptive systems, real-time platforms and vision architectures permitting the development of novel computational frameworks, integrating multiple cues for scene modelling and capable of recognising large numbers of different objects. The aim is to provide the methods and techniques that enable construction of vision systems that can perform task oriented categorization and recognition of objects and events and yield rich semantic models of the environment. Cognitive performance, adaptability, robustness, run-time efficiency, cost-effectiveness and development of a generic cognitive vision architecture, that can be adapted automatically to underlying tasks and environments are essential elements of the research. This requires the bringing together of statistical learning theory, computer vision and cognitive science experts.

A network of excellence has been put in place. The objectives of EC-Vision are to bring together a disparate community of computer vision and artificial intelligence researchers in Europe, to promote vision research through education, training, and information dissemination, to provide a forum for technology transfer with industry by highlighting current capabilities and application successes and to maximise the effectiveness of future research by identifying a detailed research agenda, addressing basic scientific techniques, systems engineering methodologies, application requirements, computational architectures, and hardware infrastructure. Details about the IST Cognitive Vision cluster and about the EC-Vision Network are available under Ref. 4.

Presence Research

Within the Forward and Emerging Technologies area of IST, a new initiative has been launched concerning Presence research. It intends to support the development of novel media that convey a sense of "being there". A theory of presence, emerging through interdisciplinary research that explores the cognitive and affective roots of sensory perception is expected to give rise to the design of innovative systems that offer "richer" experiences than any current media and communication technologies.

The focus is on understanding presence, defining appropriate degrees of immersion according to context, and developing a common reference model. Research will explore the full potential of novel media from the perceptual perspective and identify their inherent characteristics. This initiative is expected to attract a range of contributions from fields such as vision science, psychoacoustics, haptics, telecommunication engineering, computer science and artificial intelligence, hardware technologies, media and performing arts, psychology, phenomenology,

as appropriate in specific projects. Imaging is likely to play a central role. Details of this initiative are available under Ref. 5.

Mixed Reality and New Imaging Frontiers

The objective of this Action Line is to bridge the gap between real and virtual worlds for innovative applications. The focus is on the Reality-Virtuality continuum for:

- Augmenting virtuality and bringing virtual worlds to life by enhancing realism and level of detail, introducing intelligence, making them persistent and reactive environments;
- Augmenting reality and fusing real and virtual universes by enhancing real environments for applications ranging from wearable computing for navigation and industrial processes to programme production and interactive entertainment; and
- Discovering new sensory frontiers by addressing high definition, 3D, full space imaging, multisensory cues and very advanced display systems to create fully immersive environments distributed over heterogeneous networks and platforms in which users will be able to enjoy rich, multisensory experiences for virtual- or tele-presence.

Mixed Reality (MR) makes the best out of two worlds, effectively marrying the flexibility of computer graphics with the realism of real-life pictures. For this, computer vision, computer graphics and advanced audio-visual representation and coding techniques need to be integrated. There is little doubt that within the not too distant future, MR will lead to new visual interfaces, which are needed to move beyond the desktop paradigm. MR is not limited to visualisation and should also be seen in a wider context, opening the way to the integration of mechanics, robotics, toys and appliances with visualisation and IT equipment. Future MR applications will seamlessly integrate real world objects one can touch and feel with software and audio-visual representations.

20 projects have so far been accepted for funding under this action line. More details are available in Refs. 3 and 6.

Sample Projects

A few examples of representative running projects are given below. These should illustrate the type, size and scope of typical projects funded by IST.

CogVis: Pushing the Limit of Cognitive Vision

The objective of this project is to develop methods and techniques that enable to construct truly cognitive vision systems. In the context of an embodied agent such vision systems should be able to perform categorisation and recognition of objects and events in a task-oriented manner and in realistic environments. The functionality will for example enable construction of mobile agents that can interpret the action of humans and interact with the environment for tasks such as fetch and delivery of objects in a realistic domestic setting. To enable design, implementation and deployment of a fully fledged cognitive vision system, the project addresses issues such as visual tasks (identification, recognition, description, detection and maintenance), memory (allowing the coupling between visual perception, tasks, knowledge and the "seeing" system), categorization and identification of object classes, events and scenes across visual appearance, robustness in particular in terms of recognition and temporal consistency, learning and adaptation (in particular learning from experience and adaptation to unexpected changes) and integration in the context of an embodied system.

CogVis brings together 6 partners from 5 European countries. Details about the CogVis project are available under Ref. 7.

RealReflect: Photo Realism and Sophisticated Light Simulation for the Next Generation of VR Systems

In current Virtual Reality systems there is only a very limited set of possibilities to visualize the appearance of different materials and to simulate safety relevant aspects of the design such as blinding the driver by interior lights in a night driving situation. RealReflect aims at developing physically correct simulation of light distribution and reflection as well as an image-based real-time visualization technology for synthetic objects with complex reflectance behaviour. This new technology will be integrated into an existing VR-system and tested in different application scenarios in automotive industry, like the simulation of safety and design aspects in the automotive industry as well as photorealistic VR simulations in architecture. The project will validate the technology on two industrial areas: Virtual prototyping, ergonomic investigations, and safety simulations in the automotive industry; Virtual interior design in architecture by correctly visualizing the atmosphere of a building interior. RealReflect has 10 partners from 4 countries. See Ref. 3 for details.

VIRTUE: Revisiting Telepresence

You are at a meeting table with people spaced around in front of you. You are able to communicate with them effectively as if they are sitting next to you in the same room, in fact you are led to believe they are present in the same room, but they are actually located at several remote locations. For many types of meetings, interviews, etc. this high-realism telepresence conferencing system will replace the need to travel. This has been a vision of through-the-screen conferencing for many years within the telecommunications industry. Computer vision and graphics techniques have now developed to a position where this vision is achievable. The VIRTUE projects makes this happen in Europe and has already demonstrated the innovative technology necessary to produce a convincing impression of presence in a semi-immersive teleconferencing system. Critical imaging issues addressed by the project are: Realistic wide view synthesis for dynamic scenes, object-based segmentation and motion tracking, flexible camera setup and multiple sensor fusion. VIRTUE has 5 partners from 3 countries. See Ref. 3 for details.

Arthur: Augmented Reality and Tangible Interfaces for Enhanced Shared Working Space

ARTHUR will bridge the gap between real and virtual worlds by enhancing the users' current working environment with virtual 3D objects. Developments focus

on providing an intuitive environment, supporting natural interaction with virtual objects while sustaining existing communication and interaction mechanisms. Real world objects are used as tangible interfaces to make 3D environments attractive even to non-experts. The project develops new types of user-friendly see-through displays, non-intrusive object tracking mechanisms and intuitive user interface mechanisms within a location independent multi-user real-time augmented reality environment. The emphasis is on affordable components to address a wide area of applications. In addition to the display, the main imaging challenge is a flexible and sophisticated object tracking mechanism based on computer vision, that will additionally allow recognition of user gestures without disturbing the user in his or her natural behaviour by cumbersome hand tracking devices. The augmented round table approach will be demonstrated by an architectural design and urban planning application. This application will support the intuitive collaborative design of multiple users. ARTHUR has 5 partners from 4 countries. The project's web page can be found in Ref. 3.

Framework Programme 6 Perspectives

The European Commission is currently proposing orientations for the next Framework Programme covering the period 2002-2006. The future IST Programme will carry forward the 'ambient intelligence' vision with an overall budget comparable to the current IST Programme. It will however bring major changes as far as funding mechanisms are concerned, and mainly be based on new funding instruments such as Networks of Excellence and so called 'Integrated Projects'. The following is an extract of the current draft Commission Proposal. See Ref. 8 for details and updates.

New Funding Instruments

The objective is to strive towards greater integration of research in Europe by means of focused action in priority thematic research areas to bring together the research actors and reach critical mass. It is also to promote the networking and joint action of national and European frameworks for research, and the opening up of national programmes.

Networks of Excellence (NoE)

NoEs will strengthen European scientific and technological excellence by means of a progressive and lasting integration of research capacities existing or emerging in Europe at both national and regional level. Each network will aim at advancing knowledge in a particular area by assembling a critical mass of skills. The network will be organised around a core group of participants to which others may be added in order to create a virtual centre of excellence. Activities will often be multidisciplinary, and oriented towards long-term objectives. In addition to these integrated research activities, the network's joint programme of activities will also comprise integration activities as well as activities related to spreading of excellence outside the network.

The size of the network may vary according to the areas and subjects involved. On average, in financial terms, the Community contribution to a network of excellence may represent several million euros per year. The partnership may evolve when necessary, within the limit of the initial Community contribution, by replacing participants or adding new ones. In most cases, this will be done through publication of a Call for Applications. The programme of activities will be updated yearly and will entail a reorientation of certain activities or launching of new ones not initially foreseen, which could involve new participants. The Commission may launch Calls for Proposals with a view to the allocation of additional contribution in order to cover, for example, an extension of the integrated activities of the existing network or the integration of new participants.

Integrated Projects (IP)

IPs will strengthen European competitiveness or contribute to resolve major societal problems by mobilising a critical mass of research and technological development resources and skills existing in Europe. Accordingly, each integrated project will have the aim of obtaining identifiable scientific and technological results applicable to products, processes or services. The activities carried out in the context of an integrated project will have by definition clearly defined objectives even in the case of risky research. In general, the participants in the projects will be organised around a core group made up of the main participants.

The size of an integrated project may vary according to the themes and subjects, depending on the critical mass necessary in order to obtain the expected results under the best possible conditions. The combined activities of an integrated project may represent a financial size ranging from several million euros to several tens of millions of euros. In most cases an integrated project will comprise a set of specific actions, relating to certain aspects of the research needed to achieve the objectives pursued, of variable sizes and structures according to the tasks to be executed, implemented in a closely coordinated manner. In some cases, however, an integrated project may take the form of a single large project with a single component.

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Imaging and Experience

Given their significance for the Information Society at large, it is very likely that imaging technologies will continue to be supported in future Programmes. The key core technological challenges are expected to remain i.e. sensors and display, computer vision, audio-visual data manipulation and storage including computer graphics, and mixed reality and standards. It will be essential to ensure a successful interaction between core technologies

by, for example, promoting the development of synergy between natural image processing, computer vision and computer graphics or encouraging a deeper integration of vision and speech work. Work on human/human interaction and human/machine interaction should also be combined with work on language, vision and intelligent information presentation.

Reaching beyond ***presence***, the concept of ***experience*** has been proposed as a powerful driver for integration of various technologies. As opposed to 'conventional' media for communication, retrieval or "consumption", enjoying an experience is strongly related to being able to re-establish context. It is also about enhanced interactivity and advanced user interfaces involving multi-sensor(y) data collection including continuous, real-time acquisition and tracking of events. A real experience requires powerful databases and knowledge management systems as well as effective ways to generate and distribute metadata for personalisation. Above all, it needs high-quality visualisation technologies including 3D, VR, mixed reality and immersive displays. Experiences are about content that is highly personalised, interactive, contextual and event-centric. Experiences reach beyond information and could be seen as being the ultimate media.[9]

Against this exciting background, the imaging research community should take up the opportunity offered by IST to develop Europe-wide networks of excellence and establish synergetic relationships with representatives of other scientific disciplines as well as industry and user groups.

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Disclaimer

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Biography

Eric Badiqué obtained his PhD in Engineering Science from the University of Besançon, France in 1988 and the Master of Physics from Ball State University, Muncie, USA in 1983. From 1984 to 1988 he was a Visiting Scientist at Tokyo Institute of Technology working on colour image correlation, stereo-based 3D modelling and image restoration. From 1988 to 1992 he worked on low bit-rate video coding and face tracking at Philips Communications in Nuernberg, Germany. He joined the European Commission in 1992 as a Project Officer and oversees R&D projects in the Digital Media area. His interests include computer vision, representation/coding and virtual/mixed reality technologies.