ARtificial GUidance System

ARGUS

— Part C —

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Contents

C.3 Community Added Value and Contribution to EC Policies

The overall goal of ARGUS is research and technological development of a portable object recognition rystem which will meet the navigational needs of blind and visually impaired people. The system will compliment existing navigation aids by providing significant spatial information to the user about their immediate environment. It will enable them to go about their daily business while being less reliant on the help of the seeing; it will add to the users' ability to react to unforeseen situations; it will greatly enhance their perception of their surrounding; and it will ultimately allow them to explore hitherto unknown areas of their surrounding with confidence and without the need to rely on other people's help. By doing this it will bolster the blinds' confidence and ultimately allow them the active participation in social and community activities that seeing people take for granted. This is in agreement with a long history of EC funding programmes, e. g. the TIDE programme initiated in 1991, to name but one. Benefits for the Community include:

1. Technological developments play an increasingly important part in addressing the growing market opportunities presented by the needs of older and disabled persons. The early and efficient deployment of technologies in this sector can help the European industry to compete with international competitors, many of whom have a favourable market position due to, e. g., progressive legislation. In addition, a strong European assistive technology industry has the potential to create a large number of jobs, many of these in SMEs distributed throughout the Community.

2. Projects like ARGUS contribute to the creation of a framework for cooperation and coordination between the parties involved in assistive technology industry — industry, researchers, users. This continues the TIDE efforts of bringing together players of the fragmented European assistive technology market.

3. Experts of several European countries are brought together to create synergies. In fact, the ambitious goals of this project can only be achieved through the combined expertise in several technological fields and subfields. Expected synergies will pertain to user requirements, RTD in Computer Vision, and system integration, as summarised below.

C.3.1 User Requirements

The navigational aid ARGUS is a development whose future economical feasibility may be significantly increased if the mobility requirements of blind people from more than a single country can be met. A development based on the experiences of partners, and in particular organisations of the blind, from several European countries will have definite advantages:

- Erroneous assumptions regarding the universal needs of blind people will be avoided, as well as erroneous assumptions about the conditions and the structure of the environment in which ARGUS will operate.
- Design decisions based on input from multiple European organisations for the blind will improve the acceptance for ARGUS within the blind community.
- ARGUS is a multinational project and its outcomes will be disseminated widely through the international consortium. Once turned into a product (outside the scope of this proposal), ARGUS would become readily available to the large European market via marketing strategies already used by the EBU and other partners.

C.3.2 RTD in Computer Vision

The functionality of ARGUS, although limited to tasks well below the capabilities of human vision, requires contributions from a significant number of distinct computer vision subfields (lead contractor in parentheses):

- Segmentation of natural scenes (LKI)
- Texture analysis (UALG)
- Colour, illumination, photometry (LKI)
- Learning, experience-based vision (LKI)
- Binocular stereo (ITI, ALU)
- Invariance theory (ALU)
- Geometric uncertainty management (ALU)
- 3D Structure recognition (ALU)
- Motion detection (LKI)
- Text localisation and OCR (UALG)
- Template matching, sign recognition (ALU)
- Search and decision strategies (LKI)

The large number of contributing subfields, most of them with their own methodological basis, is typical for real-life vision tasks. In order to obtain excellent and innovative solutions, it is necessary to bring together research teams whose combined expertise covers all aspects of the proposed task. The partner short-name behind each item (in parentheses) indicates the coverage within the proposed consortium. It is evident that the European dimension provides a far better basis than any national effort.

C.3.3 System integration

The proposed project calls for the integration of special purpose software and hardware developments into a prototype system. While it is not expected that a product stage can be reached, system integration has to be performed with a market perspective. Hence it is necessary to involve partners who are

- technical experts,
- experienced with product development and the needs of blind people,
- provide access to the European market.

VISYS is a spin-off of JURCA Optoelektronik GmbH, Rodgau, Germany. JURCA has been the hardware integration partner and project leader in the German national project MOVIS, which provides an important basis for this proposal (other partners in this project were ALU and LKI). Also, JURCA has been the company which established the initial contact between the German organisation of the blind and LKI as early as 1992. The vision system activities of JURCA have been handed over to VISYS together with key-personnel, including Dr. Reuter, and the connections to the blind community.

TEIMA is a specialist in hardware development and low-level programming. The company is presently part of a TIDE consortium which is developing an advanced tool aimed to help improve the speaking ability of people with impaired hearing. TEIMA has a good relationship with key people in ONCE (Spanish National Organisation of the Blind).

Software integration will be performed by SiE which has important experiences with portable digital assistants as well as in the areas of health-care, tourism, GIS systems, publicity and advertising, transport, services and banking. SiE too has relations to ONCE and will actively participate in user-tests and system specifications.

C.4 Contribution to the Community Social Objectives

ARGUS is designed to exploit high technology for the benefit of the handicapped, furthering the integration of the blind and visually impaired into the Community by increasing their mobility. Hence, in its entirety, the project will contribute to the Community social objectives. In the following, we elucidate some aspects of the social situation of the blind.

In Germany alone there are more than 150 000 registered blind and an estimated number of 500 000 visually impaired people. While numbers are hard to come by for all of the EC, it is estimated that between 6.5 million and 7.4 million or approximately 2 % of the EC's population are blind or visually impaired[6]. Only about 20 % of the blind are professionally active, more than half of the blind rarely leave their homes. The main obstacles are missing confidence and fear of traffic accidents. A navigational aid could provide the means for a professional rehabilitation, decreasing unemployment for people who often have the potential for an excellent professional career and important contributions to society. Their life could be improved considerably by the navigational aid ARGUS which will be developed in this project, opening up new social and professional opportunities.

More than half the blind are older than 60 years and will usually have lost their sense of vision over the last few years. They will as a rule lack the confidence to leave the house unaided by a seeing person, and will as a result become socially isolated, without an opportunity to participate in the social and community activities that sighted people take for granted.

A navigational aid like ARGUS would be a welcome tool for many of these elderly blind, bolstering their confidence and thereby increasing their mobility. It would be particularly important for the progressively visually impaired (e. g. suffering from Retinitis Pigmentosa) who turn blind at an average age of 40 to 50. These often do not adjust well to their increasing blindness, even ignore the onset of blindness as long as possible, and as a result only possess the most basic mobility skills.

The past has shown, and consultations with individual blind persons and representatives of organisations for the blind have confirmed this, that not every aid is a welcome aid. Several attempts to develop navigational aids have had limited success because essential user requirements could not be met. ARGUS will be based on the results of extensive interactions with blind users in the (nationally funded) pilot project MOVIS, and will benefit hugely from the direct involvement of the EBU (European Blind Union) which is a member of the ARGUS consortium and will perform user tests and user surveys in several European countries, including France, Belgium, Spain, and Italy, and from the involvement of German organisations for the blind through the company empirica, which will act as a sub-contractor to VISYS.

[6] In geographic Europe, the number is estimated to be 1.1 million blind and 11.5 million visually impaired [COST 219].

C.5 Project Management

Since the project has a relatively small number of participants and the organisation in terms of workpackages is straightforward, with almost no hard dependencies or bottlenecks, the management structure imposed will not be particularly complex.

Each workpackage is managed by a group leader (the workpackage's lead contractor as specified in Table B1). The group leader will stay in contact with the collaborating participants' scientific staff; partners collaborating on a particular task are encouraged to foster and improve this collaboration by the exchange of researchers for a limited period. The group leaders are free to solve problems within their package and between packages. If solutions imply that the course of the project will change significantly, the coordinator must be informed and the latter will consult all participants and, eventually, the Commission. The coordinator will also control situations in which no consensus can be reached, neither between the project leaders directly involved, nor by a majority vote between all group leaders; the coordinator will in these cases have the last vote, if necessary after consulting experts not belonging to the consortium or the Commission. However, while it is of course necessary to set up the above formal structure it should be noted that experience with other projects has shown that most problems can easily be solved in an informal way, usually simply by email.

Participants have the obligation to inform the coordinator, as soon as possible, about problems that may affect the timing of deliverables or the project as a whole. The coordinator, on the other hand, will regularly contact the project leaders in order to detect possible problems and delays, and where possible to redistribute (sub)tasks. This complements the normal management reports which serve to determine what tasks and workpackages are within schedule and which are not.

The 6-monthly management reports will be short, normally a couple of pages, detailing the personnel and staff working on the different tasks and the status of all tasks. An essential element concerns the assessment of the project in terms of deliverables and the quality of these in view of the project objectives. Apart from the assessment on the basis of the workpackage deliverables, two major assessment milestones have been defined: a mid-project evaluation (D 18 at month 18) and a pre-final evaluation (D 33 at month 30). The coordinator will establish the rules for the partners' contributions to the scientific and management reports, the text-processing formats, the deadlines, and so on. He will do this following the kick-off meeting. The project language is English, and all reports are therefore to be written in English only.

The coordinator and the other participants will organise seven project meetings, one at the start of the project (kick-off meeting) and one meeting every six months. The first one is only for the scientific project leaders, and serves to discuss practical matters, e. g. a consensus concerning reporting, software exchange, and documentation, as well as questions of intellectual property rights. Similar considerations apply to the three meetings after month 6, 18, and 30. These are basically for the discussion of internal design decisions. The other meetings, i. e. after each full year, will be combined with public workshops in order to attract other researchers and to establish active collaborations beyond the partnership. The (restricted) meetings serve to evaluate the work done, to synchronise the participants, to discuss problems and improvements, and to prepare the annual reports as well as the work planned for the next six months. It is the coordinators responsibility to produce a clearly identified agenda for each meeting.

The coordinator, assisted by the other participants, will prepare webpages with public and restricted-access information. These will explain the project aims, participants and structure, and will contain all useful data, software, publications etc., as well as links to related projects and groups. In order to improve the exchange of information between the participants and all project personnel, an `ftp` server and mailing list will be established.

The coordinator will be responsible for the administration of the project, the management of all project resources according to EC rules (providing periodic cost statements and distributing project funds in a task performance related way), the sampling of reports and cost statements, and the organisation and scheduling of internal workshops and meetings. All partners are individually

responsible for their contributions to written reports and the deliverables relating to their part of the project, which the coordinator will combine into due progress reports. The coordinator is responsible for all interaction between the consortium and the EC and will apply corrective measures in the event of failure to achive objectives, which will be assessed through the periodic progress reviews and quality assurance methodologies described above.

C.6 Description of the Consortium

No.	Laboratory or Department	Institution	Short name	City (country)
1	Institute of Pattern Recognition and Image Processing	Freiburg University	ALU	Freiburg (Germany)
2	Artificial Intelligence Laboratory	Hamburg University	LKI	Hamburg (Germany)
3	Vision Laboratory	University of Algarve	UALG	Faro (Portugal)
4	Information Processing Laboratory	Informatics and Telematics Institute	ITI	Thessaloniki (Greece)
5		VISYS AG	VISYS	Bad Homburg (Germany)
6		TEIMA Audiotex	TEIMA	Madrid (Spain)
7	RTD Department	Sistemas Expertos SA	SiE	Madrid (Spain)
8	Commission on Liaising	European Blind Union	EBU	Paris (France)

ALU (1) will develop and test software for the recognition of selected traffic signs and icons in WP 3 as well as for the recognition of selected 3D objects in WP 4. The Institute for Pattern Recognition and Image Processing has the necessary competence and equipment to carry out this task. ALU has successfully worked on a similar project MOVIS, funded by the German ministry for research, for which it implemented similar functionality [23, 25, 43].

LKI (2) will develop and test software for qualitative scene interpretation in WP 5 and the recognition of user-trainable landmarks in WP 6. The Artificial Intelligence Laboratory has the necessary competence and equipment to carry out the task, in particular with respect to segmentation and analysis of cluttered real-life scenes. The institute has successfully worked on a similar project, MOVIS, for which it implemented similar functionality [33].

UALG (3) will develop and test software for text recognition in WP 2 as well as the the GIS/GPS in WP 7. The UALG Vision Laboratory has the necessary competence in image processing and pattern recognition in general, and specifically with respect to GIS and text analysis.

ITI (4) will develop and test software for centre path travel and the recognition of obstacles in WP 1. The Informatics and Telematics Institute has the necessary competence in image processing and pattern recognition in general, and extensive experience with stereo-vision and 3D modelling.

VISYS (5) will develop and test the head mounted stereo-camera system integrated into a pair of glasses which will be used in ARGUS (WP 8). VISYS has the necessary competence and equipment to carry out this task. Key personnel of VISYS was actively involved in the successful development of similar cameras during the TIDE project 1211 POVES (see [1], due as a product in May 2000) and the nationally funded project MOVIS, on which ARGUS is based [16].

TEIMA (6) will develop and test the processing unit used in ARGUS (WP 9). TEIMA has the necessary competence and equipment to carry out this task.

SiE (7) is responsible for the integration of the software and overall integration of soft- and hardware in WP 10 and WP 12. SiE has the necessary competence and equipment to carry out this task.

EBU (8) is responsible for user requirements and user tests in WP 11. The EBU is the European umbrella-organisation of the individual national organisations for the blind and therefore ideally suited for this task, for which it has the necessary competence and equipment.

C.7 Description of the Participants

C.7.1 Freiburg University

The Institute for Pattern Recognition and Image Processing was founded in 1997 within the Department of Applied Sciences at the Albert-Ludwigs-Universität Freiburg. The department itself is very young and well equipped. The group working at the Institute for Pattern Recognition and Image Processing has a long tradition and international reputation in the field of image processing, image analysis and computer vision. Research topics include: invariants in pattern recognition, optimal image restoration methods, motion estimation algorithms, parallel algorithms in image processing and pattern recognition, parallel computer systems, image analysis and vision guided control of combustion processes. Currently the group consists of about 12 persons and is steadily growing (its old size before moving from TU in Hamburg was about 25 persons). The key objectives of the Institute are

- research in the area of image processing, image analysis and computer vision
- technology transfer of developed methods by cooperations and joint projects
- lectures, giving local courses as well as contributing to international seminars
- knowledge dissemination in conferences and journals

The research performed so far covered different fields of image processing and analysis. The activities include the construction of invariant features for pattern recognition (fast invariant transforms (CT), affine Fourier-descriptors, grey-level Fourier-descriptors, affine moment invariants, grey-level invariant features by averaging techniques), motion estimation, image restoration, vision guided process control, stereo-vision, scene analysis as well as parallelisation of image processing and computer vision algorithms. As a result the Institute for Pattern Recognition and Image Processing has well founded algorithmic know-how in the fields of stereo-vision and segmentation, which can be contributed to ARGUS. The Institute for Pattern Recognition and Image Processing has many contacts to national as well as international researchers in common projects as well as other events like cooperative organisation of summer-schools and seminars. The most important activities were:

- the project COST13 “Low level vision and image processing”,
- team leader of the consortium 3035 “Development of Fundamental Vision Algorithms with Parallel Environment” within the “ESPIT-BRA Working Group on Vision” (ESPRIT-BRA 3352),
- partner in the ESPRIT BRA project NAT — Nonlinear and Adaptive Techniques in Digital Image Processing, Analysis and Computer Vision (1993–1996),
- coordinator of ESPRIT LTR project NOBLESSE — Nonlinear Model Based Analysis and Description of Images for Multimedia Applications (1996–1998),
- German Research Ministry project MOVIS — Mobile Optoelectronic visual interpretative system for visual impaired persons (1994–1997),
- several projects funded by the German Science Foundation,
- chair of the European Conference on Computer Vision — ECCV 1998.

CV of the key-person involved

Hans Burkhardt received his Dipl.-Ing. degree in electrical engineering in 1969 and Dr.-Ing. degree in 1974 from the University of Karlsruhe, Germany. In 1981 he became Professor for Control and Signal Theory at the University of Karlsruhe. From 1985 until 1996 he was full Professor at the Technical University of Hamburg-Harburg. Between 1990 and 1996 he was also scientific advisor for the Microelectronic Application Centre (MAZ) in Hamburg. Since 1997 he is full Professor at the Computer Science Department of the University of Freiburg, director of ALU and currently Dean of the Faculty for Applied Sciences. He has published over 100 papers and given more than 150 lectures. He is a consultant for several national and international institutions, e. g. the German Science Foundation (DFG), the European Commission and different international organisations and journals.

C.7.2 Hamburg University

The Laboratory for Artificial Intelligence (LKI) is an institution at the University of Hamburg dedicated to application-oriented research in Artificial Intelligence. It is one of the six German centres of excellence which are members of the Association of the German AI Institutes (AKI). The LKI was founded in 1988 in close connection to the Cognitive Systems Laboratory (KOGS) which has carried out successful work in Computer Vision and Artificial Intelligence since 1971, including pioneering work on image sequence interpretation in real-life scenes. Recent projects at KOGS and LKI include basic research in formal models of segmentation, industrially funded work in medical image analysis, industrial cooperation in aerial image analysis, and work in the nationally funded joint project MOVIS which provides an important basis for this proposal. Both, application-oriented projects at the LKI and basic research at KOGS, generate a fertile ground for activities ranging from research into theoretical foundations to developments of application systems.

In MOVIS, the project most relevant for ARGUS, LKI had the task to develop basic requirements, concepts and laboratory solutions for landmark recognition as a navigational aid for the blind. LKI has the scientific staff and the working environment to carry out the proposed work of ARGUS under optimal conditions.

Selected publications of the scientific staff of LKI include:

[11] J. Heers, C. Schnörr, and H.-S. Stiehl. Investigation of Parallel and Globally Convergent Iterative Schemes for Nonlinear Variational Image Smoothing and Segmentation. In *Int. Conf. Image Processing*, Chicago, 1998.

[33] Bernd Neumann. Landmerkenerkennung in MOVIS. Abschlußbericht LKI-M-1/98, Labor für künstliche Intelligenz, Universität Hamburg, March 1998.

[37] K. Rohr and H.-S. Stiehl. Performance Characterization of Landmark Operators. In R. Haralick, R. Klette, H.-S. Stiehl, and M. Viergever, editors, *Proc. Dagstuhl Seminar "Evaluation and Validation of Computer Vision Algorithms", Dagstuhl-Seminar-Report 205*, 1998. IBFI, 11.

CV of the key-person involved

Bernd Neumann studied Electrical Engineering at Darmstadt in Germany (Dipl.-Ing. 1967) and Information Theory at MIT/USA (M.S. 1968, Ph.D. 1971). He joined the Department of Computer Science at Hamburg University in 1971 as a lecturer. Since 1982 he is Professor at this department, since 1986 head of the Cognitive Systems Laboratory. He is also the head of the Artificial Intelligence Laboratory which he founded in 1988. He is a member of GI, ACM, AAAI, IEEE; he was the Chair of the national German association "Artificial Intelligence and Pattern Recognition" from 85 till 88; since 97 he is the Chair of IFIP TC-12 "Artificial Intelligence". He is advisor of the journal "Image and Vision Computing", and has been the Programme Committee Chairman of several international conferences, as well as Advisor or reviewer to German and European projects.

C.7.3 University of Algarve

The Vision Laboratory at the University of Algarve (UALG) was founded five years ago when Prof. Hans du Buf left the EPFL in Lausanne and was appointed associate professor. By now, the laboratory has grown to 4 postdocs, 4 PhD students plus Masters' and graduating students. Well equipped with an SGI Origin 200 server and workstations etc., its activities include image processing and pattern recognition, computer graphics, human visual perception (psychophysics) as well as parallel processing. Currently running projects are

- Integrated System for the Analysis and Characterization of the Seafloor (ISACS, MAS3-CT95-0046),
- Automatic Diatom Identification And Classification (ADIAC, MAS3-CT97-0122) and
- Advanced Modelling Of Visual Information Processing (AMOVIP, ESPRIT INCO/DC 961646).

Detailed information is available at `http://w3.ualg.pt/~dubuf/vision.html`.

CVs of the key-persons involved

Hans du Buf received his MS from Eindhoven University of Technology in 1983 and his PhD from the same university in 1987. He worked at the Swiss Federal Institute of Technology at Lausanne before moving to the University of Algarve in March 1994, where he is an invited associate professor. He has extensive experience in image processing and pattern recognition, notably texture analysis, image segmentation and Gabor analysis. He is the UALG key person in the projects listed above, and he is the Coordinator of the ADIAC project with 7 partners and with a budget of 1.25 million Euro. He is (co)author of more than 20 journal papers and more than 25 conference papers.

Hamid Shahbazkia received his PhD in Image Processing and Document Analysis in 1998 from the University of Strasbourg. He is currently a postdoc at the University of Algarve in Faro. His research experience includes document analysis (text and graphics), cadastral (land-registry) map analysis and GIS, invariant recognition, multi-agent and hybrid systems.

C.7.4 Centre for Research and Technology Hellas, Informatics and Telematics Institute

The Centre for Research and Technology Hellas, Informatics and Telematics Institute (ITI), is a non-profit organisation under the auspices of the General Secretarial of Research and Technology of Greece, with its head office located in Thessaloniki, Greece (`http://www.iti.gr/`). The ITI research group has long and very extensive experience in image and video analysis and coding algorithms, content/model based coding and segmentation, indexing and retrieval algorithms for medical applications. In recent years, ITI has closely followed the MPEG-4 and MPEG-7 standardisation procedures since it is a part of the Greek body responsible for the adoption of ISO and IEC standards. It has also published research work related to these standards. It is participating in a large number of research collaboration forums, like the COST211quat, whose objectives include content and feature extraction, audio-visual content identification and content-based visual database query and indexing. The Information Processing Laboratory of ITI has participated in the major ACTS II and III projects DISTIMA and PANORAMA which dealt with 3D Imaging and its applications, and has very extensive experience in 3D modelling and analysis. It has also participated in the Telematics for Health project SAMMIE II (HC1044) where it developed visualisation tools for 3D MRI medical images. ITI is currently participating in many research projects funded by the EC and the Greek Secretariat for Science and Technology. More specifically, ITI is participating in the following relevant European and National research projects

- "HISCORE: High Speed 3D and Colour Interface to the Real World" (IST, 1999-2002).
- "INTERFACE: Multimodal Analysis / Synthesis System for Human Interaction to Virtual and Augmented Environments" (IST, 1999-2002).
- "VIDAS: VIDeo ASsisted with audio coding and representation", (ACTS II, 1996-).
- "Coding of face image sequences using 3D models for tele-education purposes", (Greek National Project PENED, 1995-2000).
- "MPEG4 ToolBook", (Greek National Project PENED, 1999 - 2001).
- "Coding of face image sequences using 3D models for teleeducation purposes", (Greek National Project PENED, 1995-2000).
- "Object based stereo video coding", (Greek National Project PENED, 1995-2000).
- "A system for fast searching, browsing and composition of audiovisual information", (Greek National Project EPET II - PAVE, 1999 - 2001).
- "Industrial Telepresence System for Dangerous Procedures Support", (Greek National Project EPET II - PAVE, 1999 - 2001).
- "Processing, Registration and Telecommunication of 3D Medical Images", (Greek National Project HYPER99, 1999 - 2001).

ITI has also completed successfully the following relevant projects

- "PANORAMA: Package for New OpeRational Autostereoscopic Multiview systems and Applications", (ACTS, 1995-1999).
- "PLATON: Coding for very low bit rate mobile video communication", (Bilateral French-Greek project, 1995-1998).
- "NIKA: Medical Image Archiving Coding and Transmission System", (EPET II, 1994-1998).
- "Coding for the Transmission of still and moving ultrasound images", (Greek National Project PENED, 1996-1998).

Relevant publications include:

[8] N. Grammalidis, D. Beletsiotis, and M. G. Strintzis. Sprite generation and coding in multiview image sequences. *IEEE Trans. on Circuits and Systems for Video Technology, Special Issue on 3D Video Technology*, 10(2):302–311, March 2000.

[10] N. Grammalidis and M. G. Strintzis. Disparity and occlusion estimation in multiocular systems and their coding for the communication of multiview image sequences. *IEEE Trans. on Circuits and Systems for Video Technology*, 8(3):328–344, June 1998.

[18] I. Kompatsiaris, D. Tzovaras, and M. G. Strintzis. 3d model-based segmentation of videoconference image sequences. *IEEE Trans. on Circuits and Systems for Video Technology*, 8(5):547–561, September 1998.

[19] I. Kompatsiaris, D. Tzovaras, and M. G. Strintzis. Flexible 3d motion estimation and tracking for multiview image sequence coding. *Image Communication, Special Issue on 3D Imaging*, 14:95–110, 1998.

[28] S. Malassiotis and M. G. Strintzis. Model based joint motion and structure estimation from stereo images. *Journal of Computer Vision and Image Understanding*, 65(1):79–94, January 1997.

[29] S. Malassiotis and M. G. Strintzis. Tracking textured deformable objects using a finite element mesh. *IEEE Trans. on Circuits and Systems for Video Technology*, 8(6):76–77, October 1998.

[34] Th. Papadimitriou, K. I. Diamantaras, M. G. Strintzis, and M.Roumeliotis. Robust estimation of rigid body 3-d motion parameters based on point correspondences. *IEEE Trans. on Circuits and Systems for Video Technology, to appear*, 2000.

[40] M. G. Strintzis and S. Malasiotis. Object-based coding of stereoscopic and 3d image sequences. *IEEE Signal Processing Magazine, Special Issue on Stereo and 3D Imaging*, 16(3):14–28, May 1999. Invited paper.

[42] D. Tzovaras, N. Ploskas, and M. G. Strintzis. Rigid 3d motion estimation using neural networks and initially estimated 2d motion data. *IEEE Trans. on Circuits and Systems for Video Technology*, 10(1):158–165, February 2000.

CVs of the key-persons involved

Dr. Michael G. Strintzis is a professor of the University of Thessaloniki and the director of the institute. He received his Ph.D. from Princeton University, in 1970. His current research interests are in 2D and 3D image and image sequence processing and coding. In the last 4 years, he has authored over 50 articles in scientific journals and delivered over 100 scientific conference presentations in these and similar areas. Dr. Strintzis is an IEEE senior member and a recipient of the centennial medal of the IEEE. Until 1999, Dr. Strintzis was a member of the RACE/ACTS Management Committee. From July 1999, he is an Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology.

Dissemination ITI will feature heavily in the project's information dissemination activities, presenting the results of the project in well-known and widely read international scientific journals.

C.7.5 VISYS AG

The VISYS AG at Bad Homburg, Germany (near Frankfurt) develops vision systems for different applications in the areas of medicine, rehabilitation, and security. The technical key-personal has extensive experience in the development of vision systems. Reference projects are, e. g.:

- TIDE project 1211 (POVES), a portable optoelectronic vision enhancement system for different kinds of visual impairments,
- BMBF-project MOVIS within the framework of the programme "Electronic Eye", for the recognition of special landmarks based on computer vision (much of ARGUS is based on experience gained within MOVIS),
- HESIS, a helmet controlled vision system for vehicle driving. The motion of the driver's head is used to control a camera system outside of the vehicle. The images which the camera receives are displayed on the helmet-mounted display worn by the driver.

A new product of VISYS, coming to the market in May 2000, is a spectacle-like night-vision system, especially developed for persons with night-blindness, e. g. due to retinitis pigmentosa.

CV of the key-person involved

Arnulf Reuter received a Dipl.-Ing. degree in electrical engineering in 1961 and a Dr.-Ing. degree, also in electrical engineering, in 1969, both from the RWTH Aachen (Germany). From 1969 to 1992 he worked first as a scientific employee and later as a scientific manager at Battelle Europe (Frankfurt) (Communication technologies and systems development). He was development manager and vice president at JURCA Optoelektronik GmbH (Rodgau) from 1992 to 1999. Since then he is director for research, development and production of VISYS AG (Bad Homburg / Germany). He has been involved in the development of systems for military and civil applications, quality control and inspection in industrial production, and for medical and rehabilitation applications. He has been the coordinating manager of TIDE project 1211 (POVES) [1] and of the BMBF-project MOVIS [16].

C.7.6 TEIMA Audiotex

TEIMA started in 1994 as a spin-off of the Polytechnic University of Madrid. Since then TEIMA has specialised on three basic lines:

1. Computer Telephony Integration for Small and Medium Enterprises. TEIMA has developed its own hardware and software platform for CTI in the SME market. TEIMA's solution is based on Texas Instruments TMS320C31 floating point DSP; all functionality is achieved as algorithms running in the DSPs. Functionality includes: call progress analysis, pulses and tones detection and generation, recording and playback of speech using common industry standards, echo cancelling for barge-in, port conferencing, speech recognition (isolated words and continuous), text to speech conversion, FAX group 3 sending. Operating systems supported: WINDOWS 95, 98 and NT.

2. Boards for real-time signal processing, based on TMS320C30, TMS320C31 and TMS320C40. Software tools include: RtkDsp (real-time kernel), DspIo (real-time i/o system), DspEmu (real-time emulation). The boards support Code Composer.

3. Turn-Key, including hardware and software, projects

CVs of the key-persons involved

Sofia Moreno received her MS in telecommunications (electrical engineering) from the Polytechnic University of Madrid in 1990 and for 3 years was enrolled in the Signals and Systems Department PhD-programme working on speech coding; the programme included a one term stay at Georgia Tech, USA. In 1994 she started working for TEIMA, specialising in project management. Since 1998 she is TEIMA's Managing Director.

Jesus Frias received his MS in telecommunications (electrical engineering) from the Polytechnic University of Madrid in 1995. He then joined TEIMA, where his main area of activity has been the development of low level programming tools and real time signal processing architectures.

Pablo Estebanez received his MS in telecommunications (electrical engineering) from the Polytechnic University of Madrid in 1995. He afterwards joined TEIMA, where his main area of expertise is in hardware architectures design and implementation.

C.7.7 Sistemas Expertos SA

Sistemas Expertos SA (SiE) was formed in 1986 with the purpose of carrying out work mainly in the fields of artificial intelligence and advanced information processing technologies. The company commercialises turnkey systems and applications resulting from developments including a combination of third party products and internal research. This line of activity is complemented with commercialisation of informatics and communication products (internal and external) and services and consultancy in areas related to information technologies, communications, artificial intelligence, and environment. The company is active in fields including: healthcare, tourism, GIS systems, publicity and advertising, transport, services and banking.

SiE's experience and skills include:

- user requirements capture,
- formal specification and algebraic modelling,
- web based applications,
- multidatabase systems and distributed information retrieval,
- middleware products,
- multimedia graphical user interfaces,
- object-oriented databases,
- client/server applications,
- intelligent agents,
- symbolic and non-symbolic AI techniques,
- pilot applications implementation and evaluation,
- project management.

SiE is an active member of the Committee for European Normalisation (CEN), the IEEE Computer Society, the ACM, the OII and ISO. Partnerships are established with:

- Microsoft. Member of the Microsoft Developers Network.
- SUN. Partner of SUN Systems Ibérica, SA.
- Silicon Graphics. Partner of Silicon Graphics Ibérica.
- Symbol Technologies. Partner of Symbol Technologies, SA.

In 1996, SiE received the prize EUROPE, an award established by the Spanish Association of Chambers of Commerce and University Enterprise Foundation granted to the company with the best records in R & D and in the collaboration with European institutions.

SiE has been awarded the professional merit prize for Madrid SMEs in 1998, established by the prestigious publication 'Actualidad'.

CVs of the key-persons involved

Alfonso M. Rey received his degree in computer science from the University Complutense of Madrid in 1995. He first joined TIDSA in 1993 and since 1996 has been working in the Research and Development of SiE. He has been working in the EC projects EIVIS and MultiPort and has large expertise in object-oriented techniques and information storage and retrieval systems.

Jesus Garcia received his computer science degree from the University Complutense of Madrid in 1996. He works for SiE since 1997. He has been involved in the development of applications for healthcare institutions and hospitals and has ample expertise in requirements collection, assessment and user interface design.

Belen Martinez received a high degree in marketing and enterprises management from the Autonoma University of Madrid in 1992; she joined SiE's External Relations Department in 1993, where she has been working in a number of EC projects for DXIII and DGIII.

C.7.8 European Blind Union

The European Blind Union (EBU) was founded in 1984 and was registered in Paris on 4 June 1990. It is a non-governmental and non-profit-making organisation. EBU is one of the seven regional bodies of the World Blind Union (WBU). EBU is together with IRPA EUROPE (International Retinitis Pigmentosa Association) the only organisation representing the interests of blind and partially sighted people in the European Union (EC) and in geographic Europe. EBU is an active member of the Board of the European Disability Forum.

EBU's purpose, as set up in its constitution, is:

- to work towards the advancement of the well-being of blind and partially sighted people in Europe with the goal of equality and full participation in society;
- to provide a European forum for the exchange of knowledge and experience in the field of blindness and partial sight and;
- to promote the prevention of blindness and partial sight in Europe.

EBU currently has 44 member countries, each represented by a national delegation. The 15 EC member countries are gathered by the EBU Commission on Liaising with the EC (EBU/CL/UE). The work is directed by an executive board composed of elected officers who are accountable to the EBU general assembly held every four years.

The detailed work of EBU is carried out by a number of standing commissions. Their areas of activity reflect the major interests of the EBU, such as:

- Commission on Rehabilitation, Vocational training and Employment,
- Commission on Technical devices and Services,
- Commission on Mobility,
- Commission on Access to Culture and Information,
- Commission on Activities of Elderly Blind and Partially Sighted People
- Commission on Advancement of the Interest of Blind and Partially Sighted women,
- Commission on Social Rights...

EBU's offices in Paris and Brussels are responsible for communication and liaison between member organisations of EBU and for information and documentation.

EBU has participated in a number of EC projects under TIDE; DGV budget lines (coordination, pilot projects, etc.), LIEN/PHARE and TACIS. EBU was also involved with the end users trials for a number of EC co-financed projects aimed to promote autonomy and equal opportunities for Blind and partially Sighted persons (i. e. TIDE project OPEN).

It is the believe of EBU that disabled people should be able to benefit from all EC funding programmes, and the EBU seeks to use the Quality of Life and Management of Living Resources programme to provide opportunities for blind and partially sighted people.

CVs of the key-persons involved

Rodolfo Cattani is the chair of the European Blind Union Commission for Liaising with the European Union. He holds a university degree in Philosophy of science from the University of Bologna (1966). Since 1974 he has been active at different levels in national European and World organisations of and for persons with disabilities. He was the managing director of the Italian National Library for the Blind from 1979–1998. He now works as a freelance consultant for disability and visual impairment issues. He is blind.

Yvonne Toros is the executive director of the French Federation of the Blind (FAF) and Secretary of the EBU Commission on Liaising with the EC. She received a PhD from Brussels

Free University in 1986 and a second PhD from the Universities of Paris-Sorbonne and Paris-Vincennes à Saint Denis in 1992. She has worked as a visiting teacher and researcher at Stanford University, USA, from 1981–1982, and as the director of a computer service enterprise (S3P) from 1982–1987. She is the author of 16 publications and conference presentations.

Ronald Stephens works as an expert for the EBU. He received his BSc in Physics from London University in 1964 and his PhD from the same university in 1969. He was Director of an Institute of Rehabilitation Technology in Portsmouth and has directed several international projects related to the needs of disabled people. He is an advisor on rehabilitation technology to leading UK charities. He is on the Scientific Committee for REHAB 2000, an international conference and exhibition in Dubai. He is currently working as Consultant in Rehabilitation and Assistive Technology in a large private clinic in Oman (Arabs Emirate) with the Oman Association for Blind People as well as other groups and individuals. He is the joint author of 49 publications and conference proceedings. He was project director for OPEN, funded by TIDE, which developed a navigation system for blind people and was installed in metro stations in London, Paris, and Amsterdam. He has been an expert for DGV, DGXII and DGXIII in the European Commission.

C.8 Economic Development and Scientific and Technological Prospects

The project aims at developing the navigational aid ARGUS as a testable prototype. To achieve the desired functionalities, significant RTD contributions are required, ranging from scientific advances in the field of Computer Vision to application-oriented software and hardware design. In the following, we will first describe scientific and technological prospects, and then the prospects for economical exploitation.

C.8.1 Scientific Prospects

A major challenge of ARGUS is to solve recognition tasks in an unrestricted environment. It is well-known in the scientific community that Computer Vision methods do not yet allow the development of vision systems for the recognition of all objects familiar to humans and under real-life conditions. The approach followed with ARGUS accepts the challenge of real-life conditions but is restricted to the recognition of selected object classes and so-called landmarks which are useful for navigation.

The results regarding reliable recognition under real-life conditions will provide important advances for Computer Vision in general. They pertain to various factors which influence the visual properties of objects and landmarks in images, in particular lighting conditions, view-point variations and changes of the scene composition.

The development of object descriptions and algorithms which support recognition in the face of real-life variability may considerably extend current application areas of Computer Vision and open up new ones, beyond the application as a vision aid for the blind which is pursued in this project.

One such application area is robotics. There is growing interest in mobile robots with sufficient vision to permit reliable navigation in natural environments. A landmark-based robot navigation system could directly exploit results obtained in this project.

A very different but equally important application area is image archiving, in particular queries by example. Given one view of an object or scene, how can one retrieve different images of the same object or scene? The techniques developed for ARGUS will undoubtedly also contribute to this area.

Another challenge of ARGUS is real-time performance. It is estimated that a stereo colour image pair must be processed within at most a second and results be available in less than two seconds. The ARGUS prototype will be designed to meet these requirements using affordable hardware components. This will considerably advance today's state-of-the-art.

It is important to note that the ARGUS system design will also be relevant for applications other than the ARGUS navigational aid per se. Real-time requirements for recognition tasks of around one second are very common in Computer Vision tasks, hence the ARGUS system design may be an interesting basis for a large class of applications.

C.8.2 Economic Exploitation

This project is the centre piece of a 3-phase development towards a product. The first phase was formed by the nationally funded German project MOVIS, carried out between 1994 and 1997, where the basic feasibility of key recognition functionalities could be proven. ARGUS will be a complete prototype with significantly extended functionalities and implemented as a portable system which allows field tests. Because of the need for research and innovative solutions, ARGUS is not expected to reach the product stage. This will be the goal of a third development phase following this project.

Nevertheless, several preparatory steps have been taken for economic exploitation. First, the

consortium includes 3 companies whose interest is commercial exploitation of the ARGUS results. One of them, VISYS, is a spin-off of the commercial partner JURCA Optoelektronik GmbH, at Rodgau / Germany, leading the predecessor project MOVIS.

Second, contact has been established to the Austrian company Caretec GmbH, which is one of the most successful producers and vendors of aids for the blind and visually impaired in Europe. This company will follow the progress of ARGUS closely and has shown interest in a later product development.

Another important measure in the interest of economic exploitability has been to conceive a decomposable and scalable functionality for ARGUS. Several component functions are useful by themselves (e. g. sign reading) and could be candidates for independent economic developments.

In order to foster the exploitation and dissemination of results obtained within ARGUS as well as the system itself a special workpackage on Exploitation and Dissemination was created (WP 13).

Dissemination will be addressed by all partners through:

- the creation and management of ARGUS Users Groups which will continuously be informed of the project results and providing feedback into the development. Started right at month 0, these will bring together users from different European countries and different age-groups, compare WP 11.
- joint participation at relevant events.
- independent participation at events related to each partner's specific field of expertise.
- promotion, workshops and presentations during periodic meetings.
- broad based publicity through the ARGUS WWW site.
- presentation of results at major international meetings and conferences.
- publication of professional and scientific papers.

One particularly important part of these activities is the creation of a Dissemination Report (D 37) and exploitation Plan (D 38). These will contain a market study and evaluate ARGUS' possible market position, pricing and distribution policies. An investment schedule for the creation of a final product will be appropriately described. This plan will be prepared based on expected investments needed and possible sales. All marketing activities will be scheduled and managed by the ARGUS Marketing Board, grouping all involved partners as well as additional dissemination actors to be invited to the board's regular meetings.

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