CENTER FOR
MACHINE PERCEPTION

CZECH TECHNICAL
UNIVERSITY

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1 Executive summary

The Center for Machine Perception (abbreviated CMP) is a research unit active in the fields of computer vision, pattern recognition, and mathematical modeling of uncertainty. The CMP, established in 1996, is a part of the Department of Cybernetics at the Czech Technical University (CTU) in Prague. CMP is funded through a number of national, European and industrial grants.

Current main CMP research interests lie in the following areas: reconstruction of scenes from multiple images (Pajdla, Werner, Urban, Hlaváč), omnidirectional vision (Pajdla, Svoboda, Hlaváč), reconstruction of 3D models from unorganised 3D points (Šára), stereo matching (Šára), physics-based vision (Šára, Drbohlav), object recognition and image retrieval (Matas, Haindl, Hlaváč), sonographic image analysis (Šára), digital topology (Pták), quantum and fuzzy logic (Navara, Pták), nonlinear diffusion filtering (Mrázek), gene expression profile analysis using pattern recognition methods (Hlaváč).

Summary of main **scientific results** obtained in 2000:

Computer vision A generalization of Hartley's trifocal tensor estimation method was proposed. It allows a projective reconstruction of a scene from many uncalibrated images [98, 100, 99]. Experiments with purpose-designed mirrors for the SVAVISCA log-polar sensor have been performed [97] and a uniform-resolution mirror matching the sensor was designed [16]. A novel approach for colour-based object recognition and image retrieval - the Multimodal Neighbourhood Signature – was proposed [54] and extensively tested [46, 44]. Nonlinear diffusion filters were generalized from piecewise constant to piecewise linear model in [62, 64]. Texture analysis methods for sonograms of chronic inflammation of thyroid gland were studied and several classifiers were tested [85, 88, 86, 1].

Mathematical modeling of uncertainty Characterizations of spaces of measures on quantum and fuzzy logics were generalized and published in high quality journals (Algebra Universalis, Journal for Mathematical Analysis and Applications, International Journal of Theoretical Physics) [8, 57, 68]. A new type of fuzzy logics is studied in [13]. A progress was made in the study of fuzzy arithmetic [75] and satisfiability in fuzzy logics [70].

<u>Achievements in 2000</u>

- CMP participates in a Fifth Framework EU Project: OMNIVIEWS No. IST-1999-29017.
- CMP became part of a national centre of excellence, the Center for Applied Cybernetics. The 4-year grant supports four full time research fellows.
- DrSc (Doctor of Science) degrees were conferred on M. Navara and M. Haindl.
- Four PhD theses were successfully defended.
- A first long term visit of an EU researcher (Anna de Simonne from the University of Naples, Italy) was successfully completed, 4 journal papers were submitted during the year-long visit.
- CMP post-docs accepted research positions at two leading European computer vision laboratories; T. Svoboda at ETH Zurich, Switzerland and T. Werner at the University of Oxford, United Kingdom.
- A new Socrates EU student exchange agreement was signed with University of Patras, Greece.

Consultancy and industrial applications. The CMP performed **consultancy** and **research and development** for the industry (e.g. Robert Bosch, GmbH., Germany, Institute of Criminology, Czech Republic). CMP expertise is channelled to the industry via Neovision, a spin-off company specialising in machine vision. For successful applications, see `http://www.neovision.cz`.

For more information about the CMP and on-line **publications** see `http://cmp.felk.cvut.cz`
Demos of our research are available at `http://cmp.felk.cvut.cz/cmp/cmp_demos.html`

2 The CMP Research Group

The CMP group comprises fourteen members of academic and research staff (two part-time), eight full-time PhD students, a group administrator and a system manager. T. Svoboda is on a 3 year leave since September 2000. He joined Prof. L. Van Gool's group at ETH Zurich. O. Drbohlav became a lecturer. In 2000, three PhD. students, P. Krsek, P. Mrázek and V. Zýka became members of research staff.

Academic and Research Staff

Prof. Václav Hlaváč	head, professor
Prof. Pavel Pták, DrSc.	professor (part time)
Dr. Ing. Michal Haindl DrSc.	research fellow (part time)
Dr. Ing. Mirko Navara DrSc.	senior lecturer
Ing. Pavel Krsek	research fellow
Dr. Ing. Jiří (George) Matas	research fellow
Ing. Pavel Mrázek	research fellow
Ing. Tomáš Pajdla	lecturer
Ing. Vladimír Smutný	lecturer
Dr. Ing. Radim Šára	research fellow
Dr. Ing. Tomáš Werner	research fellow
Dr. Ing. Tomáš Svoboda	lecturer
Dr. Ing. Martin Urban	research fellow
Ing. Vít Zýka	research fellow
Ms. Eva Matysková	group administrator
Ing. Daniel Večerka	system administrator

Doctoral students

	supervisor	proposed thesis title
Jan Buriánek	J. Matas	Appearance-based recognition.
Jan Dupač	V. Hlaváč	Structural pattern recognition.
Petr Bílek	J. Matas	Illumination-invariance in object recognition.
Hynek Bakstein	V. Hlaváč	3D reconstruction.
Vojtěch Franc	V. Hlaváč	Learning in Statistical Pattern Recognition.
Jana Kostková	R. Šára	Fuzzy rules for stereoscopic matching.
Martin Matoušek	V. Hlaváč	Correspondence in dense sequences.
Štěpán Obdržálek	J. Matas	Object recognition.
part time students		
Ondřej Drbohlav	R. Šára	Physics-based surface features for computer vision.
Jan Vydržel	V. Hlaváč	Improving correspondence algorithms.
Vít Zýka	R. Šára	Shading consistency analysis for local shape modeling.
Pavel Mrázek	M. Navara	Modeling uncertainty in image processing.
Pavel Krsek	V. Hlaváč	Differential surface characteristics.

2.1 CMP Scientific Advisory Board

The role of the CMP Scientific Advisory Board is to comment on CMP scientific goals and research results and to advise on future directions of research. The scientific advisory board consists of:

Prof. Ruzena Bajcsy	University of Pennsylvania, USA
Prof. Josef Kittler	University of Surrey, U.K.
Prof. Walter Kropatsch	Vienna University of Technology, Austria
Prof. Jan Uhlíř	Faculty of Electrical Engineering CTU Praha, Czech Republic
Prof. Shimon Ullman	Weizmann Institute, Israel
Prof. Luc Van Gool	Catholic University Leuven, Belgium
Prof. Vladimír Mařík	Head of the Dept. of Cybernetics, CTU, Czech Republic

3 Research

3.1 Reconstruction of 3D scenes from multiple images

Projective reconstruction from many images in a ”Cake” configuration has been generalised to images taken by omnidirectional catadioptric cameras [98, 100, 99].

Work on view selection for scene representation by images and its reconstruction, the start of which dates back to 1996, has been completed [104] and complemented by real-world experiments.

Experimental Matlab toolbox supporting experiments with scene reconstruction from multiple images was released as a freeware. The toolbox includes methods for doing projective and similarity reconstructions from multiple images, manual selection of correspondences, RANSAC based correspondence filter, and provides VRML textured models. For details, see

`http://cmp.felk.cvut.cz/cmp/recx`

3.2 Omni-directional vision

A combination of mirrors with an image sensor having a non-uniform pixel distribution was proposed. The idea was formulated in a EU Fifth Framework proposal, which was granted (OMNIVIEWS No. IST-1999-29017) to the consortium comprising the University of Genoa, the Instituto Superior Technico Lisboa, and the CTU Prague.

A simulations for a SVAVISCA log-polar sensor has been performed and verified by taking real images with the proposed sensor [97]. Based on the insight gained in the simulations, a uniform-resolution mirror matching a classical as well as the log-polar SVAVISCA camera was designed in order to obtain constant angular resolution when projecting objects in a constant distance from the cameras [16].

Epipolar geometry for conventional as well as omnidirectional cameras was reviewed from the point of view of orientation of the rays emanating from the camera [103]. It was clarified under which conditions the orientation of rays introduces a constraint on image point correspondences. Epipolar geometry of central catadioptric cameras was concluded by deriving epipolar constraints also for the cameras with a parabolic mirrors [79].

3.3 Non-classical cameras

Non-classical cameras proposed already in [76] were further investigated. A review of non-classical cameras described in the literature was compiled [3]. A visibility closure concept was proposed to introduce an analogy of epipolar planes for cameras whose rays do not intersect in one point. A special class of cameras, oblique cameras, whose rays do not intersect at all was introduced. Their arrangement was studied, and their visibility closures characterized [77]. Epipolar geometry of non-symmetric panoramas has been analyzed [39] and it was shown that epipolar curves are not straight lines. A dynamic programming stereo-matching algorithm has been applied to panoramic images from catadioptric cameras [102].

3.4 Physics-based vision

A method of determining incidence plane in every surface point by polarised illumination was identified. Together with previously known possibility to determine the emittance plane in each point by analysis of polarisation of reflected light, the new result gave birth to the method that enables direct surface normal estimation [9]. Research continued on embedding the polarisation-based shape constraints into other photometric methods.

3.5 3D model reconstruction from passive vision

Our approach to stereo matching based on the principle of stability was pursued [83]. Polynocular image verification as a decision problem on consistency of local 3D geometric models was studied [108, 109].

To evaluate the consistency, four measures with a different invariance to image intensity deformations were proposed and compared.

3.6 Sonographic Image Analysis

Sonographic data from 39 persons were collected. 17 individuals were healthy and 22 had Hashimoto's lymphocytic thyroiditis. The diagnosis was confirmed by clinical examination of the increase in the level of antibodies against thyroid gland and by fine needle aspiration biopsy. Our research focused on finding a descriptive set of local textural features. We used co-occurrence matrices [88, 85, 86], texture features proposed by Muzzolini et al. (paper submitted to *Ultrasound in Medicine and Biology*), and started investigating systematic feature construction [1]. Our recent results show that patient diagnosis rate of 92% can be achieved with ultrasonic imaging alone (leave-one-out error).

3.7 Colour-based Object Recognition

In [54], a novel approach to colour-based object recognition and image retrieval, the Multimodal Neighbourhood Signature (MNS), was proposed. The method directly formulates the problem of representing object colour appearance by computing signatures of colour features derived from robust estimates of the modes of a local colour density function. From a multimodal neighbourhood signature, a number of invariants can be computed to address changes in the imaging conditions within the application environment. In addition, by computing features from image neighbourhoods, the MNS method facilitates region-based query specification and image retrieval.

The MNS representation was tested on a standard dataset and compared favourably with three well known recognition algorithms. Very good performance (average match percentile 99.5%) was achieved. In general, the MNS signatures is concise and thus significant data reduction was achieved. An image was typically represented by a few hundred bytes, a few thousands for very complex scenes. Performance evaluation, illumination invariance and suitability for image retrieval of the MNS method is studied in [44, 45, 46].

3.8 Invariants for Object Recognition

A new appearance-based object recognition method has been proposed [51]. The "invariant pixel set signature" method (IPSS) is based on computation of invariants computed on pixels sets inside convex hulls of n-tuples of interest points.

3.9 Face Recognition

Support Vector Machines were tested on the face identity verification task on the large, publicly available XM2VTS database [42, 43]. J. Matas participated in the organisation of the ICPR face verification contest [53]. New distance measure for LDA-based Face Verification was proposed [49, 50].

3.10 Pattern Recognition

The collaborative effort with the Prof. M.I. Schlesinger from the Ukrainian Academy of Sciences in Kiev resulted in a monograph [87]. An English edition is being prepared and is expected to be published by Kluwer Academic Publishers, The Netherlands.

The theory of random field models is one of the basic tools for modeling spatial, temporal and spectral relations in complex pattern recognition and image processing tasks. Different Markov random field models, simultaneous autoregressive models, and problems with their parameter estimation, synthesis and optimal contextual support set detection were our primary research interest. Research results were applied in texture segmentation [19], texture mapping [26], shape and texture data fusion [29], image restoration [18], and in a natural colour texture synthesis [27] application.

We have proposed a novel recursive Gaussian Markov random field pseudolikelihood parameter estimator [19] which was applied in a colour texture segmentation algorithm [19], [32]. This segmentation algorithm is an order of magnitude faster than the best previously published algorithms of similar type. Two original image restoration algorithms using a combination of causal and non-causal weak Markov models were introduced in [18]. Test results of a new causal weak Markov colour texture model are in [27].

3.11 Detection of Geometric Primitives

In [52] the *Progressive Probabilistic Hough Transform* (PPHT) was introduced. Unlike the Probabilistic HT of Kiryati, where Standard HT is performed on a pre-selected fraction of input points, PPHT minimises the amount of computation needed to detect lines by *exploiting the difference in the fraction of votes needed to reliably detect lines with different numbers of supporting points*. The fraction of points used for voting need not be specified ad hoc or using a priori knowledge, as in the probabilistic HT; it is a function of the inherent complexity of data. In [17] the use of gradient information for PPHT enhancement was empirically evaluated.

3.12 Nonlinear diffusion filters

Pavel Mrázek continued his research in the field of image filtering and constrained approximations. As the main result, the nonlinear diffusion filtering was generalized from piecewise constant to piecewise monotone, or piecewise linear model in [62, 64]. Further research topics in 2000 included the discrete numerical methods for anisotropic nonlinear diffusion [66] and the optimal selection of diffusion parameters [65].

3.13 Mathematical studies of descriptions of uncertainty

The investigation of uncertainty continued in the directions of basic and applied research. One of the main theoretical results is a construction which proves that quantum logics with rich state spaces allow for equations of mean values of states [57]. This new construction technique already brought answers to old open questions in mathematical foundations of quantum logics. (One of the solved problems dates back to 1966.)

An extensive study of a new simplified approach to states on quantum logics is presented in [67, 68]. It possesses a new view on quantum logics together with a very general tool for modelling of state spaces using hypergraphs.

Generalization of satisfiability of a set of formulas from classical to fuzzy logic is studied in [70]. A new class of fuzzy logics seems to be very perspective — fuzzy logics based on residuated implications and strong fuzzy negations [13].

Practical applications of fuzzy arithmetic appeared to brought difficulties in the implementation of so called constrained fuzzy arithmetic (introduced by G. Klir). We classified these problems and suggested methods for their efficient solution in a relatively general context [75].

3.14 Other research results

As a new project we studied mathematical models of the inner ear. The perception of sounds is still not completely understood and can hardly be measured in practice. Previous models could explain the transmission of sounds through the middle ear relatively well, but they failed to describe the transmission through the bone. We developed a model that is highly simplified, but gives well corresponding results for both ways of transmission [48].

A cooperation with the Hitachi Central Research Institute Tokyo, Biosystems Department was initiated during Prof. Hlavac's five month visit. We are interested in applying pattern recognition techniques to analysis of gene expression profiles [35]

4 Projects

Geometry and Appearance of a 3-D Scene Based on a Large Set of 2-D Images

Duration: January 2000 - December 2002

Investigators: Václav Hlaváč, Tomáš Pajdla, Radim Šára, Martin Urban, Tomáš Werner.

Funding: Czech Grant Agency, Grant No. 102/00/1679, 629K Kč (US$ 19K) (in 2000)

Objectives: The project studies reconstruction of 3-D scenes from several views. The interest is in: (a) minimizing errors in the reconstruction by providing more than three views, (b) studying the correspondence problem in dense sequence of images, (c) unifying various reconstruction methods in the developed toolbox RECX (publicly available).

Photogrammetry Method for Measurement and Analysis of Lower Jaw Motion in Temporo-Mandibular Joint

Duration: June 2000 – December 2002

Investigators: Vladimír Smutný

Funding: Ministry of Health of the Czech Republic, NN6333- 3/2000, 639K Kč (US$ 19K) (in 2000)

Objectives: The project aims to build a system for measuring the shape of a jaw joint.

Partners: Institute of Dental Research, Prague

Texture Analysis of Sonographic Images for Endocrinopathies and Metabolic Diseases

Duration: January 1999 - December 2001;

Investigators: Petr Sucharda (Charles University), Daniel Smutek (Charles University), Radim Šára, Martin Švec (student).

Funding: Ministry of Health of the Czech Republic, NB 5472-3 250K Kč (US$ 7K)

Partners: 1st School of Medicine, Charles University Prague

Objectives: The goal of the project is to aid the diagnosis of diffusion processes in thyroid gland parenchyma, which is currently done (a) subjectively from a sonogram and/or (b) quantitatively by a laboratory immunological, hormonal, and metabolic sample analysis. In the project, we aim (1) to help diagnose the various parenchyma conditions based solely on the sonogram texture analysis and (2) to attempt a correlation analysis between standard laboratory measurements and the quantitative properties of the visual texture of the sonograms.

Presentation of Department of Cybernetics at Brno International Engineering Fair

Duration: January 2000 – December 2002

Investigators: Vladimír Smutný

Funding: Czech Ministry of Education, LP0042 125K Kč (US$ 4K)

Objectives: The aim of the project is to present our department at Brno International Engineering Fair. The CMP was already present on the fair from 1997. We obtained the financial support for next three years.

Partners: Certicon a.s., Neovision s.r.o.

OCAMS - Optimal Model Selection for 3D Data Segmentation

Duration: January 1999 - December 2000

Investigators: Tomáš Pajdla.

Funding: Grant of the Czech Ministry of Education, Grant No. 4/11/AIP CR (1999-2000) 55K Kč (US$ 2K) (in 1999)

Objectives: The goal of the project is to upgrade the approach to 3D data segmentation developed at the CMP for simple objects (quadrics) in two respects. Firstly, we study criterial functions optimal for different tasks and compare them to the current approach. Secondly, we plan to upgrade the surface models from quadrics to more flexible ones like NURBS.

Approximation and Noise Filtering Methods in Computer Vision

Duration: January 2000 - December 2000

Investigators: Pavel Mrázek

Funding: Grant CTU 300008403, 57K Kč (US$ 2K)

Objectives: The project deals with noise reduction in images and other types of data (e.g. range data for 3D reconstruction) which are assumed to be piecewise continuous, and piecewise monotone. The main result consists in the developments of a new type of a nonlinear diffusion filter capable of enhancing the desired piecewise monotonicity of the data.

5 Consultancy, Applied R & D, Industrial Applications

Robert Bosch, s.r.o.

Duration: October – December 2000

Investigators: Vladimír Smutný, Tomáš Pajdla, Radim Šára, Pavel Krsek, Vít Zýka

Funding: 550K Kč (US$ 16K)

Objectives: confidential

Neovision

Duration: long term

Funding: 60K Kč (US$ 2K)

Investigators: Tomáš Pajdla, Vladimír Smutný, Daniel Večerka

Description: Neovision s.r.o. (`www.neovision.cz`) is a small machine vision company closely associated with CMP. Neovision s.r.o. uses CMP facilities for special measurements and consults CMP members.

Universal Production Partners, Prague, Czech Republic

Duration: January – March 2000

Investigators: Vladimír Smutný, Radim Šára

Funding: 20K Kč (US$ 1K)

Objectives: The high end camera for film scanning was measured to determine its parameters.

Institute of Criminology, Prague, Czech Republic

Duration: 1999-2000

Funding: 20K Kč (US$ 1K) (in 2000)

Investigators: Vladimír Smutný

Description: A standard method for capturing surface maps of cylindrical lock cores was designed. Experiments on larger set of cores were performed. Further development of the system is expected.

6 Facilities and Equipment

The CMP has good facilities for controlled image acquisition and precise radiometric and colorimetric measurements. These include a four meter optical bench and two optical tables, a three-chip Hitachi HV-C20 colour camera and a 16-bit Santa Barbara Instruments SB-7 cooled camera. Six Pulnix TM 9701 digital cameras with custom built synchronization hardware allowing synchronous acquisition. Pulnix TM 1001 digital camera with 1024 $\times$ 1024 resolution is used for precise measurements. Several computers are equipped with mid-range cameras and frame grabbers. An industrial microscope allows us to measure objects with size in the range of 2–50 mm. Two panoramic cameras utilizing convex mirrors which provide view angles about $360° \times 110°$ were built. Digital capturing of images in the outdoor environment is now available by the digital camera Nikon Coolpix 950 with the field of view from 2 $\times$ 2.7 cm to infinity. The camera is also equipped with fish eye lens which enables to capture panoramic images 0°–360° by 0°–91°. The new digital camcorder Canon XM-1 allows capturing video sequences in the outdoor and indoor. Such video sequences can be easily used for 3D reconstructions. Together with a new video editing card Matrox RT-2000, Canon XM-1 is a powerful tool used for demonstrating our results.

Three rangefinders are in routine use: a laser plane rangefinder (resolution 0.2 mm), one-shot binary coded rangefinder (resolution 64×80 points, video frame rate acquisition) and a new laser plane range finder carried by a six degree of freedom manipulator. Four-camera synchronised stereo vision system with stereo matching and surface reconstruction software is installed in the laboratory. Panoramic camera and a video radio link were added to an autonomous vehicle that was built by the group.

CMP computing facilities comprise 30 computers connected to the university-wide network (ATM). Besides two Silicon Graphic workstations (Indigo^2 and Indy) all the computers are high-end PCs running either Linux or MS Windows 9x/NT. In 2000, the CMP computing facilities have been enhanced by 4 high-end PCs with good 3D and video editing support. Four new portable powerful computers have been bought.

The CMP equipment includes a postersize colour printer HP DesignJet 755CM, the HP ScanJet 6100C scanner and a film scanner Nikon LS-30. For more detailed information on CMP equipment, visit `http://cmp.felk.cvut.cz/cmp/hardware` .

7 Teaching

In 2000, CMP members taught the following courses:

Course name	level[a]	Language	Lecturer	Laboratory supervisor
Mathematical logic	MSc/1	CZ	P. Pták	
Mathematics 4 [complex functions, probability, first order differential equations]	MSc/2	ENG	P. Pták	
Robotics	MSc/4	CZ	V. Smutný	V. Smutný
Computer vision for informatics	MSc/4	CZ	T. Pajdla	T. Werner
Signal and image processing	MSc/4	ENG, CZ	V. Hlaváč	O. Drbohlav
Pattern recognition	MSc/4	CZ	J. Matas	T. Svoboda
Mathematics 6F [statistics and fuzzy logic]	MSc/4	CZ	M. Navara	
General systems theory	MSc/5	CZ	R. Šára	O. Drbohlav
Computer vision and virtual reality	MSc/5	CZ	V. Hlaváč	V. Smutný
Intelligent robotics	MSc/6	CZ	T. Pajdla	H. Bakstein, M. Matoušek
Introduction to computer vision and pattern recognition [for students of the Faculty of Mathematics and Physics, Charles University in Prague]	MSc/1-5	CZ	V. Hlaváč	P. Mrázek
Numerical methods	MSc/1-5	CZ	M. Navara	
Mathematics for cybernetics	PhD	CZ	P. Pták	
Introduction to computer vision	PhD	CZ	V. Hlaváč	T. Pajdla
Pattern recognition	PhD	CZ	V. Hlaváč	V. Hlaváč
3D computer vision	PhD	CZ	R. Šára	T. Pajdla

[a] Indicates whether the course is intended for PhD or MSc students. For MSc courses, the marker is followed by the recommended year.

Currently, the CMP offers students the opportunity to study abroad for periods ranging from 3 weeks to 10 months. The receiving institutions are image processing laboratories in Finland, the United Kingdom, Austria, Slovenia, the Netherlands and Greece. A full list, with details on funding, is available at

`http://cmp.felk.cvut.cz/cmp/opport.html`

CMP members participated in the following teaching-related project:

Fuzzy Control and Fuzzy Logic

Basic facts: Coordinator Radko Mesiar (Slovak Technical University in Bratislava, Slovakia), contact person at CTU Mirko Navara, CEEPUS network, No. SK-042; funds in 2000 34K Kč (US$ 1K); started September 1995, ends August 2002.

Project topic: Coordination of education in fuzzy control and fuzzy logic, mobility of teachers, undergraduate and postgraduate students.

Miscellaneous: Participating institutions: Slovak Technical University (coordinator); Technical University of Budapest, Hungary; Linz University, Austria; Ostrava University in Ostrava, Czech Republic. Technical University Cracow, Poland.

8 Visits to CMP

(ordered by the length of the visit)

name	institution	duration
Johel Mitéran	Universite de Bourgogne, France	2 months
Olga Nánásiová	STU Bratislava, Slovakia	1 month
Michail Schlesinger	Ukrainian Academy of Sci., Kyjev, The Ukraine	14 days
Aleš Leonardis	University of Ljubljana, Slovenia	8 days
Josef Pauli	Christian-Albrechts-Universität Kiel, Germany	4 days
Terry Windeatt	University of Surrey, United Kingdom	4 days
Robert Sablatnik	TU Wien, Austria	4 days
Martin Kampel	TU Wien, Austria	4 days
Michael Hofer	TU Wien, Austria	4 days
Dzemyda Gintautas	Institute of Mathematics and Informatics, Vilnius, Lithuania	4 days
Michel Pindavoine	Universite de Bourgogne, France	4 days
Mariusz Nieniewski	Polish Academy of Sciences, Warsaw, Poland	4 days
Theo Gevers	University of Amsterdam, The Netherlands	3 days
Goffredo Pieroni	University of Udine, Italy	3 days
Horst Bischof	TU Wien, Austria	2 days
Milan Rüder	Frauenhofer IVI, Dresden, Germany	2 days
Thomas Schlögl	TU Wien, Austria	2 days
Csaba Beleznai	TU Wien, Austria	2 days
Kostas Sarras	TU Wien, Austria	2 days
Jiří Sklenář	University of Virginia, USA	1 day
Masaki Nakagawa	Tokyo Univ. of Agri. & Tech., Tokyo, Japan	1 day
Takayuki Nakamura	Tokyo Univ. of Agri. & Tech., Tokyo, Japan	1 day
Tetsushi Yoshikawa	Tokyo Univ. of Agri. & Tech., Tokyo, Japan	1 day
Gejza Jenča	STU Bratislava, Slovakia	1 day

Visits of students:

name	level	institution	duration
Dmitri Koubaroulis	PhD	University of Surrey, UK	3 months
Hadas Roth	MSc	Technion Haifa, Israel	2 months
Stefan Gaechter	MSc	EPFL Lausanne, Switzerland	2 months
Chris Wauters	MSc	TU Delft, The Netherlands	2 months
Ronald Heil	MSc	TU Delft, The Netherlands	2 months
Bouthoom Huilbert	MSc	TU Delft, The Netherlands	2 months
Glasbergen Coen	MSc	TU Delft, The Netherlands	2 months
Quint Mouthaan	MSc	TU Delft, The Netherlands	2 months
Laurence Hoffmann	MSc	TU Delft, The Netherlands	2 months
Martijn Stellinca	MSc	TU Delft, The Netherlands	2 months
Christiaan des Bouvrie	MSc	TU Delft, The Netherlands	2 months
Mohamed Bakouri	MSc	ENST Paris, France	2 months
Chia-Yen Chen	PhD	University of Aucland, New Zealand	1 month
Fay Huang	PhD	University of Aucland, New Zealand	1 month
Shou-Kang Wei	PhD	University of Aucland, New Zealand	1 month
David Rinner	PhD	Technical University Wien, Austria	1 month
Matej Artac	PhD	University of Ljubljana, Slovenia	1 month

9 Events held at CMP

The CMP has been organising regular one-day meetings on computer vision and pattern recognition. The meetings take place approximately every four months, full programmes including abstracts are available on-line at

`http://cmp.felk.cvut.cz/cmp/events/past.html`

About six talks are presented each time, making a visit to CMP worthwhile for researches outside Prague. The speakers in 2000 came from the UK, The Netherlands, Germany, France, Poland, Slovenia, Austria and the Czech Republic.

Selected seminars held at CMP:

J. Miteran	Universite de Bourgogne, France	Developping Real-time Image Processing Application in One Hour.
G. Pieroni	University of Udine, Italy	Retrieving Images by Concepts and Structure
H. Bischof	TU Vienna, Austria	Local Recovery of Global Eigenimages.
A. Leonardis	University of Ljubljana, Slovenia	Robust Localization Using Eigenspace of Spinning-Images.
J. Mareš	Charles University Prague, Czech Republic	Functions of Visual Analyser (Receptors, Nerve System)
M. Nakagawa	Tokyo Univ. of Agri. and Tech., Japan	Handwriting Recognition and Applications.
J. Miteran	Universite de Bourgogne, France	A real time defect detection system on textured images
P. Breedveld	TU Delft, The Netherlands	Improvement of Depth Perception and Eye-Hand Coordination in Laparoscopic Surgery
S. Mizik	TU Budapest, Hungary	Fuzzy model inversion.
A. de Simone	University of Naples, Italy	Two highly nontrivial algebraic results obtained by fairly trivial topological reasoning.

Publications of CMP members in 2000.

[1] M. Bakouri and R. Šára. The reconstruction analysis: A tool to mine structures in sonographic images. Research Report CTU–CMP–2000–17, Center for Machine Perception, Czech Technical University, Prague, Czech Republic, October 2000.

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