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Report on the scientific activity of the
MTA SZTAKI
in 2010

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I. Main duties of the research unit in 2010

At the *Computer and Automation Research Institute, Hungarian Academy of Sciences (MTA SZTAKI)* information science based developments exploitable both in Hungary and abroad, together with high-level advisory activity, are built upon basic-research results of international standard, aiming at a center of excellence which provides themes of interest and attracting conditions for talented young people in Ph.D. study, for starting their creative work.

The adequate *infrastructure* is an indispensable requirement of high-level research activity. In this sense the setting up of an up-to-date *3D virtual environment* was considered a task of 2010. They intended to start the establishment of an *up-to-date control experimental laboratory* for the research of robust, fault-tolerant control of robot vehicles and UAVs (unmanned aerial vehicles) and their demonstration.

In the *Seventh Framework Programme (FP7) of the EU* they intended to participate in well-considered areas, possibly in the most powerful consortiums having the chance of winning, in themes which seem to guarantee the national user background.

They attached importance, henceforward, to their most significant industrial partners: GE Hungary PLC, Paks Nuclear Power Plant PLC, Hungary PLC, AUDI Motor Hungaria Ltd., Robert Bosch Ltd., Knorr Bremse Braking Systems Ltd.

In accordance with the European research efforts aiming at the establishment of the European research area, they intended to continue the establishment and operation of *international virtual institutes and laboratories.*

The indoor motivation system introduced in 2010 was expected to have an effect of improving efficiency. The system is composed of elements more intentionally supporting the different forms of R&D activity more concrete and measurable than the previous ones.

II. Outstanding research and other results in 2010

a) Outstanding research and other results

Mathematics and computer science

In mathematics and computer science the emphasis of the research activities was on contributing to the solution of some major open problems of the field. Therefore, they concentrate, e.g., on modelling, analysing complex systems, including, for example, extremal graphs, data mining, stochastic systems, operations research, algebraic research, and biology-inspired computer science.

One of the major trends, which – in our days – can be considered as one having long traditions, is *the research and* application *of* efficient *algorithms.* The common guiding principle of their research in this area is manifested in the effort to elaborate algorithms having theoretical efficiency guarantees. They examined the algorithmic complexity of finding matrices of maximum rank in linear spaces of matrices. One of their major results is a deterministic polynomial-time algorithm for the case when the space is spanned by an arbitrary matrix and by several rank one matrices. A polynomial-time quantum-algorithm is provided in class-2-nilpotent groups for solving the problem of hidden subgroups. They succeeded in generalizing the combinatorial Nullstellensatz theorem for multi-sets, instead of finite point-sets. They successfully dealt with covering sets in finite vector spaces, and with the vector analogue of Hilton-Milner Theorem.

The issues of *combinatorial computer science, graph theory* are related to several branches of mathematics and applied research as well (such as information sciences, coding theory, cryptography, optimization, scheduling, communication, networks). Thus, the obtained

theoretical results often have consequences in everyday life. Regarding the dominant parts of networks, they examined that from among some important structural theorems, which ones can be extended to infinite networks from finite networks, and which ones lapsed. Regarding optimal-sum numbering (weighted colouring) a general upper-bounding estimate was provided with the help of set-systems, and they proved an exact minimax theorem, which – simultaneously – emphasizes the connection of the problem sphere and the classical Perfect Graph Theorem. By applying Regularity Lemma, they achieved new results in Ramsey Theory. Their results in combining the extensions of perfect graph classes and Ramsey Theory are also significant.

Stochastic systems, financial mathematics: they provided the one point asymptotic characterization of the real-time estimation of continuous time linear stochastic systems, solving this way a problem open since the 80-s. Sufficient conditions were given for the stability of hybrid linear stochastic systems. A proved convergent recursive evaluation process was elaborated for GARCH models, which are of central significance in the theory of financial time series. For the identification of the latter, an efficient numerical procedure was developed. The Page-Hinkley detector was applied for detecting changes of hidden Markov processes, and sharp estimation was given regarding the frequency of false alarm. Sharp asymptotic formulae were proved for the maximum-likelihood estimation of the dynamics of Quantized Gauss AR(1).

In course of their research in *biology-inspired computer science* they proved that every language that can be enumerated recursively can be generated by environment-independent grammar with diffused text-conditions which have maximum 2 nonlinear symbols. The result is significant, since it shows that every language recognizable by Turing machines can be generated by a limited parallel rewriting system, the alphabet of which differs from the alphabet of the language in a minimal number of symbols only.

Due to the development in information sciences of the past decades, large amounts of measured and observed data are available characterizing the different natural, social, technical processes – data, out of which hidden information can be retrieved by the methods of statistics and machine learning. Several methods were provided for stationary time series forecasting, which are universally consistent with the combination of the principles of non-parametric estimations and machine learning algorithms. Their search-algorithm UCT developed formerly is henceforward the main building block and fundamental algorithm of computer GO; presently, the major part of the best programs is based on this method.

Distributed computing structures, Grid systems

Their most important results in multifold research of *Grid-systems*:
- The 3G Bridge (Generic Grid-Grid Bridge) service was further developed, making the integration of any service grid (SG) and desktop grid (DG) systems possible. In 2010 extensions increasing the efficiency of job forward in SG→□□□□□DG direction were emphasized, and which extend the applicable infrastructure types. As a result of the above further development, the number of jobs that can be handled simultaneously by the 3G Bridge was increased with an order of magnitude, allowing the support of data-intensive applications above the computing-intensive ones. Also the resolution of the link with cloud systems was an important extension. Based on all this, European research communities are better inclined to accept the view, initiated by researchers at the institute in course of earlier projects, according to which inexpensive and economical DG systems can be efficiently applied for increasing the capacity of SG systems.

- P-GRADE grid portal, elaborated during the past years and widely used nowadays in several countries world-wide, was considerably further developed in co-operation with colleagues at ETH Zürich. As a result, a portal specialized for supplying proteomics research was brought about, used by biologists at ETH Zürich in everyday practice. Co-operation with MoSGrid project was started, which set up a grid system for several hundreds of chemists in Germany. Joining this project, a new version of WS-PGRADE portal was prepared, which significantly improved the security-technical solution of the portal. The WS-PGRADE portal was integrated also to the Unicore grid system, meeting the requirements of MoSGid. The integration of WS-PGRADE portal to Eucalyptus and Amazon EC2 cloud systems was completed. As a result of all the above, the WS-PGRADE portal became one of the most up-to-date portals in Europe, providing the access and application of all the distributed infrastructures used on the Continent.
- In the range of project Web2Grid a frame system supporting web 2.0 communities was elaborated, assisting the members of the community to run their applications on the desktop grid assembled from among their own desktop computers.

Computers of several thousands of processors

According to their tradition, they have a pioneering role in the area of cellular and sensory wave computing systems where, quite rarely in our environment, above algorithm research, they contribute to the circuit-design of new architectures.

- New theoretical results were achieved in the field of several thousand processor computers:
  - A new partitioning method was elaborated in the FPGAs implementation of multiprocessor computer architectures, for determining the optimal number of memory and processing elements and control units, furthermore, and their ratio. Moreover, successful experiments were carried out for combining data- and control buses, due to which, simpler data-driven architectures were prepared.
  - In the field of 1D binary cellular automata, the time-variant input and boundary constraint were introduced, which resulted in completely new dynamic elements.
  - It was proved that Eden Island appearing in 1D cellular automatas is the simplest form of Gödel's incompleteness theorem.
- A hologram positioning servo was prepared for the phase-encoded holographic data storage system.
- Sensors of CMOS technology operating in THz domain were developed.
- The first prototype of colour digital holographic microscope automatically analysing the quality of drinking-water was completed. The device, identifying the different types of alga, wracks and vermin in the water flowing through it, is applied in the laboratory of the Municipal Waterworks for the continual control of the drinking-water in Budapest.

Next generations of internet; data mining and information retrieval

In 2010 in the area of *distributed systems*, research in Web-based network software-technology and experimental developments, namely, evolving digital library and archive systems and services, groupware applications and developments in environmental intelligence were concentrated on.

- New results were attained in the fields of self-adaptive service oriented systems, and SLA (service level agreements).
- In the framework of FP7 project *BREIN (Business objective driven reliable and intelligent Grids for real business)* results in basic- and applied research were attained

in Grid, in the fields of ontology building, elaboration of service integration model and methodology. The SLA management of web-services, the monitoring of agent-technology based grid/cloud services and resource adaptation were solved primarily by help of semantic web-technologies.

- The indoor financed project named Cross Media, with a length of 2 years, aims at the development of the prototype of a network-based service system supporting distributed data storage and computing and advanced signal processing, with semantic search platform. The network service to be realized will be suitable for storing multimedia dataflows and for content-based processing. The dataflows archived in data-storages annotated with events can be searched after the automatic processing of different filtering algorithms through the web platform linked to the system.

The institute got into the line of the most recognized ones world-wide also in connection with *Web Spam* filtering. The international recognition of research is reflected by the fact that content-related quality forecast provided for internet archives was defined as *Discovery Challenge task of Conference ECML/PKDD 2010*, and MTA SZTAKI was invited to organize the event. In 2010 the International Internet Preservation Consortium (IIPC) started to apply the results in web spam filtering achieved by the institute.

The public organisation „Foundation for Higher Education, Telecommunication and Telematics" by the Hungarian Telecom for the academic year of 2010/11 provided a support of HUF 30 Million for their research comprising both basic research in business intelligence, data mining, furthermore, web-based information retrieval and those used in industrial applications. Their major results in the first semester:

- Application of multi-core architectures in solving multimedia based information retrieval tasks.
- Learning the measures of difficulty of textual ranking and search expression.
- Application of graph-algorithms in a system for visualising customer relations.

Regarding the quality of *information retrieval and ranking* processes, they significantly further developed their Hungarian image information retrieval system. The system integrates both the image and natural text based methods and, among other things, contains the efficient implementation of image segmentation and feature selection.

The newly formed group in *language-technology* considers the research and development of all the technologies necessary for man-machine communication as their aim, including technologies related to the layer of words (etymons, morphological analysis, spell-checking, dictionary support), to the layer of sentences (syntactic analysis, generating, question answering) and to the layer of dialogues (information extraction, semantic search, dialogue-handling).

The *Hungarian Bureau of World Wide Web Consortium* has been located in MTA SZTAKI since September, 2002. They carry on spreading the communication standards of Internet Web in Hungary and organizing scientific conferences and workshops related to the field.

Control of unmanned land and aerial vehicles, automotive industry related R&D

The theoretical and methodical backgrounds of automated control systems are provided by systems and control theory. Their R&D activity in continuous and discrete systems is grounded in their basic research. Their results are exploited primarily by the energy- and vehicle industries, furthermore, by production-related firms and the international networks of those, but their applications are successful, e.g., in medical spheres as well.

In the field of systems and control theory the following theoretical results are to be highlighted:

- Regarding nonlinear system theory, the methodology of time-invariant geometric system theory was elaborated for linear parameter varying (LPV) and quasi linear parameter varying (qLPV) frameworks. By the dualisation of the design algorithms related to the LPV and qLPV model classes, significant results were obtained for filtering and detection problems. New results were obtained concerning the controllability of specific classes of reconfigurable switching systems.
- A tensor-product (TP) model transformation was conceptionally incorporated into the linear matrix inequality (LMI) based control-design strategies applicable to qLPV and LPV models. The TP model transformation was elaborated in such a way that it should be capable of transforming time delayed systems to non-time-delayed state-space qLPV model representations where the time delay appears as a parameter. By this the majority of modern control design strategies developed for non-time-delayed systems can be applied efficiently to systems having time delay.
- The hyperbolic wavelet constructions brought about as a further development of rational orthogonal bases – besides applications of signal- and system modelling and system-identification – make it possible to describe systems with indefinite metrics, and through the latter, the framing of a theory of hyperbolic systems. The theoretical foundation of those, furthermore, the real life application chances of the same in physical, technical and biological medical systems are objectives of present research at the institute, similarly to those of the past period.
- In the field of adaptive robust control a novel mixed model was examined where the part of the problem that can be well modelled is described with a stochastic Markov model, and the unknown part is modelled with an arbitrary varying reward function. As to different variants of the problem, efficient algorithms for the real case when the environment and the reward function can be observed only in the actual state, were proposed.

Research in intelligent vehicle control is of major importance from the point of view of both the national automobile industry and logistics gaining importance. The research activity in project TRUCKDAS provided new results in the field of intelligent vehicle control systems. The main directions of research included the design of fault-tolerant vehicle architectures, the control of co-ordinated platoon systems and intelligent unmanned vehicle systems, the design of sensor fusion and network-based communication solutions and the integration of active vehicle control components of the suspension, steering and braking systems. Control design methods were developed for a platoon system in order to achieve two main performance goals, i.e., to improve safety compared to that of the individual transport and to reduce the total fuel consumption. These results contribute to the more economical and efficient operation of both single vehicles and fleets.

Research in the recently founded *Unmanned Aerial Vehicles* laboratory included the development of integrated navigation, guidance and control systems for aerial applications. The research objective is to find advanced control methods to support more autonomous flight operations. Development of an extensive concept for the safe insertion of unmanned aerial vehicles into the national airspace begun, relying on the current expertise of the laboratory. The research aims at integrating unmanned vehicles with the current users of the airspace, by combining the results of safety-critical flight control systems and sensory systems capable of detecting abnormal flight situations. To support real time air surveillance systems with the help of unmanned autonomous air vehicles, a multi-target tracking system was elaborated. As part of the system, an algorithm for the classification and segmentation of flying objects was

developed. This was supplemented with a high-level feature-recognition functionality based on a law level image and video content interpretation method.

Based on the scientific relations the institute has earned in earlier activities with key players of space and avionics systems and technology developers, companies, universities and research institutions, the FP7 project *ADDSAFE*, came into existence by the support of 8 European partners, basically to meet the development requirements of *Airbus aircraft manufacturer*. In this project the institute elaborates efficient technologies, develops and applies fault-detecting methods.

The results in production control research related to the vehicle industry as well are enumerated in the next section.

<u>Engineering and business intelligence; control of complex production and business systems</u>

The main objective of research in the field of engineering and business intelligence is to research and elaborate techniques applicable for handling complex production and business systems working in an uncertain, changing environment, in a real-time manner, with special emphasis on informatics, operations research and knowledge-based approaches, balancing the aspects of optimisation, autonomy and co-operation. Their major results in 2010 are:

- An exact algorithm was elaborated for the load balancing problem (typically of the machine operator). The objective function measuring the exploitation rate of the resource may emerge from a wide family of functions; typical examples are the linear or quadratic objective functions.
- An algorithm of polynomial time was elaborated for the version of the interrupted open-shop problem where the machines are arranged in two groups, and the operations need either unique machines or all the machines within a group of machines.
- A novel method based on column generation was elaborated for load balancing problem.
- Former research aiming at the elaboration of co-operation models that can be adapted to practice, realised in supply chains was continued. The co-ordination planning mechanism elaborated in the frame of a European integrated R&D project *AC/DC* in the automobile industry closed in 2010 with classification "outstanding", contributed to the significant reduction of both the delivery times and the inventories along the transport chain. The method is based on the principle of sharing the advantages and risks deriving from the co-operation.
- With a production optimization aim, data mining solutions were developed for cleaning data bulks stored in large-scale production-engineering databases and contain faulty and noisy data as well.

A considerable part of applied R&D related to the field is done in the frame of *Fraunhofer-SZTAKI Project Center for Production Management and Informatics* established in 2010. Their basic research results were introduced in real life application in the frame of 5 industrial projects closed with success. Among the contractual industrial partners one finds e.g., Audi Hungaria Motors, Knorr Bremse Braking Systems Ltd, Andritz Ltd, and Bosh Rexroth Pneumatics Ltd. The scheduling system developed by the SZTAKI was introduced in the factory of Bosch Rexroth, in Eger. Due to the general nature and standard interfaces of the system, further applications are expected. The German and Hungarian partner institutes of the Project Center participate in several projects by the EU. Hundreds of companies operating in Hungary were invited to complete an internet-based questionnaire with an aim of assessing the production control and manufacture-information conditions and future requirements of

national firms active in manufacturing and logistics. The evaluation of the answers is in progress, to be followed by purposeful visits and workshops.

The R&D co-operation of the SZTAKI and *HITACHI* is to be stressed, in the frame of which colleagues from the institute continue their co-operation in the development of the production control systems of the Japanese firm's factories in California, Japan and the Philippine Islands, producing hard discs, in the field of *adaptive forecast of production system behaviour*. In 2010 the co-operation was extended to a new branch of industry, namely the manufacture of energetic equipment. New production scheduling systems were developed, allowing to take advantage deriving from the alternative production routings, in the interest of the smooth loading of production equipment and reducing the lead time. The new methods were tested with success on large-scale industrial problem instances (of several thousands of production operation in about a three-month time horizon).

In the field of *computer integrated manufacturing* they concentrated mainly on the questions related to extended/virtual enterprises: Time span and service-designing methods were developed which take the environmental aspects and social expectations into consideration. Within technological platform *MANUFUTURE-HU*, they survey international trends, deal with the exploration of national potentials, and have remarkable role, both national and international, in laying the course of future directions.

<u>Computer-aided image processing, 3D representation and reconstruction of dynamic objects</u>

In the field of *geometric modelling and computer vision* the following results are to be stressed:

- A previously developed method for weak-perspective camera auto-calibration and 3D reconstruction was extended to the case of varying focal length.
- It was shown that optimal calibration algorithms can be created for weak-perspective and scaled orthographic cameras.
- A novel radiometric camera calibration method based on the principle of superposition was developed for a projector-camera setup.
- The shape design method based on highlight lines was extended to handle large surface irregularities and complex highlight line structures.

It is advancement in *telesensing* research that new procedures, based on marked Markov point-processes and an algorithm describing a new characteristic point, were developed for detecting buildings and their changes jointly in registered aerial- and satellite images.

New location procedures were elaborated for *multi-camera surveillance systems*:

- A new statistical system was provided for locating objects of unknown shape, either overlapping, without using camera-calibration.
- A novel method based on dynamic optimization was developed for finding the position of persons moving in crowds, partially overlapping each other and for estimating their height.

A new procedure was elaborated for the general categorization of visual information by integrating local image and the low-level image characteristics describing the structure into an organic model. For handling the deficient and noisy data, a new grouping procedure was developed based on paired-graphs.

A 3D CAVE – immersive 3D virtual laboratory was set up providing opportunity for the simulation and design of complex systems. The setting up of a 4D studio was started for the reconstruction of moving, mutable objects. All the major hardware and software components of the studio have been completed.

Automation and information sciences related problems of traditional and renewable energy sources

Research in systems and control theory is focused partially on the automation of energy production. Based on the high-level theoretical background in the field of safety-critical process control, concrete applications were started at their traditional strategic partner, the Paks Nuclear Power Plant. The systems installed and the relating expert activity contribute to the safe and economical operation of the power plant. The institute takes part in control, technical expertise activity related to the life-cycle prolongation of the 4 available blocks of the power plant. In course of this, the current systems are revised from the points of view of life-cycle management and the conditions of a further-operation in the long run. They participate in the preparation of the reconstruction of the Control and Security System to be restored in a short time, furthermore, in determining the requirements of the new system to be delivered, and in the evaluation process of the offers by the suppliers. They continue the computer- data- and network-security related assessment of the process control systems at the power plant, the exploration of deficiencies endangering the safety, and the preparation of the power plant's new information security system.

Remarkable results are achieved in connection with their intelligent decision support system of the sub-station developed for the Paks Nuclear Power Plant, with respect to the increase of security and engineer/operator speed. The second version of their system and the modifications due to line interrupter were put into operation. The training-simulator of the 400/120kV sub-station was manufactured with the direction of SZTAKI and with the assistance of several sub-contractors.

An optimization-based procedure was developed for determining the most frequent and most sporadic realization of reaction kinetic networks, a wide class of nonlinear positive systems. A method was elaborated for the formal simplification transformation form of the above system-class in the manner that the simplification should keep the dynamic structural properties (e.g., stability). This way, the dynamic analysis of complex biochemical reaction networks can be simpler. The theoretic results attained in the field of analysis and control of nonlinear process systems may be of considerable economic benefit in the control-technical reconstruction of Paks Nuclear Power Plant. In this respect the model-based control operation of certain primary circuits and the elaboration of the optimal control strategy for normal load changes may produce major results.

For Siemens Corporate Research an optimizing motor based on an interior point algorithm was elaborated. For the time being, the software developed is under a testing procedure on optimization tasks for large-scale electric energy networks.

The aim of FP7 Project *ReliaWind* to be closed in spring 2011 is to develop new operation and maintenance technologies for increasing the reliability of *wind farms*. Within the above, research was done in fault detection and –prognostics, and maintenance-design. The outstanding result of the project is the development of state-surveillance- and maintenance-design system (WindMT) of wind turbines and wind turbine farms. The model of scheduling contains all the important requirements characteristic to the application area, e.g., weather, availability of special devices and hired services, human resource skill, or the effect of certain operations on the running of wind turbines or wind farms. For solving the scheduling task, an algorithm combining mathematical programming methods and special heuristics was elaborated. Negotiations on the further development and future application of the system are carried on with one of the leading European manufacturers.

b) Relationship between science and society

The research areas cultivated at the SZTAKI are in accordance with the *big challenges* the world is facing. Information sciences can be one of the driving motors of the responses to the challenges: the R&D areas highlighted at the institute, such as mechatronics research (electronic vehicle and vehicle control) related to the vehicle industry, or such as the automation, informatics related issues of traditional and renewable energy resources are directly connected with the challenges. Naturally, the fields are in harmony with the *R+D programmes of the EU*, primarily with Information and Communication Technologies; Nanosciences, Nanotechnologies, Materials and new Production Technologies; Energy, Transport (including Aeronautics).

The New Széchenyi Plan sets priority with a view to the entire economy to mobility, automobile industry, and logistics; information sciences and computer science; and new developments, R+D+I, in the fields of the energy sector and environment protection. The aim of *Fraunhofer - SZTAKI* co-operation, established in the fields of production management and information sciences, is the industrial utilization of applied research results based on theoretical results, in the framework of international collaboration.

Their new generation *mobile tourist system*, which was awarded at the CeBiT the gold degree of *European Seal of e-Excellence*, allotted by the European Multimedia Forum (EMF), aims at introducing Hungarian cities and regions. The online dictionary service of MTA SZTAKI has been available for users for 15 years, growing in the meantime into the most frequently visited Hungarian internet-based dictionary, with more than 1-1,2 Million searches a day by 100-140 thousand people showing interest. The openness of science towards the society was deepened by their researchers' reporting on the institute results on the television and the radio upon a great number of occasions, and taking all the opportunities of publishing those through the medium of the press.

III. A presentation of national and international relations

International relations

Their activity in FP7 was prominent, with their participation in 24 granted projects and in several cases acting as the head of consortium. Within the frames of the programs, they work in collaboration with the most distinguished companies in Europe, in the area of information sciences, automobile- and aircraft manufacturing and energy production.

In accordance with the efforts aiming at the development of the European research area, the institute carries on establishing and operating *international virtual institutes and laboratories*. As a result of several-year-long preparatory work and research co-operation, the "*Fraunhofer-SZTAKI Project Center for Production Management and Informatics*" was established in May, 2010 with all solemnity. The two parties' partially overlapping, partially supplementary R&D and consulting potentials provide unique opportunities both for doing R&D of required efficiency and adapting the results in real life applications in Hungary and abroad alike. It must be admitted that the expansive recognition of Fraunhofer Institute renders help to MTA SZTAKI – and through the Project Center to other research institutes of the Academy, and universities as well – in forming connection with Central-European firms, particularly in German ownership, furthermore, in entering into R&D co-operation.

In the recent past of the institute R&D co-operation with the Japanese firms *RICOH* and *HITACHI* was uniquely successful. Signing of similar frame-contracts with *Bosch* and *GAMESA*, Spain, producing wind farms, is in preparation.

Researchers at the institute take part in the management and working groups of the most significant international scientific organizations (CIRP, IEEE, IFAC, IFIP, etc). Several of their colleagues are members of Editorial Boards of leading international journals

National relations, participation in higher education

At the institute interdisciplinary research and development in information sciences and other branches of science (materials-. life- and social sciences, mathematics, artificial intelligence, systems- and control sciences, automation, operations research) and in application areas (sensory computers, vehicle industry, transport, production engineering, production management, cultural heritage, health-care, information society, data-security, medical science) are concentrated on which may determine the conditions of the institute in the longer run.

In their projects the institute co-operates with remarkable major enterprises such as GE, Audi, Hungarian Telekom, MOL, Paks Nuclear Power Plant, Knorr Bremse, Bosch. At the same time, the participation of small enterprises guarantees that the institute's results should keep spreading in the widest possible spheres.

Gradual and postgradual education is henceforward regarded at the institute as an important attribute of research activity, and an indispensable condition of future-shaping. Regular education is in progress at the following universities in Hungary: Budapest University of Technology and Economics (BME), Eötvös Loránd University (ELTE), Corvinus University of Budapest, University of Pannonia, University of Pécs, University of Miskolc, Pázmány Péter Catholic University (PPKE), Central European University (CEU). The form of co-operation is manifold: secondary or full-time employment of researchers, common chairs run at the institute, employment as the head of a department, co-operation in establishing information science faculties.

In the fields of electrical engineering-information sciences and biological sciences (particularly, of neurobiology), the *Hungarian Research Center in InfoBionics* is run by 6 research institutes of the Hungarian Academy of Sciences and 6 university research laboratories. Also the establishment of the *Hungarian Grid Competence Center* (MGKK) was initiated by the SZTAKI. Co-operating partners are: BME ELTE and the National Information Infrastructure Development Institute (NIIFI), later KFKI Research Institute for Particle and Nuclear Physics (RMKI) joined.

As a sign of a many-year-long co-operation, in the frame of "*Regional University Knowledge Centers*", the institute participates in the project *Advanced Vehicles and Vehicle Control Knowledge Center*, led by the BME. Similarly is outstanding the role of the institute in the National Office for Research and Technology (NKTH) project titled *Mobile Innovation Center*, headed also by the BME.

On the average, 25 Ph.D. students do research at the institute, under the scientific supervision of leading researchers. Doctoral schools in Hungary have colleagues from the institute as collaborators in 25 cases, and as permanent foundation members in 5 cases.

The most significant scientific conference organized by the institute in 2010 was the *19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010),* held in Budapest, between 5-9 July, with 450 participants.

IV. Brief summary of national and international research proposals, winning in 2010

In 2010 considerably many EU-supported projects were started at the institute. In these projects they work, for the most part, with prominent universities, research institutes and, on several occasions, with firms of world-wide fame (with the names of the project leaders from the SZTAKI and the most important data of the projects, including also the amount of the support won by the institute related to the *entire length* in parentheses):

LAWA: Longitudinal Analytics of Web Archive Data *(András Benczúr, FP7, 2010-2013, EUR 309.600*

For novel Web applications, information related to the size, spread, structure and evolution of the Internet is explored. An experimental environment is created for large-scale heterogeneous Web experiments, emphasizing the sustainable infrastructure, its scalability, and the easy application of the gathering, retrieval and analysis modules.

SCIIMS: Strategic Crime & Immigration Information System *(András Lukács, FP7, 2010-2013, EUR 252.726)*

The project deals with the following research themes: development and application of information-handling techniques, safe information infrastructure. Development and application of informatics-based tools which support the decision makers at the police with analysis and forecasts related to human trafficking, human smuggling and organized crime.

EDGI: European Desktop Grid Initiative *(Péter Kacsuk, FP7, 2010-2012, EUR 484.172)*

The objective of the project co-ordinated by the institute is the consolidation of integration results of service grid – desktop grid achieved in project EDGeS, the further development of the technology, moreover, extension to further service grids and cloud computing. The task is to optimize the outcome and extend it to cloud computing.

SHIWA: Interoperable Workflows for large-scale scientific simulations on Available DCIs *(Péter Kacsuk, FP7, 2010-2012, EUR 452.510)*

The objective of the project co-ordinated by the institute is to realize the co-operation opportunity of workflow systems most commonly used in Europe. Their primary task is to integrate the P-GRADE workflow system developed by the SZTAKI into the technology and infrastructure to be developed by SHIWA.

HP-SEE: High-Performance Computing Infrastructure for south East Europe's Research Communities *(Péter Kacsuk, FP7, 2010-2012, EUR 65.000)*

Project HP-SEE - by linking the infrastructures already available in the region and the High-Performance Computing (HPC) infrastructures to be designed in the near future - aims at the development of a joint infrastructure. A further aim is to open the HPC centres of the region for wide circles of users, mainly in research fields in physics, chemistry and life sciences.

DEGISCO: Desktop Grids for International Scientific Collaboration *(Róbert Lovas, FP7, 2010-2012, EUR 161.960)*

Based on research results elaborated in project EDGeS, the SZTAKI co-ordinated project aims at extending the service co-operating with each other and the European research infrastructure developed from Desktop Grids, by involving partner countries outside the EU.

EGI-INSPIRE: Integrated Sustainable Pan-European Infrastructure for Researchers in Europe *(Róbert Lovas, FP7, 2010-2013, EUR 72.135)*

As the continuation of former project EGEE, grid education and support of application based development.

ADVANCE: Advanced predictive-analysis-based decision-support engine for logistics *(Elisabeth Ilie-Zudor, FP7, 2010-2013, EUR 684.712)*

The aim of the project led by the SZTAKI is to elaborate methods for co-operative networks at firms, which contribute to increasing the efficiency of the participating firms by the analysis of operation data, decision support, and generally, by network division of locally present data.

APIS: Array passive ISAR adaptive processing *(Tamás Szirányi, EU EDA JIP-ICET, 2010-2012, EUR 115.720)*

Study and realization of a demonstrator for the synthesis and process of ISAR radar images. Implementation of autofocus techniques contrast optimization methods. Testing of image reconstruction procedures. Follow-up, description and recognition of targets on ISAR image series. Consideration of land, aerial and space platforms in course of realization.

QC2_CORN: Quantifiable, Closed Quality Control, QC^2 *(Zsolt János Viharos, CORNET, 2010-2012, HUF 21.207.000)*

The aim of the project is to identify and development of structures and methods which support firms in better managing their activities related to the quality of their operation, production and production systems.

ManuCyte: Self-learning modular manufacturing platform for flexible, patient specific cell production *(János Nacsa, FP7, 2010-2013, EUR 214.000)*

Development of a self-learning modular manufacturing platform for flexible, patient specific cell production.

CIS3D: Completeness Inspection in 3D *(Géza Haidegger, EU-EUREKA-EUROSTARS, 2010-2012, EUR 80.000)*

Project CIS3D aims at the system level elaboration of a novel camera-computer 3D industrial measuring equipment family (partially) for industrial purposes. As a result of the 3D image transformation, lack of e.g., parts can be detected.

MANUCLOUD: Distributed Cloud product specification and supply chain manufacturing execution infrastructure *(István Mezgár, FP7, 2010-2013, EUR 244.000)*

Development of a distributed cloud infrastructure for product specification and supply chain management.

OTKA-OMFB: Meaning-based language-technologies *(András Kornai, 2010-2013, HUF 77.121.000)*

Their aim is to develop semantics-based language-technology, on the level of words, and later, on more complex units (phrases, sentences, paragraphs, documents).

OTKA 80352: Coherent feature-systems in artificial and human visions *(Tamás Szirányi, 2010-2012, HUF 31.407.000)*

Research of methods is carried out in the frame of the project, which are suitable for searching shapes, features, situational relations, geometric structures, and also for searching the structural, causal or probability relations between the same, comparing continuously the data of temporary measurement with the cases showing similarity.

OTKA 83438: Indexing and retrieval of video contents *(Levente Kovács, 2010-2013, HUF 12.070.000)*

Research of visual content –databases related, novel indexing, relevant description search, efficient retrieval and visualisation solutions for searching high-level video-contents.

V. List of important publications in 2010

Books

[1] Vámos, T.: Knowledge and computing: a course on computer epistemology. Budapest, New York, CEU Pr., 2010., p. 218

[2] Baatar, C. (szerk) - Porod, W. (szerk) - Roska, T. (szerk): Cellular nanoscale sensory wave computing. New York, Springer, 2010., p. 249

Journal publications

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[4] Bacsó, G. - Jung, H. - Tuza, Z.: Infinite versus finite graph domination. **Discrete Mathematics** 310 (9) : 1495-1500. (2010.)

[5] Bozóki, S. - Fülöp, J. - Rónyai, L.: On optimal completions of incomplete pairwise comparison matrices. **Mathematical and Computer Modelling** 52 : 318-333. (2010.)

[6] Bujtás, C. - Tuza, Z.: Smallest set-transversals of k-partitions. **Graphs and Combinatorics** 25 (6) : 807-816. (2009.)

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[9] Farkas, Z. - Kacsuk, P. - Balaton, Z. - Gombás, G.: Interoperability of BOINC and EGEE. **Future Generation Computer Systems** 26 (8) : 1092-1103. (2010.)

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[18] Kulcsár, B. - Bokor, J. - Shinar, J.: Unknown input reconstruction for LPV systems. **International Journal of Robust and Nonlinear Control** 20 (5) : 579-595. (2010.)

[19] Licsár, A. - Szirányi, T. - Czúni, L.: Trainable blotch detection on high resolution archive films minimizing the human interaction. **Machine Vision and Applications** 21 : 767-777. (2010.)

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