Computer and Automation Research Institute
Hungarian Academy of Sciences

Report on the scientific activity of the
MTA SZTAKI
in 2011

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I.   Main duties of the research unit in 2011

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 they continued the setting up of an up-to-date *control experimental laboratory* for the research of robust, fault-tolerant control algorithms of robot vehicles and UAVs (unmanned aerial vehicles) and their demonstration. Considerable efforts were made to establish a *SmartFactory* laboratory where novel production control research is intended to convey, including autonomous systems and the integration of real and virtual manufacturing.

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 Fékrendszerek Kft.

Based on the indoor motivation system introduced in early 2010, they intented to concentrate further on their research portfolio, forming units of size showing greater efficiency, capable of performing basic research results-rooted R&D activity at least up to prototype level. On the other hand, for forming research units able to complete tasks of larger scale, they find establishing and running national and international co-operations, consortiums, virtual laboratories as natural solutions.

II.   Outstanding research and other results in 2011

a)   Outstanding research and other results

In the following part, above the description of their four major domains of basic research (computer science, systems- and control theory, engineering and business intelligence, machine perception and human-computer interaction), five sub-sections contain a summary on how their basic research results support the R&D activities which aim at fields considered as particularly important both on EU-level (Horizon 2020) and in Hungary (New Széchenyi Plan). Consequently, their application-oriented results achieved in the fields of vehicle industry and transport, production informatics and logistics, energy and sustainable development, security and surveillance, furthermore, networks, distributed computing structures and next generations of internet are detailed in separate sub-sections.

BASIC RESEARCH – MAIN DOMAINS

Computer Science

Their research in Computer Science leverages on the synergies of several interrelated fields, including the theory of algorithms and databases with emphasis on new parallel hardware architectures, data mining, information retrieval, machine learning, and graph theory.

Business intelligence, e-science and Web mining are rapidly growing sources of extreme large scale information processing problems. Their goal is to provide efficient solutions to distill knowledge from "big data". Unique to the institute is the strong collaboration of engineers and mathematicians: while their results are always experimentally validated over real data, due to the huge size of the problem, their algorithms are based on deep theory of

algorithms, probability and algebra.

Man-machine communication is increasingly moving towards the natural dialog conducted in human language (Hungarian, English). They conduct research in all key technologies involved in the man-machine dialog, let them be word-, sentence-, or discourse-based.

Selected most important results in 2011:

- One of their young researchers won the highly prestigious Starting Grant from the European Research Council. He is the first Hungarian to win a grant of this type in Computing Sciences. His project PARAMTIGHT was awarded 1.15 MEuros, for five years. In the framework of the project, from January 1, 2012, a new research group will be established at the Institute, which focuses on the parametric complexity aspects of algorithmic problems.
- Advanced machine learning techniques (Gaussian Mixture Modelling over GPGPU graphical coprocessors, Fisher kernels) were used for content based image classification. Graph theoretical methods were developed for selecting focused areas in images. A new method for grouping and evaluating image descriptors based on feature graphs was published.
- Their team won the prize for the "Outstanding Integration of Computational and Visual Methods" at the "IEEE Visual Analytics Science and Technology Challenge 2011".
- In the framework of combinatorial batch codes they have given an optimal arrangement for distributed storage and reliable retrieval of data. The solution is optimal in several regions of the parameter domain which describes the system and the retrieval conditions.
- Under different conditions, they have obtained tight upper bounds for the number of parts in allowed subdivisions of graphs and set families.
- They have proved for several combinatorial optimisation problems that they cannot be approximated with arbitrary precision by fast algorithms (the problems do not admit polynomial time approximation schemes).
- They have developed some novel applications of the Regularity Lemma in Ramsey theory. Using a Behrend construction, they improved results of Erdős, Frankl and Rödl.

Their basic research leads to research and development projects in co-operation with T-Online Hungary, Econet.hu, Hungarian Telecom, AEGON Hungary, Fornax, and several Hungarian SMEs (Schibsted Media Group, GVI, Universitas Press). They developed web and IT log analysis systems for T-Online, Econet.hu and AEGON. Hungarian Telecom, Vodafone and AEGON rely on their search technology as well as provide research testbed for their research in text mining in co-operation with Hungarian SMEs.

Systems- and control theory

The theoretical and methodical backgrounds of automated control systems are provided by systems- and control theory. The research offers a firm theoretical basis for other R&D activities carried out in the institute in the field of automated control systems. The basic fields of activity are system modelling and identification, theory of adaptive and robust control, signal processing and filtering, distributed and networked control systems, moreover, process control systems. Linear and nonlinear systems, both in continuous and discrete time approaches, moreover, deterministic and stochastic views are equally considered for both synthesis and analysis.

The extension of the results provided by linear time invariant geometrical systems theory to linear time varying and/or state dependent varying parameter model structures (i.e., LTV, LPV and qLPV systems) makes up a coherent strategy for the research. Dualization of LPV

and qLPV control problems are expected to bring exciting new results that can be used for the enhancement of robustness and improved performance quality of filtering in state estimation and fault detection. Investigation of various types of switching reconfigurable and adaptive control systems is expected to provide important new results for the enhancement of robustness against parameter variations and other nuissance environmental effects.

The theoretical research keeps up with the demanding of new applications of control and information technology by seeking answers to special new problems. These applications range from the (control) issues of land, aerial and space vehicles, to distributed filtering solutions in large-scale networked control applications. Towards a symbiotic view of theory and applications, research equally relies on projects supporting basic research (such as OTKA, FP7), on projects focusing on applied research (FP7, NFÜ), and application-oriented activities performed jointly with partners from the industry.

Regarding the methods and approaches characterized by the above research objectives there have been important new results obtained for the control of land and aerial vehicles in 2011. Namely, novel navigation methods, obstacle detection and control algorithms for the supervision and control of autonomous flying objects (aka drones) have been achieved. These results are subject to further applications in dependable systems solutions of unmanned autonomous vehicles. The timely recognition of critical aerial situations, like collision avoidance, by means of visual/optical detection of the unidentified obstacles and the successive reconfiguration of the control strategy of the robotic plane are of high importance.

Research along the extension of rational orthogonal basis functions in signal processing towards hyperbolic wavelets opened the way to the description of systems of indefinite metrics, and as such, to the construction of a new hyperbolic systems theory. This theory will serve a firm basis to finding new signal and system modelling paradigms, moreover an important novel idea to system identification applications. The first application of this concept was the derivation of the algorithm, which can be used for the determination of the unknown poles of a system in a revolutionary new way.

Principal end users of the results of systems and control theory are from the energy-, and the vehicle and transportation industries. There have been a number of important projects, performed both in national and international horizons, whose main consideration was the analysis of practical applicability of the developed theories. To this end, they cooperated with Airbus, Bosch and Knorr-Bremse in projects (ADDSAFE-FP7, TRUCKDAS-NFÜ), successfully. As a direct consequence of this industrial co-operation, there appeared new results in the field of the construction of fault tolerant vehicle on-board control systems, and in coordinated control and supervision of platoon systems. The integrated control of braking and steering systems together with new algorithms for intelligent unmanned vehicle control solutions, as well as for sensor fusion, got new approaches in the applied research performed in co-operation with the industry.

Engineering and business intelligence

Globalised technical and business systems of our days are characterised by extraordinary complexity. A novel difficulty in their planning and control – which in the frequently changing uncertain environment constitutes an enormous challenge in itself – is the support of the co-operation of entities in autonomous decision situations. The efficient processing of the huge amount of information which is usually generated and stored in a distributed way is of highest importance while handling the arising problems.

The fundamental goal of the R&D activities in this field is the research and elaboration of techniques applicable for handling complex production and business systems working in an

uncertain, changing environment, balancing the aspects of optimisation, autonomy and co-operation. The research necessitates an interdisciplinary approach with special emphasis on computer science, operation research, manufacturing science and knowledge-based techniques.

From among the main results of the basic research activities achieved in 2011, the following ones deserve special attention:

- Efficient algorithms were developed for large-size production scheduling problems with finite capacity resources (machines, materials, labour), taking alternative process plans and set-ups into account, supporting multiple optimisation criteria.
- For the so-called resource levelling problem an exact algorithm was given, which is faster than the known methods and gives – proven – near-to-optimal solutions.
- New results have been achieved in the field of two-party game theoretic problems where one of the players possesses full information about the behaviour of the other, and determines its own activities supposing the expected rational reaction on them from the other player. The application of the results can increase the effectiveness of supply chains.
- Four computing approaches (decomposition-based, integrated, coordinated, and bilevel programming) were compared on the determination of inventories within production chains, and the benefits of the coordinated and the bilevel ones were outlined.
- A new algorithm was given for maintenance scheduling of wind turbine farms, which, in addition to the parameters usual in production, considers other aspects such as weather forecast information.
- New data mining algorithms have been developed for filtering huge amounts of data stored in production-related or customer databases for production optimisation, marketing and fraud detection purposes.
- Novel effective techniques of convex internal point algorithms have been elaborated for solving quadratic problems. The relaxation methods developed for linear programming problems have been generalised for non-separable quadratic programs, and the convergence of the new method has been proved.
- For solving linear programs, a new, cutting plane generating algorithm has been elaborated, which combines the benefits of the „lift-and-project" and the „reduce-and-split" methods.
- In a survey paper coordinated by them and co-authored by outstanding foreign scholars they pointed out that the competitive, but at the same time sustainable production requires both the co-operation of the enterprises and their quick reaction abilities, and laid down the basics of the Co-operative and Responsive Manufacturing Enterprises (CRME).

The research activities are partly pursued in the framework of EU-supported projects – some of them coordinated by the institute. The theoretical results achieved in 2011 have been published – among other forms –in more than 10 papers in journals with impact factors, led to industry-oriented applied research and innovation activities (see the sections on Production informatics and logistics and on Energy and sustainable development).

Machine perception and human-computer interaction

Recent developments in our information-based societies, and the continuous monitoring of practically all areas of everyday life have gradually led to the establishment of automatic machine perception by multimodal fusion of data from different locations and in different time instants, modelling geometrical issues; the measured data and recognition & clustering

parameters are organized into multimodal databases for indexing and retrieval; for static and dynamic reconstruction, designing and animation of objects and scenes.

Special emphasis is put on machine learning, multimodal data mining, human perception, scene geometry, optics, optimisations and variational analysis methods, in areas such as image- and video processing, biometrical identification, connections with sensor networks and computer graphics. New sensors and sensory principles are developed, the fusion of optical-, Lidar-, and infra-measurements, THz detection and imaging technologies are processed.

Most outstanding results in 2011:

- A new methodology has been developed for segmenting textures and shapes with 98-99% efficiency.
- A new external energy function is derived for parametric active contour segmentation procedures to achieve high segmentation accuracy.
- A cross-modal indexing and retrieval software system has been developed for disk-based retrieval by using hash tree indexing, resulting in efficient database handling of huge databases of large data descriptors.
- An automatic feature selection method has been investigated for analyzing the behavior of descriptors, based on the analysis of random geometric graphs structures detecting the appearance of the giant component.
- A high sensitivity multi-spectral THz sensor array has been developed integrated with amplifier and signal converter based on 90nm silicon technology.
- A 4D studio has been built and real-time GPU based system has been developed for 4D reconstruction.

R&D ACTIVITIES

Vehicles and transportation systems

Regarding the research performed for intelligent vehicle and transportation systems, the integrated solution to combined braking and steering control solutions of cars and heavy vehicles, the advanced sensor fusion and control over network methods, moreover, the fail-safe design principles of onboard vehicle control systems are to be mentioned as the main achievements (project TRUCKDAS).

Advanced control of vehicle fleets aiding the efficient operation of heterogeneous fleet and platoon systems gives new solution alternatives to the problems raised by global safety and efficiency requirements, thus contributing to the solution of the fuel economy and pollution control problems in the vehicle- and transportation industry.

In case of intelligent land and aerial vehicles the challenge of research is to obtain methods which ensure the accurate and long-term autonomic operation of the controlled systems. It is a well recognizable research trend that the formerly independent onboard control system loops, such as traffic rolling controllers, whose operation was based either on radar distance measurements or visual camera detectors, are now being integrated (fused) in the form of a single dynamic controller, thus creating the opportunity for the solution of many new, earlier unsolvable control problems.

Increased vehicle autonomy, however, requires ultimate fault tolerance and operational reliability. To this end, research that was supported by the Research Office of the US Navy has been conducted successfully for the development of an intelligent collision avoidance system. Another research activity concerning fault tolerance and reliability, within the EU-project ADDSAFE with the Airbus Industries as industrial partner, aimed at developing an early fault detection technology for use in commercial aircrafts. For the research and

application of fault tolerant sensor and control methods to unmanned aerial vehicles, a laboratory research- and verification platform has been developed. This platform is expected to support the functional and performance verification of advanced control algorithms in a cost effective manner.

A new optical measurement system for the identification of vehicle tire profile goodness has been developed. The system is implemented as part of the suspension diagnostic system prototype developed by the German Automotive Process Institute, which won the Golden Trophy of Equip Auto 2011 trade show in Paris.

Production informatics and logistics

Production and the related logistic activity are indispensable parts of every national economy. The development and application of solutions supporting the design and effective operation of these systems, simultaneously, reckoning with sustainable development requirements and social expectations, above competitiveness, are key issues in our days. Production and the related logistics are given high priority both in the European Union (Manufuture initiative, Factory of the Future) and in the economic- and scientific policy of our country (New Széchenyi Plan).

The R&D activity of the institute aims at designing and modelling production, servicing and logistic systems, together with the digitalization, control and optimisation of their operation, on shop floor-, enterprise- and network levels alike. MTA SZTAKI makes efforts to develop solutions of world class quality well applicable both at globalized large companies and also at SMEs co-operating with them, either through e-service. A considerable part of applied R&D related to the field, and its introduction in the industry are performed in the frame of Fraunhofer-SZTAKI Project Center for Production Management and Informatics established at the institute in 2010.

Major results achieved in 2011 are as follows:

- Based on their own basic research results, a general-purpose production planning system, meeting the related international standards (ISA-95, ISA-88) has been developed answering to the special requirements of SMEs. The system is installed first at the Bosch-Rexroth factory located in Hungary.
- The prototype of their system elaborated for the maintenance-scheduling of wind turbine farms has been installed at one of the major companies world-wide in the wind power industry (Gamesa). The industry-based introduction is prepared by experts from the company and the SZTAKI, in co-operation.
- Their product tracking and tracing solution developed in the frame of an earlier EU project, TRASER, was extended to quickly perishable food. The possible chances and impacts of IoT (Internet of Things) on production- and logistic systems are studied further.
- A procedure has been developed for code retrieval of programmable logical controllers (PLCs), for automatic exploration of production systems' topology.
- Their optimisation engine based on interior point method has been further developed for Siemens Corporate Research.
- In course of their research in robotics new results were obtained in the control of robotised incremental forming of metals and polymers.

The industrial application of the results takes place at significant companies, such as Audi Hungaria Motors, Knorr-Bremse Fékrendszerek Kft, Bosch Rexroth Pneumatics Ltd., Hitachi, Gamesa, CAMPDEN. The R&D co-operation between the SZTAKI and HITACHI that has been active for several years, and has resulted in several patents applied for jointly, is to be

pointed out. Now, it is extended to the production of energy industry related machines and devices, besides the semi-conductor industry.

Energy and sustainable development

A fundamental requirement to sustainable development is the adaptation of the energy production, -transfer, and -transformation systems to the changing needs and possibilities. One of the keys to renewal in the control and supervision of electrical power systems is the increased data processing, storage, and transfer capacity of the available information technology toolset, which opens new prospects in the areas of automation and efficiency increase, however, generates new problems as well. The institute gives much emphasis to the following topics in the field of energy management and sustainable development:

- *Control and supervision of energy production systems*: MTA SZTAKI has developed new solutions for the assurance and verification of power plant safety and operation continuity. Out of these, the following projects related to the life cycle extension of Paks Nuclear Power Plant are stressed:
  - the creation of a control-oriented mathematical model of the reactor units that describes the primary and secondary loop dynamics,
  - the compilation of the formal specification of the Control Rod Control System and the Reactor Power Control System, as part of the Instrumentation and Control System Refurbishment Project of Paks NPP,
  - the redesign and reimplementation of the test systems of the Reactor Protection System at Paks NPP,
  - the development of new modelling formalisms and model checking algorithms for the verification of the proper operation of the safety logics, which can efficiently handle the extremely large state spaces (e.g. containing 10^{13} states) of the protection systems.
- *Optimisation of energy distribution networks*: the biggest challenge in the operation of electric grids is maintaining the optimal energy balance between the producer and consumer nodes in such a way that the continuous, reliable, cost effective and legal operation should be possible. Mathematically, this requires the solution of a nonlinear discrete problem over a network of 10^{3}-10^{5} nodes. The algorithms developed by the institute as the solution for this problem, have been incorporated into the software products of a world class company.
- *Supervision and maintenance planning of wind turbines and wind turbine farms*: the solutions developed by the MTA SZTAKI for problems related to the issue are being introduced at a large wind turbine manufacturer in Europe.

Security and surveillance

The importance of security and surveillance applications and areas has been rising in recent years. Computer systems can notably contribute to raising security awareness. Cyber security has been a key issue by now, which acquires importance in the domain of critical infrastructure protection (e.g. energy production, traffic).

The goal of *remote monitoring and remote sensing* research is the introduction of a new scientific methodology for the automatic interpretation of remotely sensed 4D data from various sources, acquired in different time and at different locations. This, through the separation of certain areas and the perception of defined objects and samples, will allow complex, multilevel description of surveyed sites. Analysis is performed by using air photos, satellite imagery, infrared and radar images, and ground-mounted and airborne LiDAR sensor data. The central task is the examination, registration and intelligent fusion of multiple data sources, 3D/4D representation of samples, and machine learning methodologies.

Main results achieved in 2011:

- *Automatic analysis of behavior management systems:* EU project "THIS" has developed real-time processes, which provide automatic alarm capabilities related to major events during the observation of transport hubs. The algorithms are applicable to the recognition of actions performed by single persons (e.g. losing an object, unusual behavior, falling), and, on the other hand, of interactions between persons (e.g. fighting, greeting, handshake).
- *Multi-sensor equipped tactical support network*: With the support of the European Defense Agency's Joint Investment Programme on Force Protection (EDA JIP-FP), project MEDUSA produced a flexible, expandable and robust control decision support system in urban combat environments where a number of multi-sensory processing modules are capable of fusion-based processing of spatially distributed sensors data, to recognize low- and high-level events, display events and alerts on a Common Operational Picture (COP), and integrate processing modules.
- A digital colour holographic microscope is completed, developed for automatic monitoring of drinking water, with an algae-classification system.
- Upon the request of the National Atomic Energy Authority, instructions were put in place regulating the computerized safety of process control systems of nuclear facilities, the industrial use of which is expected in course of establishing the defence architecture of the Hungarian nuclear facilities' computer controlled system.

Networks, networking systems and services, distributed computing

The importance of this field is unquestionable. A new program, Horizon 2020 (FP8) is in preparation. This program emphasizes basic research in the fields of information and communication technologies: the next generation of internet. The above subject covers the issue of the management of large-scale, connected systems. It requires the handling of extremely large amounts of data, and has to support the information exchange and collaboration of smaller or bigger, heterogeneous or ad-hoc communities by creating a context-oriented knowledge base for their common knowledge.

Their achievements can be summarized as follows:

- *Grid and cloud computing*: the design and implementation of the internationally acknowledged and applied P-GRADE Grid portal, which will serve as the base for 27 European grid portals to be established in the frame of the SZTAKI-coordinated SCI-BUS FP7 project. The SZTAKI Desktop Grid technology is used in many countries throughout Europe and Asia to integrate service- and desktop grids.
- *Ubiquitous computing*: Project ILI was focused on creating a flexible, context-oriented smart-space framework that can be installed indoor.
- *Service-oriented computing*: A multi-agent resource allocation algorithm was extended semantically to apply software licenses that can be used in grid or SaaS environments. Parts of the results were used during the development of the cloud solution for NUANCE (USA).
- *Semantic web*: A new, LOD (Linked Open Data) service was created that consists of 11 million triples constructed by converting the content of existing relational and network databases. A semantic search engine was implemented that allows free text search among millions of labels.
- *3D internet*: the institute built a 3DVRR (Virtual Reality Room) laboratory, the first in Hungary and one of the most prominent ones in the European Union, and developed the VirCA (Virtual Collaboration Arena) platform to allow the fast distribution of knowledge and efficient collaboration between institutions.

- *Application of data of extreme quantities*: the SZTAKI solved the problems of indexing and searching of billions of pages, terabyte-scale data by using scalable machine learning techniques. They also gave solutions to the identity resolution of customer database consisting of more than 100 million records. The industrial applications in this field are also remarkable: customer relations (AEGON), Web analytics (archives, surveys, market research), social media (Hungarian Telekom, Vodafone), city design and navigation (NavNGo).
- *Social intelligence and mobile internet applications*: A context-oriented middleware was developed during the Mobile Innovation Centre project. The SZTAKI Dictionary was reformed, and now it can be considered the new platform of creating social dictionaries. The DONAU system developed for RICOH (Japan) was based on an entirely industrial order. The web4us system (by Web4us Software und Services GmbH) was developed and put on the market as the continuation of the Web4Groups' EU project.
- *Visual information analysis*: A research (e-science) platform was developed that can combine and test many image and semantic search algorithms. In a distributed environment the indexing and searching of about 10 million images can be achieved effectively. In the area of "swarm intelligence" tracking methods using many cameras were developed.

b)   Relationship between science and society

The previous paragraphs support that 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; Materials and new Production Technologies; Factory of the Future, 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. In the framework of *Fraunhofer - SZTAKI* co-operation, established in the fields of production management and information sciences, the industrial utilization of applied research results based on theoretical results is successfully in progress.

The online dictionary service of MTA SZTAKI has been available for users for 16 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 service is updated by internal finance and based on the developed language technology and semantic technologies of internet services. Notable demonstrations organized in common with the BME were held in the 3D virtual studio of the institute. At the event *Researchers' Night 2011* the SZTAKI was represented by demonstrations at two sites. 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 37 granted projects and in 6 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.

Due also to the Fraunhofer-SZTAKI co-operation, their German connections have deepened further. Preparatory measures are in due course in the interest of signing similar frame-contracts with Bosch, Hitachi Yokohama Research Laboratory, and with wind turbine manufacturer, Gamesa, Spain.

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

The *International Academy for Production Engineering (CIRP)* held their 61st General Assembly in Budapest (21-27, August, 2011). The 60th anniversary of the most significant international organization in the fields of production engineering and –technology was celebrated at the event, with the participation of almost 550 noted representatives from research and industry and with 120 accompanying persons.

The event of the *9th European Workshop on Advanced Control and Diagnosis (ACD 2011)* (17-18, November), with the participation of almost 90 participants, sponsored by IEEE Control Systems Society was organized in co-operation with the BME. Also the event *CogInfoCom 2011 – 2nd International Conference on Cognitive Infocommunications* (7-9, July) with 80 talks was organized together with the BME**.** The *24th Annual Conference on Learning Theory (COLT 2011)* was organized in Budapest (9-11, July) with the participation of 80 researchers.

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). They make efforts to strengthen their strategic partnerships, and to establish new ones.

On the average, 20 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.

IV.   Brief summary of national and international research proposals, winning in 2011

In 2011 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):

ITSSv6　　　　IPv6 ITS Station stack for cooperative systems FOTs,
　　　　　　　(Edelmayer, András, FP7, 224 800 €, 2011-2014)

The project aims at elaborating mobile IPv6 communication protocol applicable in co-operative vehicle and transportation systems, and its extension with information regarding the geographic position of vehicles.

Visionair　　　VISION Advanced infrastructure for research,
　　　　　　　(Váncza, József, FP7, 172 910 €, 2011-2015)

A joint, European visualization infrastructure of world-standard, supporting scientific research is realised in the project. The institue is connected to the network with its interactive 3D virtual studio.

CAPINFOOD　　Improving the enabling environment and public awareness for innovation
　　　　　　　in the food sector in the South-East European countries through
　　　　　　　transnational collaboration, *(Haidegger, Géza, SEE, 153 064 €, 2011-2014)*

The improvement of innovation chances in the food sector in 9 South-East European countries is dealt with.

SMART　　　　Smart framework conditions for SMEs focused on Modern Industrial
FRAME　　　　Technologies, *(Kopácsi, Sándor, EU-CE, 246 390 €, 2011-2014)*

The aim of the project is to develop Central-European innovation networks, with focus on promising market technologies: materials, surfaces, technology-oriented processes, sensors and actuators, furthermore, their integration into products and production.

GLOBAL　　　　Extended curriculum for science infrastructure online,
Excursion　　　*(Lovas, Róbert, FP7, 63 344 €, 2011-2014)*

Project objective: to extend curriculum for natural science with e-infrastructure. The institute's share: Desktop Grid research**.**

SCI-BUS　　　　SCIentific gateway based user support,
　　　　　　　(Kacsuk, Péter, FP7, 690 387 €, 2011-2014)

Objective: Based on WS-PGRADE portal by the institute, development of a general-purpose DCI portal and based on this, creation of 27 application-specific portals, and their operation as service. Institute tasks: acting as co-ordinator, further development of WS-PGRADE portal and its extension to computing clouds.

CRISP　　　　　Cluster of research infrastructures and synergies in physics
　　　　　　　(Kacsuk, Péter, FP7, 50 000 €, 2011-2014)

9 ESFRI research infrastructures are joined by the project. Objective: to provide service of high quality in the European Research Area.

AgINFRA　　　　A data infrastructure to support agricultural scientific communities
　　　　　　　(Kacsuk, Péter, FP7, 320 000 €, 2011-2014)

Elaboration of a data infrastructure to support agricultural scientific communities. The institute's share to the project is based on their gUSE and WS-PGRADE products**.**

ACTUATION 2015   Modular electro mechanical actuators for ACARE 2020 aircraft and helicopters, (*Bokor, József, FP7, 314 640 €, 2011-2014*)
The project goal is to research electro-mechanical actuators not yet wide-spread in aviation due to the technology and high price, and to establish their development environment in the interest of realizing All-Electric Aircrafts.

VERYSCHOOL   Valuable energy for smart School,
(*Ilie-Zudor, Elizabeth, FP7, 125 975 €, 2011-2014*)
Objective: Elaboration of a frame-system aiming at accessing and improving energy-efficiency of school buildings.

RLW Navigator   Remote laser welding system navigator for eco & resilient automotive factories, (*Váncza, József, FP7, 295 400 €, 2012-2014*)
Objective: Design and operation of robot-based laser welding systems, effective based on technical, economic and environmental criteria, motivated by European car-manufacturers' demands.

PARAMTIGHT   Parameterized complexity and the search for tight complexity results,
(*Marx, Dániel, FP7, 1 150 000 €, 2012-2016*)
Objective: More exact understanding of the complexity of algorithmically difficult problems, with tools of parameterized complexity. Partly: the exact definition: how the different parameters of the task influence the time necessary for solving the problem. Partly: creating algorithms – with optimal dependence on operation time parameters.

INARMERA-ICT   Integrating Armenia Into Era: Information and Communication, Technologies, (*Demetrovics, János, FP7, 80 678 €, 2012-2015*)
Objective of the project, co-ordinated by the Informatics and Automation Institute, Armenian Academy of Sciences, primarily, joining the research activities of the institute, (and through them Armenia's) and the research programs by the EU.

PROACTIVE   Predictive reasoning and multi-source fusion empowering anticipation of attacks and terrorist actions in urban environments,
(*Havasi, László Rajmund, FP7, 313 240 €, 2012-2015*)

Objective of the consortium: Elaboration of a sensor-fusion decision support system predicting terrorist actions, reliable also in urban environments.

OTKA   Model-based analysis and diagnosis of nonlinear systems using first principles, (*Hangos, Katalin, 2011-2015, 22 028 eFt*)
Application of model-based systems for solving research problems in the fields of dynamic analysis and diagnostics of nonlinear systems, with the integration of thermodynamics, engineering, and systems- and control theory. Within the above, the examination of physically rational realizations of positive nonlinear systems and their structural stability, furthermore, the development of algorithms suitable for estimating the parameters of energetic- and quantum systems, based on optimisation.

NKTH-OTKA   Novel multimedia service layer with advanced optimisation techniques,
(*Szkaliczki, Tibor, 2011-2013, 14 761 eFt*)
Objective: application of formal and combinatorial optimisation methods in developing a novel distributive layer for multimedia use, able to handle the big bulks multimedia data of most different quality, aims and requirements. The distributing network optimises resource management, with respect to storing, processing and service.

OTKA   Comprehensive Remote Sensing Data Analysis
101598   (*Benedek, Csaba, 2012-2014, 11 999 eFt*)
Objective: Elaboration of new pattern-recognition and reconstruction methods for the uniform handling of different remote-sensed data and their automatic process. Models are prepared for common representations of shapes, hierarchical structures and change-classes, based on 2D aerial shots, radar pictures, and 3D LIDAR data.

OTKA   Kilo-processor array computing architectures in solution of complex
84267   computational intensive problems, (*Szolgay, Péter, 2011-2014, 21 871 eFt*)
Objective: elaboration of new algorithms in the world of chips with thousands of processors by making use of the all importance of physical and logical precedence in the cellular structure of the processor and memory blocks. Speed, dissipated power, area, computation accuracy, and the bandwidth of the access to external memory are the critical design parameters to be handled simultaneously.

V.   List of important publications in 2011

[1]   Bacsó, G. - Tuza, Z.: Optimal guard sets and the Helly property. **European Journal of Combinatorics** 32 : 28-32. (2011.)

[2]   Benedek, C.: Detection of soldering defects in printed circuit boards with hierarchical marked point processes. **Pattern Recognition Letters** (32) : 1535-1543. (2011.)

[3]   Bozóki, S. - Fülöp, J. - Koczkodaj, W.: An LP-based inconsistency monitoring of pairwise comparison matrices. **Math. and Computer Modelling** 54 : 789-793. (2011.)

[4]   Corinto, F. - Gilli, M. - Roska, T.: On full-connectivity properties of locally connected oscillatory networks. **IEEE Tr. on Circuits and Systems I** 58 (5) : 1063-1075. (2011.)

[5]   Csetverikov, D. - Fazekas, S. - Haindl, M.: Dynamic texture as foreground and background. **Machine Vision and Applications** 22 : 741-750. (2011.)

[6]   Csuhaj Varjú, E. - Oswald, M. - Vaszil, G.: PC grammar systems with clusters of components. **Int. J. of Foundations of Computer Science** 22 (1) : 203-212. (2011.)

[7]   Drótos, M. - Kis, T.: Resource leveling in a machine environment. **European Journal of Operational Research** 212 (1) : 12-21. (2011.)

[8]   Farkas, Z. - Kacsuk, P.: P-GRADE Portal: A generic workflow system to support user communities. **Future Generation Computer Systems** 27 (5) : 454-465. (2011. 05.)

[9]   Gerencsér, L. - Finesso, L.: A two-stage information criterion for stochastic systems revisited. **Automatica** 47 (12) : 2791-2795. (2011.)

[10]   Gyárfás, A. - Ruszinkó, M. - Sárközy, G. - Szemerédi, E.: Partitioning 3-colored complete graphs into three monochromatic cycles. **Electronic Journal of Combinatorics** 18 (#P53) : 1-16. (2011.)

[11]   Gyárfás, A. - Sárközy, G.: The 3-colour Ramsey number of a 3-uniform Berge cycle. **Combinatorics, Probability and Computing** 20 (1) : 53-71. (2011.)

[12]   György, A. - Kocsis, L.: Efficient multi-start strategies for local search algorithms. **Journal of Artificial Intelligence Research** 41 : 407-444. (2011.)

[13]   Kacsuk, P. - Kovács, J. - Farkas, Z. - Marosi, A. - Balaton, Z.: Towards a powerful European DCI based on desktop grids. **J. of Grid Computing** 9 (2) : 219-239. (2011.)

[14]   Kecskeméti, G. - Terstyánszky, G. - Kacsuk, P. - Németh, Z.: An approach for virtual appliance distribution for service deployment. **Future Generation Computer Systems** 27 (3) : 280-289. (2011.)

[15]   Kovács, A. - Erdős, G. - Viharos, Z. - Monostori, L.: A system for the detailed scheduling of wind farm maintenance. **CIRP Annals – Manufacturing Technology** 60 (1) : 497-501. (2011.)

[16] <u>Kovács, A.</u> - <u>Kis, T.</u>: Constraint programming approach to a bilevel scheduling problem. **Constraints** 16 (3) : 317-340. (2011.)

[17] <u>Kovács, A.</u>: Optimizing the storage assignment in a warehouse served by milkrun logistics. **International Journal of Production Economics** 133 (1) : 312-318. (2011.)

[18] <u>Mészáros, C.</u>: Solving quadratically constrained convex optimization problems with an interior-point method. **Optimization Methods & Software** 26 (3) : 421-429. (2011.)

[19] Poussot-Vassal , C. - Sename, O. - Dugard, L. - <u>Gáspár, P.</u> - <u>Szabó, Z.</u> - <u>Bokor, J.</u>: Attitude and handling improvements through gain-scheduled suspensions and brakes control. **Control Engineering Practice** 19 (3) : 252-263. (2011.)

[20] <u>Rödönyi, G.</u> - <u>Gáspár, P.</u>: Iterative design of structured uncertainty models and robust controllers based on closed-loop data. **IET Control Theory & Applications** 4 (12) : 2823-2836. (2010.)

[21] Rojas, C. - Hjalmarsson, H. - <u>Gerencsér, L.</u> - Martensson, J.: An adaptive method for consistent estimation of real-valued non-minimum phase zeros in stable LTI systems. **Automatica** 47 : 1388-1398. (2011.)

[22] <u>Szabó, Z.</u> - Marcos, A. - Mostaza Prieto, D. - Kerr, M. - <u>Rödönyi, G.</u> - <u>Bokor, J.</u> - Bennani, S.: Development of an integrated LPV/LFT framework: modeling and data-based validation tool. **IEEE Tr. on Control Systems Techn.** 19 (1) : 104-117. (2011.)

[23] <u>Szederkényi, G.</u> - <u>Hangos, K.</u> - <u>Péni, T.</u>: Maximal and minimal realizations of reaction kinetic systems: computation and properties. **Match-Communications in Mathematical and in Computer Chemistry** 65 (2) : 309-332. (2011.)

[24] <u>Szederkényi, G.</u> - <u>Hangos, K.</u>: Finding complex balanced and detailed balanced realizations of chemical reaction networks. **Journal of Mathematical Chemistry** 49 (6) : 1163-1179. (2011.)

[25] Szolgay, D. - <u>Szirányi, T.</u>: Optimal stopping condition for iterative image deconvolution by a new orthogonality criterion. **Electronics Letters** 47 (7) : 442-444. (2011.)

[26] Tapolcai, J. - Ho, P. - <u>Rónyai, L.</u> - Babarczi, P. - Wu, B.: Failure localization for shared risk link groups in all-optical mesh networks using monitoring trails. **Journal of Lightwave Technology** 29 (10) : 1597-1606. (2011.)

[27] Tapolcai, J. - Wu, B. - Ho, P. - <u>Rónyai, L.</u>: A novel approach for failure localization in all-optical mesh networks. **IEEE/ACM Tr. on Networking** 19 (1) : 275-285. (2011.)

[28] <u>Váncza, J.</u> - <u>Monostori, L.</u> - Lutters, D. - Kumara, S. - Tseng, M. - Valckenaers, P. - Van Brussel, H.: Cooperative and responsive manufacturing enterprises. **CIRP Annals – Manufacturing Technology** 60 (2) : 797-820. (2011.)

[29] <u>Zarándy, Á.</u> - Rekeczky, C.: 2D operators on topographic and non-topographic architectures-implementation, efficiency analysis, and architecture selection methodology. **Int. J. of Circuit Theory and Applications** 39 (10) : 983-1005. (2011.)