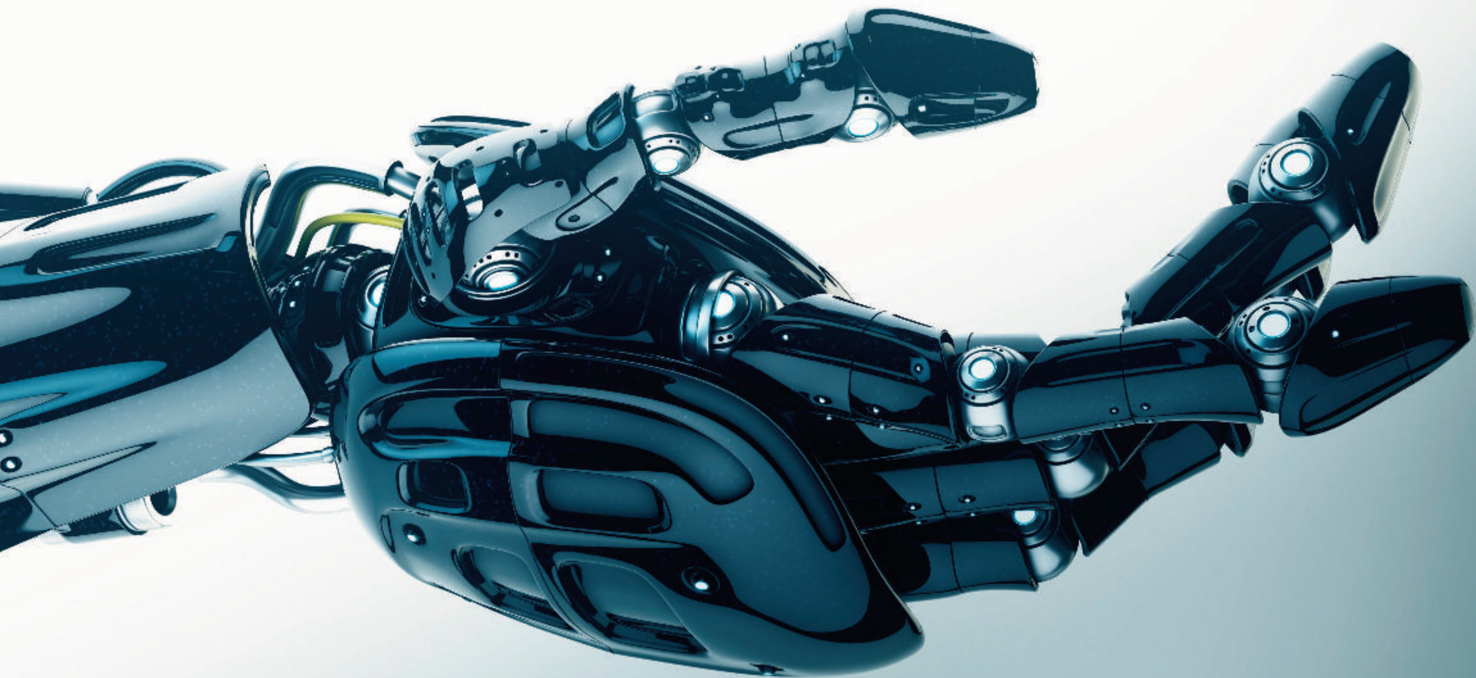
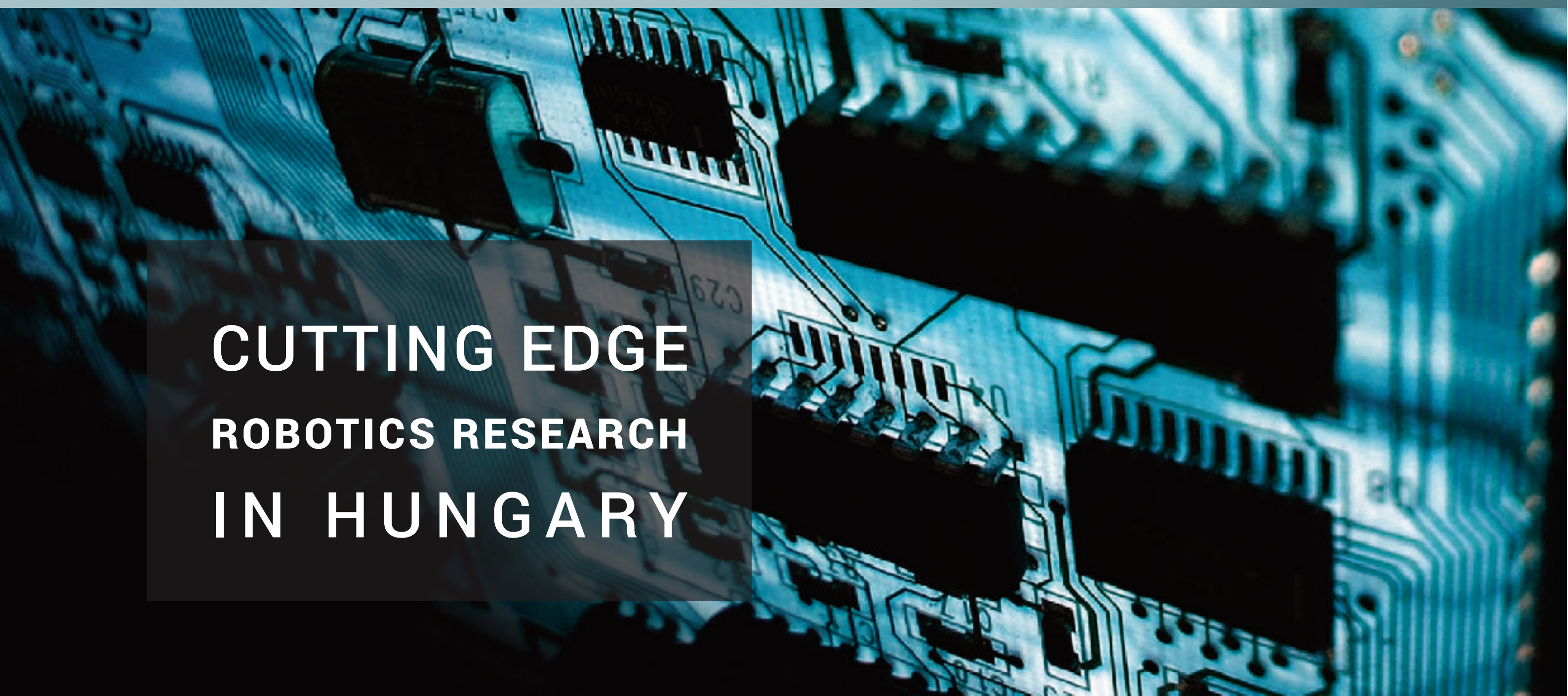
REPORT

2012-17



ANTAL BEJCZY CENTER
FOR INTELLIGENT ROBOTICS



CUTTING EDGE
ROBOTICS RESEARCH
IN HUNGARY

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WELCOME AND MESSAGE INTRODUCTION

The Antal Bejczy Center for Intelligent Robotics is proud to be in its 5th year of existence. It was a founding member organization of the University Research, Innovation and Service Center at Óbuda University. In the past years, the Laboratory has developed its laboratory space, recruited its members and became one of the most significant robotics research facilities of the region with state-of-the-art infrastructure for medical, industrial and general service robot applications. The past two years brought us to real breakthroughs—worth to be documented.

Improvements are not limited to the physical conditions. By the beginning of 2017, with the leadership of 5 senior researchers, 7 Ph.D. aspirants and more than 20 graduate and undergraduate students, the Bejczy Lab reached an important milestone on the way to complete its mission: becoming a European center of excellence in robotics research and innovation. However, this goal can only be reached through deep integration in the international robotics community. Following the good practice of Prof. Imre Rudas—the founding father of the Bejczy Lab—we are taking an active role in the movement of relevant domestic and international societies e.g., IEEE, ERF, John von Neumann Computer Society, to name a few. Furthermore, with proactive effort, the CELLI (Central European Living Lab for Intelligent Robotics) was called to life, and being operated under the leadership of the prominent people of the IROB center, in order to generate the critical mass for the better visibility at European level.

An important achievement of the past year was the establishment of our FabLab, an open workshop for all innovation-minded creators of the Óbuda University. In this little 'shrine', a great inventory of tools and equipment was made available, including 3D printers, benchtop machine tools and electronic instruments were installed to serve our dynamic community.

Our current focus is twofold: on the one hand, to further expand our exceptional human resources, and to increase our domestic and European presence in funding programs. We will continue the cooperation with regional and global robotics-related companies (ACMIT, KUKA, FANUC, etc), creating more space for joint research and student internship programs.

We are convinced that robotics and the related scientific disciplines are becoming a major accelerator factor in the economic changes of the forthcoming decades. In 2017, and beyond, people at Bejczy Lab will continue working hard to benefit from this trend, and give back as much as possible.
This report is an expression of our gratitude to all of our supporters and promoters, while it is also a standing invitation to its readers to learn more about our activities, and also to visit us, and let us discuss how we can further contribute to our closer and wider community.

Prof. József Tar & Dr. Péter Galambos
IROB Directors

OUR PLACE IN THE **R&D ECOSYSTEM**

The Antal Bejczy Center for Intelligent Robotics (IROB) is one of the knowledge centers of the University Research, Innovation and Service Center (EKIK) that opened its gates in 2014, aiming to spread knowledge, serve innovation, and to put forward research and development. The strategic goal of EKIK is to support the research of young Ph.D. students, to create the conditions of the intelligent learning and research and to develop an internationally recognized research center.

The center is directed by a board of five persons, led by Prof. Dr. Imre Rudas, former president of Óbuda University. Prof. Rudas was elected as a tribute for his internationally outstanding work in research, development and innovation. The other four members of the board are Prof. Dr. József Bokor, Ádám Merényi, Prof. Dr. József Tar and Dr. Tamás Haidegger.

EKIK is unique within Óbuda University, and even on a national level. It consists of 10 knowledge centers, and this number is constantly increasing. At this point, the following centers are involved:

- Antal Bejczy Center for Intelligent Robotics
- Bio-Tech Research Center
- Physiological Controls Research Center
- Carpathian Onlince Education Center
- SmartLab Center
- Alternative Energy Sources Research Center
- Digital Culture and Human Technology Center
- Security Science Center
- Center for Organizing Scientific Activities
- Electric Power Conversion Systems Research Center

EKIK participates in the development of technology, focusing on novel tools and research environment, linking with appropriate control structures and user interfaces, helping the application of these technologies to serve the greater society. It provides application, interface and infrastructure for the partners and the external contractors. The key to its success is the ability to bring together the theoretical R&D and the practical applications.

EKIK grants benefits for its members through integrated research projects, exchange programs, common publications and EU projects, which makes it easier for the industrial partners to access the new technologies, providing new applications and services to a wider public.

ORGANIZATION STRUCTURE

University Research, Innovation and Service Center Board of Governors

Prof. Dr. Imre Rudas, president
Prof. Dr. József Tar
Dr. Tamás Haidegger
Prof. Dr. József Bokor
Ádám Merényi

University Research, Innovation and Service Center Council

Directors of centers

University Research, Innovation and Service Center Director

Prof. Dr. József Tar

Antal Bejczy Center for Intelligent Robotics

FabLab

Dr. Péter Galambos

Bio-Tech Research Center

Dr. Miklós Kozlovszky

Physiological Controls Research Center

Prof. Dr. habil Levente Kovács

Carpathian Online Education Center

Dénes Száraz

SmartLab Center

Dr. Imre Felde

Alternative Energy Sources Research Center

Dr. Péter Kádár

Digital Culture and Human Technology Center

Dr. Rita Ősz

Security Science Center

Dr Tibor Babos

Center for Organizing Scientific Activities

Prof. Dr. Aurél Galántai

Electric Power Conversion Systems Research Center

Prof. Dr. István Vajda

ABOUT ANTAL BEJCZY

Prof. Bejczy is probably the best known Hungarian roboticist in the world. Born in Hungary in 1930, he graduated from high school in Kalocsa with excellence in 1948. Then he started electrical engineering studies at the Technical University of Budapest. He left Hungary in 1956 due to the failing revolution against the Soviets and went to Norway, where he received a Ph.D. degree with excellence in applied physics at the University of Oslo, Norway, in 1963. He was teaching at that university until 1966.

He went to CALTECH in California with a NATO/Fulbright fellowship as a Senior Research Fellow in 1966, working on optimal control and nonlinear filtering problems. First, just attending as a lecturer, he joined the NASA Jet Propulsion Laboratory (JPL) as a Member of the technical staff in 1969. Robotics and its application in space exploration became his major research interest at JPL.

He initiated work on sensing based intelligence in robot control, published over 160 technical papers and 11 book chapters on topics in sensing, dynamic modeling, control, telepresence, virtual environments, and human-machine interaction in robotics. He became a senior research scientist in 1985 and was a technical manager of the robotics program at JPL for eight years. He was the principal investigator of a robot arm force-torque sensor flight experiment on the Space Shuttle in 1994. He was a senior lecturer at CALTECH, and also an affiliate professor in systems science and mathematics at Washington University, St. Louis, MO from1983 on, with the duty of establishing and maintaining graduate studies in robotics. There he supervised ten Ph.D. students in their work in robotics in eleven years.

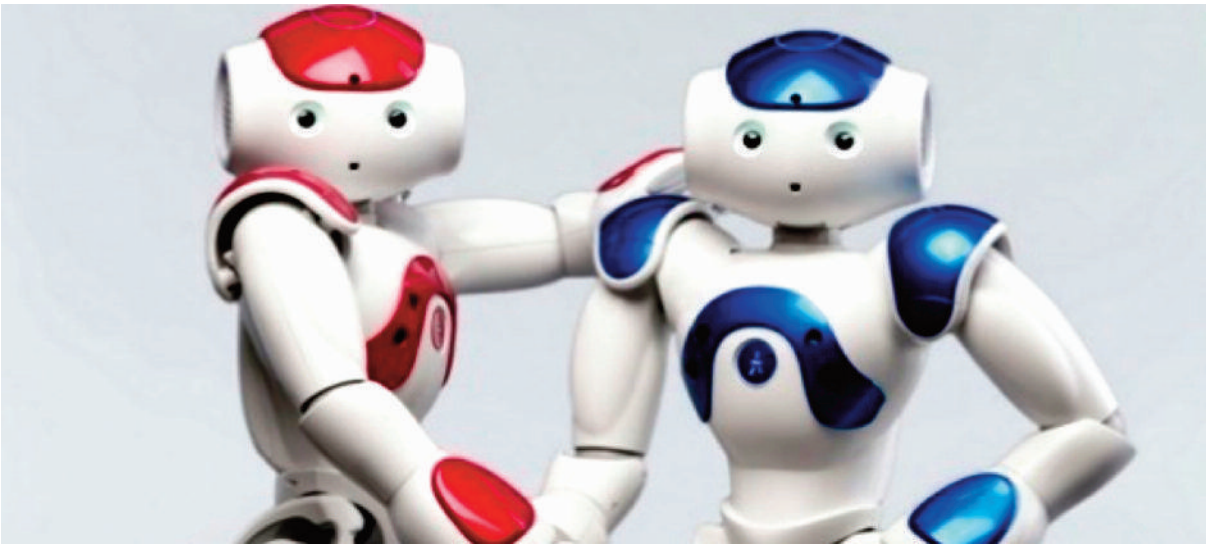
Prof. Bejczy was a frequent organizer of tutorials, workshops and sessions on robotics at the conferences of the Institute of Electrical and Electronics Engineers (IEEE). He gave lectures on robotic topics at twenty-four universities in nine countries. He was chairman of the IEEE Control System Society Technical Committee on Robotics and Automation from 1983 to 1985, general chairman of the IEEE International Conference on Robotics and Automation in San Francisco, CA in 1986, and president of the IEEE Council of Robotics and Automation in 1987 when he helped transform the Council to the current IEEE Robotics and Automation Society (RAS) with about thirteen thousand members. He served as a member of the governing board for the IEEE RAS during 1989–1991, and re-elected for 1994–1999. He was the general chair of the 8th International Conference on Advanced Robotics (ICAR) in Monterey, CA in 1997 and the general co-chair of the 10th ICAR in Budapest, Hungary in 2001, and program co-chair for the 11th ICAR in Coimbra, Portugal, in 2003. He received 43 NASA innovation awards and had 7 U.S. patents. He received the IEEE Fellow grade in 1987 for "Contributions to the theory and applications of robotics," the Jean Vertut Award of the SME&RI for "Remote application of robotic technology" in 1991, the NASA Exceptional Service Medal in 1994, the NASA Flight Experiment Achievement Award in 2000, the IEEE Third Millennium Medal, and in 2004, the IEEE RAS Pioneer Award.

He served as a curatorial member of the Zoltan Bay Foundation for Applied Sciences in Budapest from 1993 till 1999. He received the Gabor Baross and György Széchenyi awards in Hungary in 1997 and 1998, recognizing his scientific and technological accomplishments and loyalty to his Alma Mater. He is also an honorary professor at the Bánki Donát Polytechnic in Budapest since 1999. He visited Budapest and our university every year. He retired from JPL in October 2001 after 32 years of service but continued lecturing and consulting work. He was together with his wife, Margit, for 50 years. Tony Bejczy passed away in Pasadena, CA in June 2015. His lasting memory stays with us forever.

THE IROB CENTER'S **BRIEF HISTORY**

The Antal Bejczy Center for Intelligent Robotics has officially opened its gates in September 2012. The event attracted numerous experts from the field of robotics from Hungary and abroad. As a part of Óbuda University's University Research, Innovation and Service Center, the IROB has found its home in the Kiscelli Street building. The founders have laid its main objectives in integrating the research areas in the field of robotics at the university, reforming concepts in questions of education and research, collaborating in joint development projects with other departments, university centers and many others.

In December 2013, the Center held its first public Open House event, joining hundreds of laboratories within the frames of the European Robotics Week, organized by the euRobotics aisbl association. During the past years, the Center has participated in countless national and international scientific and public events, and with its ever-growing robot infrastructure, it has attracted students, researchers and experts to collaborations and projects from all over the world.



2012 September	**The opening of IROB**
2013 December	**The first IROB Open House event**
2014 February	**Our fist robots (4 NAOs) have arrived**
2014 July	**The KUKA youBot project started**
2014 August	**The da Vinci Surgical System was installed**
2015 February	**International Bejczy Colloquium**
2016 January	**1st Bejczy Day**
2016 March	**The opening of the FabLab**
2016 August	**Our KUKA iiwa arm arrived**

IROB **MEMBERS**

IMRE **RUDAS**

Professor Rudas is a Doctor of Science of the Hungarian Academy of Sciences, former President of Óbuda University. He is an IEEE Fellow and a Distinguished Lecturer, holder of the Order of Merit of the Hungarian Republic and numerous international and national awards. He is the board member of several international scientific societies, member of editorial boards of international scientific journals, leader of R&D projects, author of more than 650 publications. He is the organizer of a vast number of technical conferences worldwide in the field of robotics, fuzzy logic and system modeling.

JÓZSEF KÁZMÉR **TAR**

Professor József Tar has graduated as a physicist at Eötvös Loránd University in 1981. He has become a researcher physicist in 1981 in the Research Institute of TUNGSRAM Co. Ltd. and later a senior expert from 1986 to 1989 in the Centre of Robotics and Automation of TUNGSRAM. He has gained the degree of university doctorate in atomic and molecular physics and quantum optics in 1984 and Ph.D. in robotics in 1989. He was a scientific advisor at University of Veszprém. He has begun to work for Bánki Donát Polytechnic in 1993. From September 1994 he participated in the educational program of the Polytechnic supervised by Nottingham Trent University, UK. He has become a professor at Bánki Donát Polytechnic in 1997. The same year he won the “Széchenyi Professorial Scholarship” for four years in Hungary. In 2000 he became a professor at Budapest Polytechnic. From 2001 he is an Invited Member of the Educational Staff of the Doctoral School of University of Veszprém. From 2004 to 2005 he was an institute deputy director and from 2006 to 2008 a Program Manager at Budapest Tech. From 2010 to 2012 he was the Director at the Transportation Informatics and Telematics Knowledge Center. In 2010 he became an Associate Professor and project leader at Óbuda University. Since 2011 he is Full Professor at Óbuda University. He has gained the level DSc (doctor of the Hungarian Academy of Sciences) in 2012. From 1st October 2012 he is the Director of the “Antal Bejczy Center for Intelligent Robotics” at Óbuda University.

JÁNOS **SOMLÓ**

Prof. Dr. János Somló was born in 1935 in Hungary. He earned the DSc (Doctor of Science) degree from the Hungarian Academy of Sciences in 1983. His research interest includes control engineering, optimization of metal cutting process, production scheduling, robot kinematics and dynamics. As a professor, he educated generations of engineers for robotics in Hungarian, Russian and English languages. Under his supervision, 9 Hungarian and foreign students earned the Ph.D. degree so far. Author of more than 140 scientific publications, 3 books and contributed to several course materials. Today, he works as professor emeritus at Óbuda University and supports the scientific activity with his unique experience in robotics research.

PÉTER **GALAMBOS**

Péter Galambos received his M.Sc. and Ph.D. degrees in mechanical engineering from the Budapest University of Technology and Economics (BME) in 2006 and 2013 respectively. He was a Research Intern at the Toshiba Corporate Research and Development Center from 2007 to 2008, then joined to the Institute for Computer Science and Control, Hungarian Academy of Sciences (MTA-SZTAKI), where between 2010 and 2012, he held a "Young Researcher" Scholarship of the Hungarian Academy of Sciences. From 2011 to the end of 2015 he served as a team leader in MTA SZTAKI and coordinated the development of the VirCA VR system and its research applications. He has joined the Óbuda University in 2013 where he participates in robotics-related R&D activities and education. He is currently the director of the Antal Bejczy Center for Intelligent Robotics (Óbuda University, Budapest, Hungary). His current research interest includes telerobotics, networked control systems, nonlinear and time-delayed feedback systems and 3D Virtual Reality-based collaboration.

TAMÁS **HAIDEGGER**

Tamás Haidegger received his M.Sc. degrees from the Budapest University of Technology and Economics (BME) in Electrical Engineering and Biomedical Engineering in 2006 and 2008, respectively. His Ph.D. thesis (2011) was based on a neurosurgical robot he helped develop when he was a visiting scholar at the Johns Hopkins University. His main field of research is control/teleoperation of surgical robots, image-guided therapy and supportive medical technologies. Currently, he is an associate professor at the Óbuda University, serving as the deputy director of the Antal Bejczy Center for Intelligent Robotic. Besides, he is a research area manager at the Austrian Center of Medical Innovation and Technology (ACMIT), working on minimally invasive surgical simulation and training, medical robotics and usability/workflow assessment through ontologies. Tamás is the co-founder and CEO of a university spin-off (HandInScan) focusing on objective hand hygiene control in the medical environment. They are working together with Semmelweis University, the National University Hospital Singapore and the World Health Organization. Tamás is an active member of various other professional organizations, including the IEEE Robotics and Automation Society, IEEE EMBC, euRobotics aisbl and MICCAI. He is a national delegate to an ISO/IEC standardization committee focusing on the safety and performance of medical robots. He has co-authored more than 160 peer reviewed papers published at various scientific meeting and conference proceedings, refereed journals and books in the field of biomedical/control engineering and computer-integrated surgery. He has been maintaining a professional blog on medical robotic technologies for over 8 years: surgrob.blogspot.com.

GÁBOR **HEGEDŰS**

Gábor Hegedűs was graduated as a mathematician at the Eötvös University, he has written his master's thesis about psi-Mahlo cardinals with the support of János Kristóf. In 2001 he became a Ph.D. student at the Applied Mathematical Doctoral School of Budapest University of Technology and Economy. He has studied the Gröbner bases and standard monomials of the ideals of finite set of points with the support of his thesis advisor, Prof. Lajos Rónyai. In 2005 he finished his Ph.D. thesis „Gröbner basis in combinatorics". Here he worked out a completely new research direction: they connected the description of the standard monomials of the ideals of finite set of points with the linear algebra bound method and the James theory. In 2006 he became a COMBSTRU student at Charles University in Prague. Since 2006 he worked for Kecskemét College as a junior lecturer (later as a senior lecturer). In 2009 he became a postdoc young researcher in RICAM in Linz. In 2013 he applied successfully for a docent position at the Óbuda University John von Neumann Faculty.

TIVADAR **GARAMVÖLGYI**

Tivadar Garamvölgyi is working as chief FabLab engineer at the Antal Bejczy Center for Intelligent Robotics. His deep experience in machine design, metal and polymer manufacturing technologies and mechatronics makes him a swiss knife in our prototyping projects. He studied mechanical engineering at the Budapest University of Technology. During his studies, he worked as head of workshop at the Department of Polymer Engineering then moved to the field of Building Service Engineering where he supervised many challenging projects over 13 years of self-employed entrepreneurship. In 2016, he joined us to be the master of our community workshop that serves all creative brains of Óbuda University.

TAMÁSNÉ **SZABÓ**

Tamásné Szabó received her M.Sc. degree in economy at the University of Economics, Budapest, Hungary in 1982. From 1980-1985 she was the organizer of working process in the Textil Factory Kőbánya and in 1986 at the Metrimpex Company of Foreign Trade. In 1987-1988 she was an internal administrative supervisor at MINO Boot and Shoe Factory; from 1988-1989 at Budapest district 4 she worked as an organizer of working process at Real Estate Trustee Enterprise. She worked as a leader of secretariat in the Zichy Art Gallery from 1989 to 1993 and from 1994 to 1995 at Europapier Hungary Ltd. From 1996-2007 she worked as an accountant and leader of administration at Book-keeping Company. Since 2009, she is an assistant of the Rector and assistant of the Head of University Research, Innovation and Service Center at Óbuda University (and its predecessor: Budapest Technical College).

KRISZTINA **GERESDI**

Krisztina Geresdi got her B.Sc. degree in Light Industrial Engineering in Quality management of engineering specialization at Óbuda University, Sándor Rejtő Faculty of Light Industry Engineering in 2007. She received her M.Sc. degrees in Economics in Business Development specialization (2015), and Economics in Management and Leadership specialization (2016) at University of West Hungary, Faculty of Economics. Currently, she is a business administrator at the Research and Innovation Centre of Óbuda University. Her area of activity includes economic performance of the administrative tasks of the research center and related knowledge centers.

ÁRPÁD **TAKÁCS**

Since 2013, he is a Ph.D. student of the Doctorate School of Applied Informatics and Applied Mathematics at Óbuda University. He received his undergraduate and graduate degrees at the Department of Mechanical Engineering at Budapest University of Technology and Economics from mechatronics engineering and mechanical engineering modeling, respectively, both with an honorary degree. During his graduate studies, his research was mostly concentrated on parametrically excited mechanical systems, their mathematical description and stability analysis. In 2012, owing to the EU-Atlantis program and the scholarship of the Rosztoczy Foundation, he became a visiting student and research scholar of New Mexico State University in NM, USA. During this period, he came to know about time-delayed systems and his master's thesis was written about his combined knowledge to that point in the application of vibration modeling in milling and turning applications. Besides time-delayed systems, his current research area includes surgical robotics and teleoperation, particularly focusing on mechanical models of tool-tissue interaction.

JÓZSEF **KUTI**

József Kuti received his B.Sc. and M.Sc degrees in mechatronical engineering from the Budapest University of Technology and Economics (BME) in 2011 and 2013, respectively. In 2013 he won first prize at National Scientific Students' Associations Conference and MTA Young Researcher Scholarship. From 2014 he is Ph.D. Student. From 2013 he worked as research assistant at the Institute for Computer Science and Control, Hungarian Academy of Sciences (MTA-SZTAKI), in 2016, he joined the Antal Bejczy Center for Intelligent Robotics at Óbuda University. His research interest includes LPV/qLPV modeling, TP model transformation and Linear Matrix Inequality based control design of nonlinear and time delay systems and the corresponding linear algebraic, higher dimensional geometric questions and numerical optimisation.

DÉNES ÁKOS **NAGY**

Dénes Ákos Nagy MD first received his computer engineering degree (B.Sc.) from Pázmány Péter Catholic University in 2012. His thesis focused on modeling the image processing in the human retina. Parallel to his computer engineering studies, he also started his medical degree and graduated as a medical doctor in 2015. During the university, he participated in several medical internship programs (Internal medicine—Indonesia, Surgery—Bulgaria). After finishing his computer engineering degree, he worked one year for Femtonics Ltd. on 2 photon microscope control softwares, which he left when he received the HAESF internship. With this internship, he spent one year in Washington, DC (USA) researching medical image registration methods. After he finished his MD, Dénes's focus turned towards surgical robotics and started his Ph.D. at the Antal Bejczy Center for Intelligent Robotics (IRob).

BENCE **TAKÁCS**

Bence Takács received his B.Sc. degree in Electrical Engineering in 2014, M.sc. degree in Computer Science and Engineering in 2016. During his study, he was member of several robotics team for robot competitions (Design Challenge, euRathlon, Competition of Applied Scientific Engineering). After B.Sc. graduation he joined to Antal Bejczy Center for Intelligent Robotics. Since September 2016, he is a Ph.D. student of the Doctoral School of Applied Informatics and Applied Mathematics at Óbuda University.

TAMÁS DÁNIEL **NAGY**

Tamas Daniel Nagy earned his bachelor's degree in Molecular Bionics in 2014, and master's degree in Computer Science Engineering in 2016 at the University of Szeged. During his university studies he joined the Noise Research Group, where he worked on physiological measurements, signal processing and those application in telemedicine. Furthermore, he was employed as a demonstrator on laboratory practices. After graduation, he was hired as a technical assistant by Department of Software Engineering at the University of Szeged for six months, where he worked in cooperation with Noise Research Group on projects related to medical signals and telemonitoring. Since September 2016, he is a Ph.D. student of the Doctoral School of Applied Informatics and Applied Mathematics at Óbuda University, he is currently working on the analysis and low level automation of movement patterns in robot surgery interventions.

RENÁTA **ELEK**

Renáta Elek received her B.Sc. degree in molecular bionics engineering and M.Sc. degree in info-bionics engineering from the University of Szeged Faculty of Science and Informatics in 2015 and 2017, respectively. At the start of her M.Sc. studies she gets acquainted with surgical robotics, she joined to the Antal Bejczy Center for Intelligent Robotics surgical robotics group; during her master studies, she worked on image-based camera control methods. Since February 2017, she is a Ph.D. student at Óbuda University and she is working on computer vision methods in the field of surgical subtask automation.

SÁNDOR **TARSOLY**

Sándor Tarsoly received his M.Sc. degree in mechanical engineering from the Budapest University of Technology and Economics (BME) in 2008. He started his career as a value analyst and tender accountant. Later, he worked as a production technologist, then in 2013, he has joined to the 3D Internet-based Control and Communications Laboratory (3DICC) of the Hungarian Academy of Sciences – Institute for Computer Science and Control as a software engineer. From the spring of 2017 is a member of the Antal Bejczy Center for Intelligent Robotics at Óbuda University, where he is responsible for design and development of collaborative robot applications and cloud robotics solution development and Industry 4.0 scenarios.

ROLAND **DÓCZI**

Roland Dóczi received his B.Sc. degree in Engineering Information Technology in 2014 from the University of Debrecen. Now he is an Engineering Information Technology M.Sc. student at Óbuda University, Budapest. His main research areas are autonomous land and sea robots. In 2015, he joined to the Antal Bejczy Center for Intelligent Robotics, and he participated in several robot-related competitions (such as euRathlon 2015, ERL - Emergency Robots 2017, etc.) and conferences. During his studies, also joined several medical-engineering projects, in which eye and knee surgery robots and tools were developed.

MÁTYÁS **TAKÁCS**

Mátyás Takács received his B.Sc. degree in Mechatronical Engineering from Óbuda University in 2017. His thesis focused on collaborative robotics and human-robot interaction. During his B.Sc. studies, he won first prize at Scientific Students' Associations Conference. Right after graduation, he joined the Antal Bejczy Center for Intelligent Robotics. Since September 2017, he has been an M.Sc. student in faculty Computer Engineering at Óbuda University. His research interest is robotics and automation.

IROB **ASSOCIATES**

LEVENTE **KOVÁCS**

Dr. habil. Levente Adalbert Kovács got his M.Sc. degree in electrical engineering at "Politehnica" University of Timişoara in 2000. He received his Ph.D. from Budapest University of Technology and Economics (BME) in 2008, the Ph.D. thesis title is „New principles and adequate control methods for insulin dosage in case of diabetes". From 2005 he was a full-time instructor at BME, Department of Control Engineering and Information Technology; from 2010 he is an associate professor. In 2012 he was awarded the János Bolyai Research Fellowship of the Hungarian Academy of Sciences. From 2012 he is an associate professor in Óbuda University, John von Neumann Faculty of Informatics, Information Technology Institution; and the vice dean for education in Óbuda University, John von Neumann Faculty of Informatics. He is an IEEE member from 2009, and IFAC TC 8.2 "Biological and Medical Systems" member form 2010. His fields of interest are modern control theory and physiological controls—in these subjects, he was published more than 130 articles in international journals and refereed international conference papers.

LÁSZLÓ **HORVÁTH**

László Horváth is Professor Emeritus in multidisciplinary modeling of engineering systems at the Óbuda University. He received M.Sc. in 1971, Dr. Techn. degree in 1984, and Ph.D. in 2002 from the Technical University of Budapest. He received his CSc. degree from the Hungarian Academy of Sciences in 1993, and the Dr. habil. degree from the University of West Hungary in 2004 in intelligent engineering systems. He acted as full university professor between the years 2007-2015 at the Óbuda University. His main research results are in integration of engineering models, multidisciplinary modeling of product systems, and human intended active knowledge representation in engineering model. He is founder of the Laboratory of Intelligent Engineering Systems for high abstraction based modeling of engineering systems. He is active as professor and researcher at the Institute of Applied Mathematics, John von Neumann Faculty of Informatics and the University Research and Innovation Centre of the Óbuda University. He served as leader in numerous national and international research projects. Professor Horváth is author or co-author of more than 300 scientific publications and received 270 independent citations. He is core staff member of the Doctoral School of Applied Informatics and Applied Mathematics at the Óbuda University. He received senior member grade from IEEE and served as chair or member of program committees at numerous major international conferences.

GYULA **HERMANN**

Dr. Gyula Hermann was born in 1946 in Hungary. He earned M.Sc. degree in electrical engineering at Delft University of Technology, Ph.D. degree in mechanical engineering at Budapest University of Technology and Economics and he habilitated in 2011. Since 2000 he is an associate professor at Óbuda University. His research areas are high precision micro and macro geometric measurement technologies and control of manufacturing equipments and manufacturing systems.

EKIK BOARD

HONORARY COMMITTEE OF EKIK

GERD **HIRZINGER**

Gerd Hirzinger, director of the Institute of Robotics and Mechatronics at the German Aerospace Center in Wessling, Germany

LOTFI A. **ZADEH**

Lotfi A. Zadeh was a Professor in the Graduate School, Computer Science Division, Department of EECS, University of California, Berkeley.

ENDRE **SZEMERÉDI**

Endre Szemerédi has been the State of New Jersey Professor of computer science at Rutgers University since 1986.

MASAYOSHI **TOMIZUKA**

Masayoshi Tomizuka is a professor in Control Theory in Department of Mechanical Engineering, University of California, Berkeley.

HONORARY COMMITTEE OF IROB

FUMIO **HARASHIMA**

Fumio Harashima is President of the Tokyo Metropolitan University and Professor Emeritus of University of Tokyo.

MO **JAMSHIDI**

Mo Jamshidi is Endowed Professor at The University of Texas at San Antonio.

TOSHIO **FUKUDA**

Toshio Fukuda is Professor of Dept. of Micro and Nano System Engineering and Dept. of Mechano- Informatics and Systems, Nagoya University, Japan. He is director of Center for Micro and Nano Mechatronics.

INTERNATIONAL SCIENTIFIC BOARD

OUSSAMA **KHATIB**

Oussama Khatib is Professor of Computer Science at Stanford University.

PHILIP **CHEN**

Philip Chen is Dean and Chair Professor of the Faculty of Science and Technology at the University of Macau and Jr. Past President of the IEEE Systems, Man, and Cybernetics Society.

KEITH **HEIPEL**

Keith Heipel is Distinguished Professor of the University of Waterloo, Fellow of the Royal Society of Canada, the IEEE, the Canadian Academy of Engineering, the American Water Resources Association and Engineering Institute of Canada.

KAZUHIRO **KOSUGE**

Kazuhiro Kosuge is Professor in the Department of Bioengineering and Robotics at Tohoku University,

REN **LUO**

Ren Luo is Distinguished Professor in the Department of Electrical Engineering at National Taiwan University and President of Robotics Society of Taiwan.

BRUNO **SICILIANO**

Bruno Siciliano is a professor at the University of Naples and Director of the PRISMA Lab.

HAMIDO **FUJITA**

Hamido Fujita is a professor at Iwate Prefectural University (IPU), Iwate, Japan. He is director of ARISES (Advanced Research Institute on Software Strategies) and the director of Intelligent Software Systems.

PAOLO **FIORINI**

Paolo Fiorini founded the ALTAIR robotics laboratory in Verona. He is an IEEE Fellow, Corresponding Member of the Academy of Agriculture, Sciences and Letters.

PETER **SINČÁK**

Peter Sinčák is a full Professor in the Department of Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering, University of Technology, Kosice. He is the head of the Center for Intelligent Technologies and Head of Computational Intelligence Group.

VINCENZO **PIURI**

Peter Sinčák is a full Professor in the Department of Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering, University of Technology, Kosice. He is the head of the Center for Intelligent Technologies and Head of Computational Intelligence Group.

JACEK M. **ZURADA**

Jacek M. Zurada is a Professor of Electrical and Computer Engineering Department at the University of Louisville, Kentucky.

HUIJUN **GAO**

Huijon Gao is a Professor and director of the Research Institute of Intelligent Control and Systems at Harbin Institute of Technology.

INTERNATIONAL INDUSTRIAL BOARD

GERNOT **KRONREIF**

Gernot Kronreif is Chief Scientific Officer, Austrian Center for Medical Innovation and Technology.

THOMAS **STRODL**

Deputy manager of Department for Technology and Innovation at WKO, Vienna.

BERND **LIEPERT**

Dr. Bernd Liepert is the CINO of KUKA AG and since 2012, Dr. Liepert has been president of euRobotics AISBL – the European Robotics Association.

IROB FAST FACTS

PEER REVIEWED PUBLICATIONS

Journal papers: 73
Conference papers: 164

STUDENTS INVOLVED

Ph.D. students: 7
Graduate students: 22
Undergraduates: 11
Foreigner students: 30+

PARTICIPATION IN INTERNATIONAL AND NATIONAL GRANTS

National R&D grants: 3 successful
National and intl. R&D scholarships: 5

IROB MEMBERS' MAJOR AWARDS

2013 • Honoris Causa Award • Imre Rudas

2013 • Young Research Fellow of the Year—Óbuda University • Tamás Haidegger

2014 • Dennis Gábor Award • Tamás Haidegger

2014 • Campus Hungary Scholarship • Árpád Takács

2015 • IEEE Standards Association Emerging Technology Award • Tamás Haidegger

2015 • IEEE Robotics and Automation Award for Product Innovation • Tamás Haidegger

2016 • Young Research Fellow Publication Award—Óbuda University • Péter Galambos

2016 • Hungarian National Eötvös Scholarship—Tempus Public Foundation • Árpád Takács, Bence Takács

2017 • Antal Bejczy Student Publication Award • József Kuti

2017 • Hungarian Academy of Sciences—Bolyai Plaque for excellence in research • Tamás Haidegger

2017 • Dean's Merit • Tamás Haidegger, Péter Galambos

PROFESSIONAL AND COMMUNITIY SERVICE AND ACTIVITIES

Conf. co-organized by IROB and EKIK

IEEE International Symposium on Computational Intelligence and Informatics (CINTI)
IEEE International Symposium on Applied Computational Intelligence and Informatics (SACI)
IEEE International Symposium on Applied Machine Intelligence and Informatics (SAMI)
IEEE International Symposium on Intelligent Systems and Informatics (SISY)
IEEE International Joint Conferences on Computational Cybernetics and Technical Informatics (ICCC-CONTI)
IEEE International Conference on Intelligent Engineering Systems (INES)

Participation in international professional organizations

IEEE Robotics and Automation Society
IEEE Systems Men and Cybernetics Society
IEEE Industrial Electronics Society
IEEE Standards Association
IEEE Hungary Section
euRobotics aisbl
Intl. Standardization Organization, Intl. Electrotechnical Committee

Publishing/editorial service

Column editor for the IEEE Robotics and Automation Magazine (2016-2018)

Editor for the International Journal of Computer Assisted Radiology and Surgery (Springer), IF: 1.707 (2016-18)

Associate editor for IEEE Robotics and Automation Letters (2015)

Editorial board member: International Journal of Advanced Robotic Systems (INTECH), IF: 0.526 (2015)

Column editor for IEEE Robotics and Automation Magazine, IF: 2.413 (2014)

Associate Editor: OA Robotic Surgery (EIJARS), (2014)

Associate Editor/Track Chair for Acta Polytechnica Hungarica (Óbuda University), IF: 0.649 (2014-15)

Associate Editor for Journal of Infectious Diseases Letters, Bioinfo Publications (2013-16)

Associate Editor for World Research Journal of Medical Science, Bioinfo Publications (2013-16)

Guest editor of a special issue of the J. of Artificial Intelligence in Medicine on AI Methods in Telesurgery (2013)

Editor for Proc. of the MAVE-BME 1st Intl. Workshop on Computer-Integrated Surgery (2011)

Editor for Proc. of the BME-MATE CIS Mini-Symposia I-II. (in Hungarian) (2009)

Editor for International 24-hour Programming Contest (2000-2005): Problem Sets (2006)

Media presence

National TV interviews: Duna TV, M5, MTVA, HírTV, ATV, Novum TV, TV Vojvodina
National Radio interviews: Kossuth Radio, Mária Radio, Klub Radio
Articles in print magazines: Gyártástrend, Forbes, Hetek, Hírmondó, Manager Magazin
Online articles: origo.hu, vasarnapihirek.hu, eduline.hu, sztnh.gov.hu, hvg.hu, urvilag.hu, edupress.hu, kormany.hu

Invited talks

IEEE Space Robotics Workshop
Inauguration of the Semmelweis and Rómer Exhibition at UNESCO
Semmelweis University CVC, SMART Conference
OECD Forum
Ontologies for Robots Workshop at ERF16
Insurance Professionals' Conference, UniO–MANT Modern Space Robotics Workshop
Bimbo Club lectures, Summer School on Control of Surgical Robots
IEEE SMC Junior Conference
NJSZT DE Conference, TEDx Youth Budapest
ITSH10 workshop
AmCham Forum

Public demos and events

SIÓ advertisement
Retirement Home
Drone Race and Robotics Show
Exxon Mobile
European Pallet Association
Fujitsu Siemens Annual Events

List of national partners

Budapest University of Technology and Economics (BME, Budapest)
Semmelweis University (Budapest)
University of Pécs (Pécs)
Széchenyi István University (Győr)

List of international partners

Stanford University (California, USA)
"POLITEHNICA" University of Timişoara (Timişoara, Romania)
Austrian Center for Medical Innovation and Technology (ACMIT, Wiener Neustadt, Austria)
Taiwan National University (Taipei, Taiwan)
Queens University (Ontario, Canada)

Industrial partners and collaborations

Kwapil & Co
LabMagister Ltd.
KUKA Robotics Hungary Industrial Ltd.
FANUC Hungary Ltd.
OptoForce Ltd.
CNW System Integrator Co.

MAJOR **GRANTS**

The IROB research staff has gained relevant R&D experiences on various fields of robotics with special focus on nonlinear control (time delay systems, polytopic modeling and control), surgical applications and benchmarking, component-based modular robot software (ROS, RT-Middleware, VirCA). Research fellows of IROB have strong commitment to robotics standardization (active in committees of ISO, IEC, IEEE and euRobotics). They also play key role in the development of the VirCA (Virtual Collaboration Arena) extensible modular software platform focusing on intelligent robotic systems.

Due to its extensive laboratory background, IROB is responsible for prototype installation and the operation of pilot experiments performed within various projects. The already existing robotic infrastructure allows for setting up a broad range of lifelike test scenarios form conventional industrial robotics (Fanuc robots, KUKA youBot) to surgical applications (da Vinci Research Kit).

The Center has intensively participated in the past H2020 calls, taking part in various R&I action grant applications. Some, are still under evaluation with Brussels.

On the national level, various research and innovation projects have been launched together with prominent university, academic and industrial partners.

Members of the IROB are also taking an active role in evaluation panels and committees for H2020 R&I and FET proposals.

We are open to further collaborations with eminent robotic groups.

IROB SEMINARS

Prof. Gabor Fichtinger: "Rapid Prototyping of Ultrasound-Guided Interventions", May 29, 2014.

About the lecturer

Gabor Fichtinger received the University Doctor degree in computer science from the Technical University of Budapest, Hungary, in 1990. He is a Professor of Computer Science, with cross appointments in Mechanical and Material Engineering, Electrical and Computer Engineering, and Surgery at Queen's University, Canada. He is an Adjunct Professor in Radiology and Computer Science at the Johns Hopkins University, USA and an Adjunct Faculty of the Techna Institute of the University of Toronto, Canada; Adjunct Research Professor of Medical Biophysics at Western University. He is the director of the Laboratory for Percutaneous Surgery (http://perk.cs.queensu.ca), where his research specializes in medical image computing, computer assisted interventions and medical robotics, primarily for the diagnosis and therapy of cancer and musculoskeletal conditions. He has authored and co-authored over 300 refereed publications in these subjects. His Perk Lab also develops open-source software platforms for prototyping surgical navigation applications, used by over fifty research groups on four continents. Prof. Fichtinger is a Marie Curie Fellow, Senior Member of IEEE, Distinguished Lecturer of IEEE EMBS, and a Fellow of MICCAI. He holds a Level-1 Cancer Care Ontario Research Chair in Cancer Imaging. He serves on the board of International Society for Computer Assisted Surgery and Board of Directors of the Medical Image Computing and Computer Assisted Intervention (MICCAI) Society as General Secretary.

Abstract

Tracked ultrasound guidance is a powerful concept that has been making impact on many minimally invasive procedures. A few number of commercial navigation systems have emerged during the past decade or so, but the potential of computer-assisted ultrasound-guided interventions is yet to be realized. Our goal is to provide an open-source, easily configurable software platform for rapid prototyping and early clinical translation of image-guided intervention systems, particularly with ultrasound imaging.

The talk will introduce the SlicerIGT (www.SlicerIGT.org) for prototyping turnkey applications and the underlying Public Library for Ultrasound Toolkit (www.PlusToolkit.org) that provides supporting infrastructure for the application systems. Following a brief outline of structure and functionality, series of use cases will illustrate the power and versatility of the open-source application prototyping platform.

Prof. C. L. Philip Chen: “A New Learning Algorithm for an F-CONFIS with its Application for Computing Learning Capacity”, September 9, 2014.

About the lecturer

Philip Chen received his Ph.D. degree from Purdue University, West Lafayette, in 1988 and MS degree from the University of Michigan, Ann Arbor, USA, in 1985, all in electrical engineering. After having worked at the US for twenty-three years as a tenured professor, department head, and associate dean in two different universities, he is currently a Chair Professor of the Department of Computer and Information Science and the Dean of the Faculty of Science and Technology at the University of Macau, Macau, China.

Abstract

This talk discusses a new neural-fuzzy network architecture in which a traditional neuro-fuzzy system is transformed into an equivalent fully connected three-layer neural network, namely, the Fully Connected Neuro-Fuzzy Inference Systems (F-CONFIS). The F-CONFIS differs from traditional neural networks by its dependent and repeated weights between input layer and hidden layer and can be considered as the variation of a kind of multilayer neural network. Therefore, an efficient learning algorithm for F-CONFIS to cope with these repeated weights is derived. Furthermore, a dynamic learning rate is proposed for neuro-fuzzy systems via F-CONFIS where both premise (hidden) and consequent portions should be considered. Several simulation results indicate that the proposed approach achieves much better accuracy and fast convergence. In addition, the bounded capacity for the learning of a fuzzy neural network via the proposed F-CONFIS and its applications will be discussed.

Prof. Bruno Siciliano: “Controlling Interaction between Robots and Humans”, September 9, 2014.

About the lecturer

Bruno Siciliano is a Professor of Control and Robotics, and Director of the PRISMA Lab in the Department of Electrical Engineering and Information Technology at University of Naples Federico II. His research interests include force and visual control, human-robot interaction, aerial and service robotics. He has co-authored 7 books, 80 journal papers, 200 conference papers and book chapters. He has delivered 110 invited lectures and seminars at institutions worldwide, and he has been the recipient of several awards. He is a Fellow of IEEE, ASME and IFAC. He has served on the editorial boards of several peer-reviewed journals and has been chair of program and organizing committees of several international conferences. He is Co-Editor of the Springer Tracts in Advanced Robotics, and of the Springer Handbook of Robotics, which received the PROSE Award for Excellence in Physical Sciences & Mathematics and was also the winner in the category Engineering & Technology. His group has been granted thirteen European projects in the last five years for a total funding of 8.3 M€, including an Advanced Grant from the European Research Council. Professor Siciliano is the Past-President of the IEEE Robotics and Automation Society.

Abstract

Robotics is undergoing a major transformation in scope and dimension. From a largely dominant industrial focus, robotics is rapidly expanding into human environments and is vigorously engaged in its new challenges. Interacting with, assisting, serving, and exploring with humans, the emerging robots will gradually touch people and their lives. Applications of intelligent robots that work in contact with humans are increasing, which involve, e.g., haptic interfaces and teleoperators, cooperative material-handling, power extenders and such high-volume markets as rehabilitation, physical training, entertainment. In this scenario, the problem of controlling the physical interaction between

the robot and the human in a safe and dependable manner is of concern. This talk is aimed at presenting a unified framework for development of robot interaction control schemes using vision and force; vision provides global information on the surrounding environment to be used for motion planning and obstacle avoidance, while force allows adjusting the robot motion so that the local constraints imposed by the environment are satisfied. The proposed solution is to adopt position-based visual servoing when the robot is far from the object, where the relative pose of the robot with respect to the object is estimated recursively using only vision. On the other hand, when the robot is in contact with the object, any kind of force control strategy can be adopted (hybrid force/position control, parallel force/position control, impedance control), and the relative pose of the robot with respect to the object is estimated recursively using vision, force and joint position measurements. Remarkably, all control schemes are experimentally tested on a setup consisting of an industrial robot with open control architecture, force/torque sensor and hybrid camera. Some results with a dual-arm system are also discussed. The presentation is accompanied by videos.

Prof. Jorge Angeles: “The Development of a Fast Pick-and-Place Robot with an Innovative Cylindrical Drive”, February 13, 2015

About the lecturer

Jorge Angeles obtained the Ph.D. degree in Applied Mechanics from Stanford University. Between 1973 and 1984, he served at Universidad Nacional Autónoma de México as Chairman of the Graduate Division of Mechanical Engineering and Associate Dean of Graduate Studies in Electrical and Mechanical Engineering. Since 1984, he is with the Department of Mechanical Engineering, McGill University. His research interests focus on design theory and methodology, besides the theoretical and computational aspects of multibody mechanical systems for purposes of design and control.

Abstract

The food-processing industry is calling for ever faster means for the packaging of poultry and other edibles, which has motivated the development of fast pick-and-place robots. The tasks at hand usually comprise motions involving the subgroup of Schoenflies displacements. These are characterized by three independent translations and one rotation about an axis of fixed orientation. Commercial robots of this kind are available, e.g., Adept's Quattro and ABB's Flexpicker. The architecture of these robot stems from that of the Delta, designed to produce three independent translations of its moving plate within a parallel architecture. The challenge these systems face is the need to provide a 180-deg turn of their moving platform, which is impeded by their parallel architecture. Both the Quattro and the Flexpicker are supplied with ingenious mechanisms to produce this rotation, but the mechanism adds a substantial complexity to the overall system. As an alternative, a family of simple, isostatic architectures was proposed recently by two Taiwanese researchers. These architectures include two limbs, each carrying a cylindrical shoulder which is actuated, and ending by screw nuts coupled to each forearm by means of a universal joint. A rod that carries two screws of distinct pitches in series, and carries the gripper at one end, plays the role of the moving platform of parallel

robots. The rod is moved with four degrees of freedom in a similar fashion to the long peppermill seen in Italian restaurants, with the two screw nuts playing the role of the waiter's hands. Moreover, each shoulder is driven by one collar that undergoes cylindrical motion (rotation about an axis and translation along a direction parallel to the axis), the challenge here is the design of the drive that can provide the two degrees of freedom of a cylindrical motion. Such a drive, dubbed the C-drive and developed at McGill University, is actuated by two identical motors that are fixed to the base, and carries a closed kinematic chain that was synthesized by means of an application of the theory of displacement subgroups. One instance of the Taiwanese architecture is currently being developed at McGill University, with one C-drive per arm. The principles of operation of the robot and its main components are highlighted in this presentation.

Prof. Paulo J.S. Gonçalves: "Computer Aided Navigation Applied to Orthopedic Surgery", March 31, 2015

About the lecturer

Paulo J.S. Gonçalves is an Associate Professor (Professor Coordenador) of Electrotechnical and Industrial Engineering with the School of Technology at the Polytechnic Institute of Castelo Branco, Portugal. He is also a researcher at University of Lisbon, LAETA, IDMEC, Center of Intelligent Systems (CSI). Dr. Gonçalves was trained in Mechanical Engineering, achieving the Licenciatura degree in 1995. He earned the M.Sc. and Ph.D. degrees from Instituto Superior Técnico, Universidade de Lisboa, 1998 and 2005, respectively. Dr. Paulo Gonçalves (P.J.S. Gonçalves) presented more than 100 contributions in robotics, vision and computational intelligence.

Abstract

Three-dimensional reconstruction of images is a fundamental procedure in medical imaging because it allows building virtual models of anatomical units of the human body, useful in several areas, such as in surgical navigation. It is presented a free-hand Ultrasound acquisition system to perform bone tracking during orthopedic surgeries, and also for human femur reconstruction. The aim of this system is to acquire a sequence of 2D parallel cross-sections evenly spaced along the displacement direction to be used in the scope of computer-assisted orthopedic surgery. Here, the system is described as well as the image processing and calibration procedures implemented. Results, for Hip Resurfacing during a laboratory real experimental scenario, are presented to illustrate the operation of a KUKA LWR robotic system co-manipulated by a surgeon with the aid of ultrasound image feedback.

Wesley Snyder: „Using Sketches as Passwords", September 14, 2015

About the lecturer

Wesley Snyder is Emeritus Professor of Electrical and Computer Engineering at North Carolina State University. His research interests include shape recognition, object identification, and human scene understanding. He authored the first engineering textbook in robotics, and two books on Computer Vision, 57 journal papers, 140 conference papers and book chapters. He is a Fellow of IEEE and AIMBE. He has served on the editorial boards of several peer-reviewed journals and has been chair of program and organizing committees of several international conferences, including IJCNN and ICRA.

Abstract

The text-based password has been a longtime mechanism for users to gain access to information systems such as computers or network access. However, to maintain security, users have been burdened with stringent password rules, such as long password length and the use of special characters. Multiple passwords for different systems and frequently expiring passwords make the use of passwords a nightmare for many users. This frequently results in security risks, as users write their passwords down and use the same password on many systems. To overcome the burdens of password systems, the authors proposed a novel method for computer-access security, allowing the user to draw a simple sketch as his/her password.

In this project, we have developed a new sketch recognition algorithm, based on the PI's prior successful work in shape recognition. The new sketch based password system has been implemented and evaluated.

The user desiring access (referred to as the artist hereafter), may draw a sketch on a digitizer pad or touch-sensitive screen (e.g. iPad). The sketch is matched to a data base of sketches. The principal innovation of the proposed algorithm is treating the sketch as a function of time, and using local measures of that function as parameters for the shape-recognition algorithm, SKS.

In this talk, the SKS algorithm will be first described as a way to match curves, and then extended to recognize curves. Special modifications to be able to use sketches as passwords are included.

Peter Fankhauser: „Localization, Terrain Mapping and Navigation with Legged Robots“, October 13, 2015

About the lecturer

He is a Ph.D. student at ETH Zurich in robotics. His group at the Autonomous Systems Lab develops four-legged robots capable of running at high speeds and climbing over obstacles. Péter's current work focusses on the mapping, control and motion planning of these systems. Péter graduated with a Master's degree from ETH Zurich in 2012 and took courses at the Massachusetts Institute of Technology and the Tohoku University in Japan. For his Bachelor's degree, he led a team of thirteen students in the development of the robot Rezero that drives on a single ball while interacting with people. Setting new standards in the performance of similar robots, his team was invited to conferences worldwide and Péter has given talks at TED and Zurich Minds. In the future, Péter would like to combine his passion for robotics and entrepreneurship in creating innovative products.

Abstract

The success of walking robots in real world applications depends on how well we are able to exploit their (potential) advantage in mobility. In this presentation, I will give an insight into the approaches we are taking with the quadrupedal robots StarlETH and ANYmal for precise localization and terrain mapping to autonomously walk in challenging environments. We employ a rotating Hokuyo laser sensor for environment perception. The point cloud acquired in one full turn, which takes about 2 seconds, is dewarped. To this end, we use the robot-internal state estimation, which is a fast-updated (400 Hz) filtered state from IMU readings as well as kinematic and ground contact measurements. Scans are matched using an ICP registration framework to establish continuous localization and mapping. The laser range measurements are also used the generate probabilistic elevation maps of the environment. These maps are interpreted for traversability (slope, roughness, step height etc.), and finally, our navigation planner can find a path to the goal

position. The hierarchical approach in our planning navigation framework allows the robot to take into account a changing environment through continuous mapping and replanning.

This video shows some of the work in the context of collaborative navigation of a ground and aerial robot: https://youtu.be/9PprNdIKRaw

József Kövecses: „Analysis of Rovers Operating on Soft Soil", March 3, 2016

About the lecturer

József Kövecses is Associate Professor of Mechanical Engineering at McGill University and member of the Centre for Intelligent Machines.
His principal expertise lies in the areas of modeling, dynamics and control of mechanical systems. He has significant research and industrial experience in these fields and their applications, particularly in the robotics, mechanisms, space and power industrial sectors. He has been intensively working on problems associated with the dynamics and control of contact in mechanical systems, robotics, multibody dynamics, dynamics of wheeled robots, human-machine systems and force-feedback devices.
He has been collaborating with various industrial and government organizations. He has numerous refereed papers in leading journals and conference proceedings. He also serves as Associate Editor for two prestigious journals, the ASME Journal of Computational and Nonlinear Dynamics, and Mechanism and Machine Theory.

Abstract

Planetary exploration and surface mobility on unstructured terrain heavily depend on the availability of proper vehicles. Wheeled rovers present a possible means for those applications. The mobility of such vehicles on soft soil is of key importance for the success of their operation. This poses several important challenges for the design and operation of rovers. In this presentation we discuss elements of a framework that we have developed for the modeling and analysis of rovers on soft soil to provide tools for their design and control. The characterization and modeling of the wheel-soil contact are central for understanding the behaviors of rovers. We present a general representation for the development of dynamic models to capture the vehicle-terrain interaction.

Based on this we introduce performance indicators that can be used to optimize the mechanical design and control the operation of rovers to maximize mobility. We also discuss several experiments to illustrate the results.

Andás Lassó: „Building image-guidance systems from open-source components", July 7, 2016

About the lecturer

András Lassó graduated at the Budapest University of Technology, Hungary (M.Sc. in Electrical Engineering, 2000; Ph.D., 2011). He joined GE Healthcare as a software engineer in 2000, was appointed Lead Engineer in 2003, and Senior Engineer in 2008. He developed various software components and test infrastructure for GE Innova interventional X-ray systems and GE Advantage Workstation and led development of advanced image visualization, quantification, real-time image fusion and guidance applications. He also participated in various research collaboration projects in medical image analysis, enhancement, segmentation, registration, and fusion. He joined the Perk Lab in 2009 as a Senior Engineer to work on image-guided intervention research and system development. In 2011 he was appointed to be Associate Director of the Perk Lab. His main interests are developing high-quality, reusable, open-source software components and using them to build systems for translational research and clinical use.

Abstract

Arguably the greatest obstacle to clinical translation of experimental navigated interventional systems is their technological complexity. Putting together even the smallest and simplest navigated intervention system demands a great deal of mundane engineering effort that has no scientific value. Moreover, the level of robustness and safety required in clinical systems demands high-quality engineering that may exceed the capacity of many research labs. We believe that the burden of system engineering can be taken off of researchers by using shared, open-source application platforms. Many common features can be implemented in clinical translation platforms, while allowing full customization of the user interfaces for procedure-specific applications. If new methods are deployed as modules of a platform, results

from different research groups will be more comparable to each other, this may resolve controversial findings and facilitate multi-center clinical trials. Platforms are also a great way to share implementation details, which play an important role in the outcomes of clinical evaluation studies.

In this talk SlicerIGT translational research platform and its application to implement a navigation system for navigated breast tumor resection will be presented.

Lőrinc Márton: „Bilateral Teleoperation in the Presence of Time-Varying Delay”, November 28, 2016

About the lecturer

Lőrinc Márton has graduated at the Petru Maior University, Romania, where he received his master's degree in Control Engineering and Industrial Informatics in 2000. He resumed his studies at the Budapest University of Technology and Economics, and gained Ph.D. degree in the area of Robust-Adaptive Control of Mechatronic Systems in 2003. Later he earned the Bolyai János Postdoctoral Scholarship on the theme of Non-smooth Non-linearities in Robotic and Mechatronic Systems, and the Humboldt Postdoctoral Scholarship of Institute of Robotics and Mechatronic on Fault Diagnosis, Teleoperation. In 2016 he was worked as a visiting researcher at the Ruhr University in Germany on networked control. Currently he is associate professor at the Sapientia Hungarian University of Transylvania.

Abstract

Teleoperation is concerned with the distant control of robotic systems. In these systems the supervisor (human operator) and the robot communicate through wide-area network or wireless communication network. During the task execution, the human operator relies on visual and haptic information received from the robot side.

The communication delay has a negative influence both on the stability and tracking performances of bilateral teleoperation systems. To assure reliable bilateral teleoperation, such robot control algorithms and communication protocols have to be designed that take into consideration the time varying communication delay.

To deal with the delay induced performance degradation in teleoperation systems, in this presentation the theory of the passive systems is invoked. The

concept of the time-domain passivity control is presented for networked teleoperation systems. Some shortcomings of the original time-domain passivity control scheme are presented and a revised time-domain passivity controller is introduced. The proposed controller can assure stability and enhanced tracking performances with bounded control signals. The applicability of this control approach is shown through bilateral teleoperation experiments between Romania and Hungary, and Romania and Canada respectively.

In the second part of the talk, a data transfer control algorithm is proposed for wireless teleoperation systems to avoid excessive delays when the wireless radio signal strength in the communication channels of the telerobotic system changes in time.

Victor Raskin & Julia Taylor Rayz: "Workshop on Ontological and Lexical Acquisition", January 23, 2017

About the lecturer

Victor Raskin (Ph.D., Moscow State University, 1970) is Distinguished Professor of English and Linguistics at Purdue University, with courtesy appointments in Computer Science and in Computer and Information Technology. He has published widely in semantic theory and applications, from machine translation to information security, computational humor, biomedical domains, and robotic intelligence. He has taught at his alma mater and then at The Hebrew University of Jerusalem, Tel Aviv University (part-time), University of Michigan (sabbatical), and, since 1978, at Purdue. He has delivered numerous keynote addresses and invited lectures at international conferences and organized several of those. He has authored several books, including Semantic Mechanisms of Humor (D. Reidel, 1985) and Ontological Semantics (MIT Press, 2004, with S. Nirenburg).

Julia Taylor Rayz (Ph.D., University of Cincinnati, 2008) is an Associate Professor of Computer and Information Technology at Purdue University. She has published intensely in computational humor, ontological semantic technology, fuzzy logic, and a wide range of semantic applications. Her experience in the industry includes developing an ontological semantic system for text analytics. She has delivered a number of keynote addresses, plenary sessions, invited lectures, tutorials and workshops at international conferences and hosted a few workshops, sessions, and schools.

Abstract

The workshop focused on the technology for hybrid human-computer acquisition of comprehensive semantic ontology and lexicon for natural language whose ultimate goal is to reflect adequately human understanding of natural language. The acquisition resource, http://engineering.purdue.edu/~ost, has

been developed within Purdue's Ontological Semantic Technology (OST) project for a family of computational processing applications, ranging from information security to health domains to robotics.

The semantic ontology represents the human knowledge of the world. It is a vast lattice of concepts, representing events and objects, that are connected to each other with properties. Each concept will have a number of properties connecting it to other concepts. Thus, each event will have the properties of agent, theme, instrument, beneficiary, etc. One property is-a denotes subsumption, the only property that most published ontologies have. The OST ontology is language-independent but marked with English labels for the benefit of human acquirers. Thus, the event go subsumed by motion-event; it has animated as its agent, and is also connected, like most events, to time and location.

The OST lexicons are language-specific, and every sense of every word or phrasal in a natural language is anchored in an ontological concept with the properties restricted to correctly reflect its meaning. Thus, the English drive will be anchored in the concept go with the agent that is adult and human and the instrument automobile. Ontologies may vary in grain size depending on convenience and application: thus, drive can be introduced as a concept subsumed by go or represented by it.

The ONT Acquisition Resource provides the format for both ontological and lexical acquisition, with all the ranges for properties explicitly expressed, and the minimally trained human acquirer, often an undergraduate, provides only specific intuitive answers. With some experience, acquirers produce 6-8 concepts or 8-10 lexical senses per hour, and we consider 10,000 concepts and 50,000-100,000 lexical senses to be sufficient for any application. The ontology and lexicons are, of course, usable within any approach and easily adjustable for any application. We believe that their approximation to human knowledge of the world and understanding of their natural languages is much closer than most other, non-representational ontologies and lexicons.

IROB EVENTS

IEEE SMC CONFERENCE

After San Diego (2014) and Hong Kong (2015), in 2016 in close cooperation with the Taiwan Tech, the IEEE Hungary Section and the Óbuda University organized the IEEE SMC Society's Annual World Congress of the IEEE International Conference on Systems, Man, and Cybernetics International Conference (SMC 2016) in Budapest.

According to the final statistics, 1506 paper was sent to the international committee, and the acceptance rate was very strict 55%, totally 637 oral and 196 e-poster papers were presented from 59 countries. Most of the scientists visited the SMC2016 Conference were from China, Japan, the United States, Tunisia, Taiwan, Germany, Hungary, Korea, Canada, Poland, Australia, United Kingdom, India, Brazil, France, Czech, Italy, Slovakia and Singapore, together 1049 scientists had been registered.

The SMC2016 in Budapest provided an international forum for researchers and participants to report up-to-the minute innovation and development, summarized state-of-the-art, and exchanged ideas and advances in all aspects of systems science and engineering, human-machine systems, and cybernetics. SMC2016 was dedicated to the Hungarian born John von Neumann "a Pioneer of Modern Computer Science". In honor of him, the theme of the conference was "A theory that transformed the world to a Cyberspace".

We proudly report with great honor, that high ranking scientists were the members of the board at the opening ceremony like Prof. Dr. Barry L. Shoop, president and CEO of IEEE, Prof. Dr. Dimitar Filev, president of IEEE SMC Society, Prof. Dr. Szász Domokos, vice president of Hungarian Academy of Sciences, Prof. Dr. Imre J. Rudas the General Chair of SMC2016, Prof. Dr. Mihály Réger, rector of Óbuda University and Prof. Dr. Shun-Feng Su, Technical Program Committee Chair of SMC2016.

At this conference, the first keynote talk was presented by Jose M. Carmena (UC Berkeley), it focused on “Advances in Brain-Machine Interface Systems”.

The next keynote talk on “Spiking Neural Networks and Spatio-Temporal Data Machines: Methods, Systems, Applications” was presented by Nikola Kasabov (Auckland University of Technology).

The final keynote talk was held by Huijun Gao (Harbin Institute of Technology) with title “Networked Control Systems with Industrial Applications”.

CENTRAL EUROPEAN LIVING LAB FOR INTELLIGENT ROBOTICS

The CELLI is an independent platform within the Central European region, coordinated by the IROB Center. CELLI is extensively relying on an international network of key partner institutions and companies. It acts as a distributed research center of excellence, founded on the principals of a living lab. This living lab is a user-centered, open-innovation ecosystem, integrating concurrent research and innovation processes within a public-private-people partnership.

CELLI's aim is to become a living lab for R&D in service robotics, including social, medical and cognitive robotics. Inherently, the CELLI is involved with technological development, focusing on novel instruments, robot platforms and sensors, with adequate control structures and user interfaces, and bringing these technologies to application and social services. The CELLI is aiming to gain experience in manufacturing engineering, system testing, validation and commercialization. Technically, it provides "Software as Service (SaaS)", "Platform as Service (PaaS)" and eventually "Infrastructure as Service (IaaS)" to other partners and external contractors. The key to its success is the ability to bring together mechatronics, software engineering and usability research to create the accessible robot technology of tomorrow.

The CELLI should bring concrete benefit to its members through integrated research projects, exchange programs, joint publications and EU proposals. The CELLI should facilitate the access of industrial partners to new robotics technology, and provide new application and services to the wider public.

The CELLI takes active role in international decision and law-making affecting the domain of EU robotics. It is also a strong advocate of sustainable development and green research practices. It is operated according to the EU ethical norms, and the ISO quality management practices. These principles are expressed through the services and tasks the Center may execute for the internal and external partners.

/www.cellir.org/

INTERNATIONAL BEJCZY DAY

The I. International Bejczy Day was organized on January 18th, 2016 at Óbuda University, hosted by the Antal Bejczy Center for Intelligent Robotics. The date was chosen to be the birthday of the famous physicist, and the event was accompanied by numerous scientific and public activities. These included the opening of the permanent exhibition about the life and work of Antal Bejczy and a student publication competition.

Antal (Tony) Bejczy passed away in 2015. As a leading researcher of the NASA Jet Propulsion Laboratory, professor of the Caltech and Washington University of St. Louis, he became a well-respected and prominent pioneer of international space research and robotics—said József Gáti, Director General of Institutional Development.

József Gáti emphasized that the permanent exhibition at IRob presents the most important milestones in both the scientific and personal lives of the physicist, with a rich collection of Antal Bejczy's personal items. The collection of exhibition posters guides the reader through a career among robot control, machine intelligence and telerobotics, but family documents, handouts, publications and awards can also be found at the Robotics Center. Among many other of his honors, the Order of Merit of the Republic of Hungary, the Honor of Hungarian Heritage and his Doctor Honoraris Causa award of Óbuda University are exhibited, too.

Following the official opening of the exhibition, the Antal Bejczy Student Publication Awards were handed over to Bence Takács, Roland Dóczi, Balázs Sütő and János Kalló, students of the Jon von Neumann Faculty of Óbuda University. The award was donated to those who submitted the best paper in the topics of space exploration, robotics or control theory, either in Hungarian or in English.

In 2017 the II. International Bejczy Day was organized again to paying tribute to Prof. Dr. Antal Bejczy, the celebration of the 10-year jubilee of the European Research Council's ERC Starting and Advanced Grant program, and the joining to the elite group of Starting Grant host institutes. The university leadership, teachers, researchers, the Student Union members of Óbuda University and the members of the University Research Innovation and Service Center advisory board were invited to the event. The participants were saluted by Prof. Imre Rudas, the president of the University Research Innovation and Service Center Board of Governors. After the opening, the ERC's significance in the European research was highlighted by Prof. Levente Kovács. The event continued with the talk of Prof. Mihály Réger, president of Óbuda University about the scientific life and future perspectives at the university. The guests could also hear the presentations of several invited speakers including Prof. Domokos Szász, the MTA vice-president, and Prof. József Bokor from MTA SZTAKI. The results of the Antal Bejczy Center for Intelligent Robotics were presented by Dr. Péter Galambos, IROB director. Prof. Levente Kovács, chief researcher presented his research group's new scientific results with the title of “Tamed cancer”. After these presentations, Dr. Tamás Haidegger, IROB vice-director introduced the history of the International Bejczy Day.

Nine applications were arrived before the deadline to the Antal Bejczy Student Publication Award. The Reading Committee consists of Prof. János Somló, Prof. László Horváth, Dr. József Gáti and Gábor Szögi awarded the Antal Bejczy Student Publication Price to József Kuti, Ph.D. student of the Doctoral School of Applied Infor-

matics and Applied Mathematics for his paper „Minimal Volume Simplex (MVS) Polytopic Model Generation and Manipulation Methodology for TP Model Transformation" published in the Asian Journal of Control, coauthored by Dr. Péter Galambos and Dr. Péter Baranyi. The other authors of other applications received memorial certificates.

After the award the audience could listen to the presentation of Prof. Peter Sincak (University of Kosice) titled „Towards Cloud Based Social Robotics" and the speech of Dr. Tamás Haidegger about „Open surgical robotic research – a global network". Dr. Dániel Drexler and Dr. Csercsik Dávid introduced the audience to their scientific results titled „Engineering methods for cancer treatment", „Mathematical models of tumor growth", and „Control engineering challenges and results". After these speeches Prof. Gurvider Virk from CLAWAR presented the challenges in emerging service robots; the audience could listen to the presentation of Dr. Jan Veneman from Tecnalia about rehabilitation robotics. The program closed with Dr. Gernot Kronreif, from Austrian Center for Medical Innovation and Technology presentation: „Small is beautiful – a new robotic setup for neurosurgery".

GATEWAY TO SPACE EXHIBITION

The Antal Bejczy Center for Intelligent Robotics and the Gateway to Space Exhibition have organized a joint professional day, with Interactive demonstrations and presentations on February 4th, 2016, at Budapest Millenáris.

Antal Bejczy was the leader of the group designing and developing the teleoperation components of first Mars rover, the Sojourner. The presentations and demonstrations covered topics related to the Human–Robot Interaction, new fields of application of robotics, modern control techniques, human–robot interface, including a special exhibition of the Pille cosmic radiation

measurement device, used by Charles Simonyi and Bertalan Farkas during their journey to space. The presentations were held by professors of the Óbuda University, young researchers of the Antal Bejczy Center for Intelligent Robotics, and the representatives of the Energy Research Center of the Hungarian Academy of Sciences.

Professor Imre J. Rudas explained the importance of the work of Antal Bejczy, and how it all shaped the modern space exploration and robotics. Dr. József Gáti introduced the heritage of the famous physicist and the permanent exhibition, which is now open to public at the Antal Bejczy Center for Intelligent Robotics. The research activities and history of the Robotics Center were presented by Dr. Tamás Haidegger. Árpád Takács, Dr. Péter Galambos and Bence Takács talked about some of the most popular and interesting topics in robotics, including the connection of space and surgical robotics, the interaction between humans and robots, and the use of robotics in everyday education. Concluding the presentations, Dr. Attila Hirn introduced the Pille device, a Hungarian-developed radiation dosimeter.

The presentations were followed by numerous interactive demonstration of robots, including the Nao humanoid robots, a LEGO Mars rover, the KUKA YouBot autonomous mobile manipulator, the CALap laparoscopic camera holder and the Pille dosimeter.

WORKING WITH THE DA VINCI RESEARCH KIT

MinImally Invasive Surgery (MIS) brought a true revolution into the highly conservative and in general slowly developing field of surgery. In just about 20 years surgery as previously known changed dramatically and today the majority of procedures is done minimally invasively. It is expected that the next breakthrough is going to be the advancement of semi and fully automated robotic surgical devices. Many of these devices have already been created one major player being Intuitive Surgical with it's da Vinci Surgical System conquering an about 60-70% of the market.

The Da Vinci Research Kit (DVRK) is a tool in the field of robotic minimally invasive surgery intended towards overcoming this issue. Since the da Vinci system is used worldwide having several thousand robots already deployed. With the DVRK the da Vinci system can be used as a general hardware to develop and test algorithms on.

The Da Vinci Research Kit is a framework under development and as such has its flaws. IRob is part of an international group of universities and research institutes working with and contributing to the DVRK software, and as such part of the work done is debugging newly discovered issues. Our research with the system currently is directed towards recording surgeon movements and examining the possibilities for automating subtasks during procedures.

ONTOLOGIES FOR SURGICAL **KNOWLEDGE SHARING**

Surgery is truly changing and what was fiction once is becoming not only a possibility but in some cases is already today's reality.

This strict teleoperation seems to be engraved into surgical robots, and thus the time in software development (from the user's point of view) seems almost frozen. The reason behind this is that it is hard to prove an automated algorithms correctness in a living environment. The tool and soft tissue interaction is hard to determine and there are many possible mishaps software developers probably do not test for. For these and several closely similar reasons, it is safer for companies to keep the surgeon in the direct feedback loop and therefore leaving all the responsibility to the user.

This approach is practical but there's strong motivation to move forward and create: (currently nonexistent) standards for the safety requirements of surgical robots, and to formalize surgical knowledge in a way which can be understood by both surgeons and robotic applications. Surgical ontologies are one way currently investigated for one such formalization of surgical knowledge.

The Antal Bejczy Center for Intelligent Robotics joined the international LapOnto SPM group in an effort to create one such general ontology for Minimally Invasive Surgery.

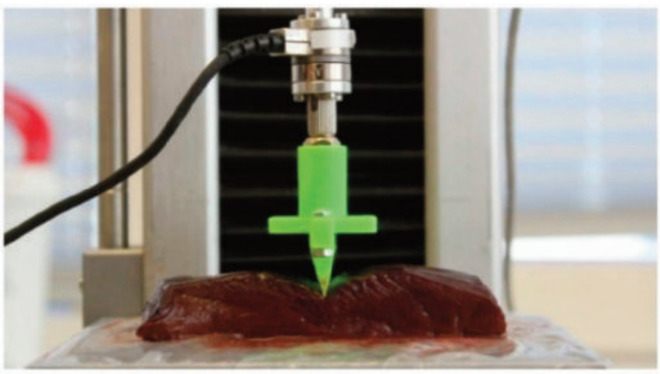
It is a middle level ontology using terms from upper level ontologies such as the Basic Formal Ontology (BFO) library, and incorporating several currently existing medical ontologies. We believe that this (open source) work if done correctly can be a base for many applications and can bring a true change to the development of robotic applications for surgical and in general medical practice.

METHODOLOGY FOR SOFT TISSUE MODELING

In the past years, research activities related to robotic surgery have gained much attention. Cutting, indentation and grabbing are just a few types of tissue manipulations that require high precision tools and techniques. In order to achieve better performance for surgical robotics applications in terms of stable control for teleoperation, it is crucial to understand the behavior of soft tissues through their mechanical properties. Creating an accurate tool–tissue interaction model would largely aid the design of model-based control methods.

A novel tool–tissue interaction model was utilized, where mass–spring–damper elements were distributed under the deformed tissue surface, represented by the Wiechert model. A uniform deformation input was applied on the surface during the experiment, and the force response data was collected. The parameter values were obtained by iterative fitting of the simulated data to the experimental measurements. In order to verify this approach, the experiments were extended to the case of non-uniform surface deformation as well.

Our method for reaction force estimation can be utilized when the surface deformation shape is known. When the describing function of the surface deformation shape takes steep slopes and sudden changes, there is a significant contribution of lateral tension forces. These effects can be compensated by taking the elongation of the tissue surface into account, which is part of the future work. The model could be a useful tool for modeling and reaction force estimation when carrying out surgical manipulations with blunt instruments, providing model data for model-based haptic feedback control methods and virtual surgical simulators.



MINIMALLY INVASIVE ENDOSCOPE HOLDER ROBOT

Despite robotic technology becoming widely available in the Operation Room (OR), in most medical facilities, it is still rarely available for educational and research purposes. To satisfy this need, the Computer-Assisted Laparoscopy (CALap) system was created to provide an easily available, low-cost platform for the education of robotic surgery. Its versatile design allows the user to modify the system so it can satisfy the need of a special training program or research applications. It is important that the surgeon understands the mechanics of the robotic platform, including its limitations. The CALap system was created with a mechanical design similar to the da Vinci surgical robot slave arms, employing a Remote Center of Motion (RCM) structure. In this mechanical structure, the tool inserted into the robotic arm pivots around a point determined by the physical setup. In order to reduce friction between the metal and the plastic parts, roller bearings were used at all joints of the system.

Similar to the hardware, the control electronics were also designed so that they can easily be modified or used for robotic education. An Arduino UNO board was used as the computational center of the system. In the CALap system, the master–slave design was implemented so that the robotic arm only needs low-level electronic design, and the high level programming can be achieved on a nearby computer. The Arduino board is only used on the slave side to translate the serial communication to motor driving impulses and report back the sensory data. This structure allows the use of simple serial communication platforms like USB, and does not require special cables or converters.

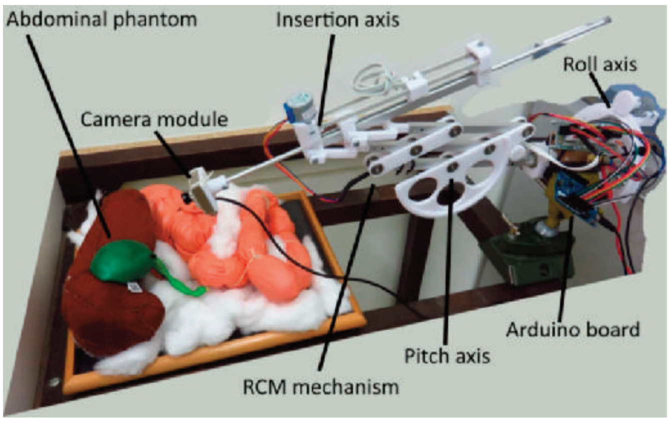
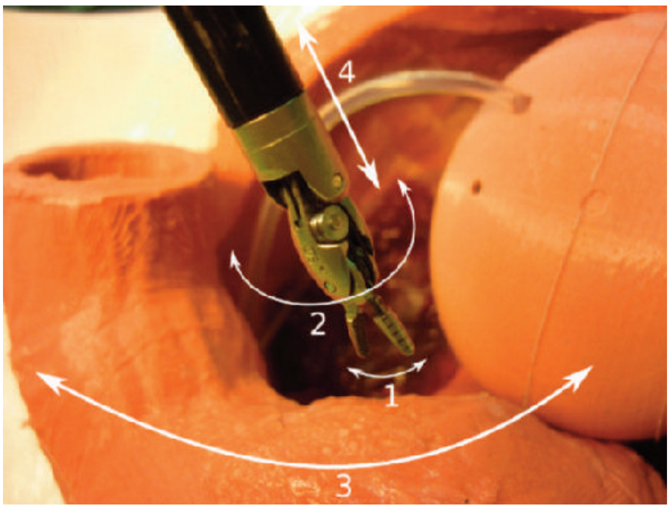


IMAGE-BASED **CAMERA CONTROL**

Automation of camera handling has a huge potential in Minimally Invasive Surgery (MIS). During traditional MIS the surgeon continually coordinates actions with the camera handler assistant. But even if they form a perfect team, the camera handling is usually not perfect, due to the assistant's physiological tremor or misunderstandings; furthermore, crowding in the Operating Room (OR) is a significant problem in hospitals. Camera handling automation with a robotic device is a possible solution to these problems. Our aim was to develop a visual servoing based tracking method, which can track objects during MIS.

For the visual servoing task we used the da Vinci surgical system and an existing laparoscopic assistant robot, the CALap system (Computer Assisted Laparoscopy) which was also created in the Antal Bejczy Center for Intelligent Robotics (IROB). We used a surgical box trainer and a pelvic phantom for the trials. In this project an object tracking method was developed, which is based on the Speeded Up Robust Features feature extraction algorithm, the Kanade-Lucas optical flow and the Kálmán filter. The visual servoing software uses each algorithm simultaneously to get a robust computer vision method, which can track several types of objects in the operational field.

This work was tested in several tasks. The conclusion is that my algorithm could not track instruments trustworthily, but it is exceptionally capable to tracking larger areas in the operational field, such as the background even with tissue motion and soft tissue deformations.



ROBOTICS SPECIAL COLLEGE

The Robotics Special College (RSC) has a 1 year of existence. It provides a professional program for young students and researchers with social engagements and material or personal conditions. Mechanical engineers, electrical engineers, informatic engineers are welcomed there. The RSC provides not only raw professional trainings but also preceptor interventions. Students are able to learn the professional ethics, how to expand views and what is the culture behind the researches. Robotics Special College is also interested in finding young potential researchers among high school students to offer its possibilities.

The management organizes factory visits, conferences, building industrial and educational relationships and offers an extensive possibility for the college members for consulting with professionals.

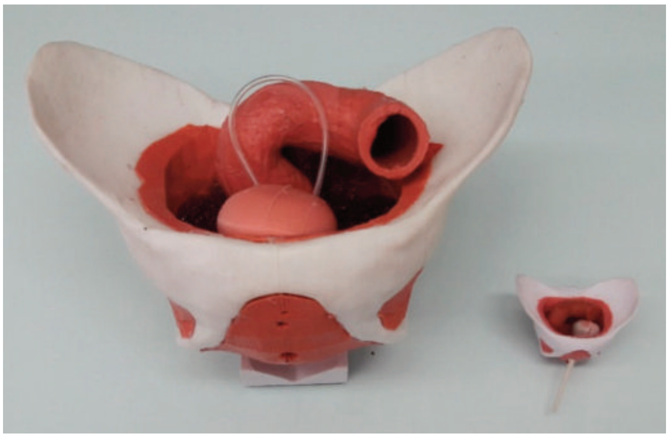
It is also possible to give scholarships for talented students to realize his/her development idea or support them for traveling to conferences.

3D PRINTING RAPID PROTOTYPING

Nowadays 3D printing technology is the best choice for rapid prototyping due to its great progress in the last few years. This technology makes possible to produce an object of almost any shape from its 3D model. Furthermore, printers are able to use different materials according to the actual task.

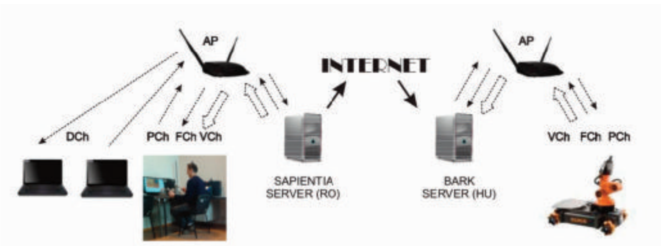
In the past year, we have assembled our rapid prototyping tool park consists of three 3D printers. Two of the devices are PLA printers, namely a MakerBot Replicator R2 and a Lambda and we have an XYZ Da Vinci 3D ABS printer. In the FabLab, we use the 3D printing in a number of student projects, such as inverted pendulum, furuta pendulum, laparoscopic trainer box, in projects of external partners, e.g the FreeHand project and Rescube robotics, and also used often to create plastic spare parts required in the lab.

In our laparoscopic trainer box project most of the parts were manufactured using 3D printers. All the bones and other hard tissues are simply printed from PLA, but the fabrication of soft tissue like rectum, bladder, prostate and connective tissue seemed to be a bit more challenging. These components were molded from silicone, the used molds were also printed by 3D printers for the required shape. Firstly, reduced size models were manufactured, and after method is tested and the best materials are found the real-sized model was produced. The smaller pelvis can be seen on the right side in the figure and the other one with a ratio of 1:1 on left side.



PROJECTS WITH THE KUKA YOUBOT

The KUKA youBot is a powerful, educational robot that has been specially designed for development and education in mobile manipulation. It is an open platform that is operated with open source software. In the past years, we had two research projects on this system. During the first one students created a ROS (Robot Operating System) based software package for youBot. To create 2D and 3D representation of the environment different sensors such as RGB-D and laser range finder has been used. To object detection RGB-D sensor has been used. This project represents an autonomous pick and place task in stochastic environment.



The second research projects with the youBot was a bilateral teleoperation system for distant control of mobile manipulators over the Internet by Department of Electrical Engineering Sapientia Hungarian University of Transylvania. Bilateral teleoperation experiments are performed through mixed communication networks, including wide area network between remote locations (Budapest, Hungary and Tirgu Mures, Romania) and wireless networks, to show the applicability of the proposed teleoperation system. In teleoperation systems, the desired position and velocity of the remote robot is generated by the human operator using a haptic device (master). In the case of bilateral teleoperation, the controlled robot (slave) transmits back to the master the reaction forces that act on the robot, allowing the human operator to sense the influence of the environment on the robot during the task execution. The teleoperation system was implemented using the facilities of two robotic laboratories situated in different countries: Antal Bejczy Center for Intelligent Robotics, Óbuda University, Budapest, Hungary and Robotics and Control Laboratory, Sapientia Hungarian University of Transylvania, Tirgu Mures, Romania. The physical distance between these laboratories is about 500 km.

PROJECTS WITH THE KUKA IIWA

The latest device in the lab is a KUKA iiwa lightweight robot platform. The LBR iiwa is the world's first series-produced sensitive, and therefore HRC-compatible (Human Robot Collaboration) robot. It has 7 DOF with torque sensor in each of its joints. Thanks to these joint torque sensors we can use it in complex applications with human cooperation. Currently we have two projects with this platform, one of them is a medical application (autonomous robotic ultrasound probe navigation) and the other is an industrial application (teleoperation and gripper with force feedback control).

In our medical application, we try to model how does the doctor does the ultrasound scanning. The ultrasound scanning is a noninvasive medical procedure that can help in a minimally invasive surgery like needle insertion. The position of the probe and the contact force are important to take appropriate images of the inside of the body. The model can make an objective evaluation of the ultrasound scanning process. Furthermore, the model can provide suitable information for autonomous robotic ultrasound probe navigation. In this project, we use the Kuka iiwa robot platform for data collection like as position, orientation, force, torque and after that use it for autonomous probe navigation.

In the mentioned industrial application, we are working on a teleoperation environment included the KUKA iiwa robot arm, the Novint Falcon haptic interface and a gripper with force feedback haptic interface. With the Falcon haptic interface we can move the robot arm in its environment and use the force feedback haptic interface we can grasp objects. This is important to feel the gripper force for example if we try to grasp soft or breakable objects.

SONOVIR PROJECT FOR VIRTUAL ULTRASOUND TRAINING

In a trilateral consortium with the ACMIT GmbH (Austria) and 3D Medilabs Ltd. (Hungary), Bejczy Lab contributed to a one-year-long prototype development project (2016-2017) in the field of medical mechatronics.

Goals of the SONOVIR project are two-fold. The first subproject is aimed at the development of a cost effective ultrasound training device that provides the user with simulated US images on a computer screen while using a USB connected spatially tracked transducer. The development activity includes the USB connected tracked "dummy" transducer and the PC software that provides the simulated sonogram stream. The dummy probe has two sensory modalities, a 9 DOF integrated IMU device for real-time orientation tracking and an RFID-based positioning system.
Through the RFID-based calibration, the position of the transducer can be localized on the phantom with reasonable spatial resolution (~8 mm). This is mainly for the selection of standard examination protocol and the corresponding relative position of the virtual model and the transducer. After the placement of the transducer on the phantom, IMU modality provides the real-time orientation data that is streamed into the host computer and updates the pose of the probe. These two senses allow us to track the transducer's pose with 60Hz of refresh rate. As a result, a cost-effective training environment can be constructed relying on open source software background.

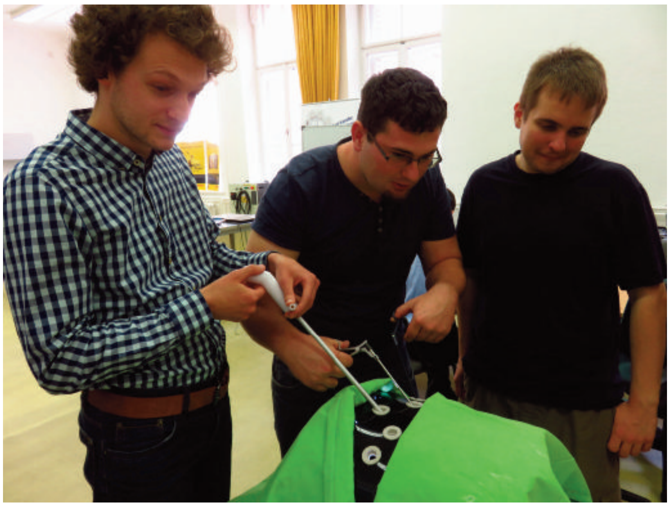
The second subproject deals with the development of a training device for laparoscopic surgery focusing on the haptic feedback capabilities. Existing solutions are generally lack of sophisticated haptics capabilities. It means that even the most advanced systems have only 3 active axes on which the force feedback is viable. However, the human-performed (i.e., not robotic) surgical scenarios usually require the senses of physical interactions along more than three axes. This project focuses on the realization of high quality haptic feedback. In our task, the mechatronic part of the development is addressed, that is comprised of the mechanical design and the servo-level control.

APPLICATION OF FPT-BASED METHODS

In the past years the main research activities and results in the field of application of fixed point transformation-based methods in adaptive control and quasi-differential inverse kinematics can be summarized as follows:

- Application of Fixed Point Transformation-based approach in the control of Hodgkin-Huxley Neuron, Elaboration of novel fixed point transformations for use in adaptive control of a nonlinear neuron model, elaboration of a simple method for the estimation of the adaptive parameters.
- Systematic generalization of a new fixed point transformation-based method for Multiple Input—Multiple Output systems and revealing clearer conditions for its applicability and convergence.
- Application of Fixed Point Transformation-based method was investigated in the control of Type 1 Diabetes Mellitus (T1DM).
- In anaesthesia control on the basis of BIS index, and Wavelet Signal.
- Application in the control of underactuated Classical Mechanical systems: 2 DoF pendulum, Kapitza pendulum, Furuta Pendulum.
- Application in the improvement of the performance of fuzzy models, fuzzy approximate models, performance improvement of fuzzy logic controllers.
- Stiffness Control of a Robotic Arm.
- Adaptive Optimal Control with fixed point transformation methods when the use of the cost function is replaced with time sharing.
- Replacement of the Gram-Schmidt Algorithm with Fixed Point Transformations in the inverse kinematics of redundant robot arms for a 8 DoF redundant robot arm constructed of a PUMA-like basic structure.
- Application in adaptive inverse kinematics.
- Application of Fixed Point Transformation for parameter tuning.

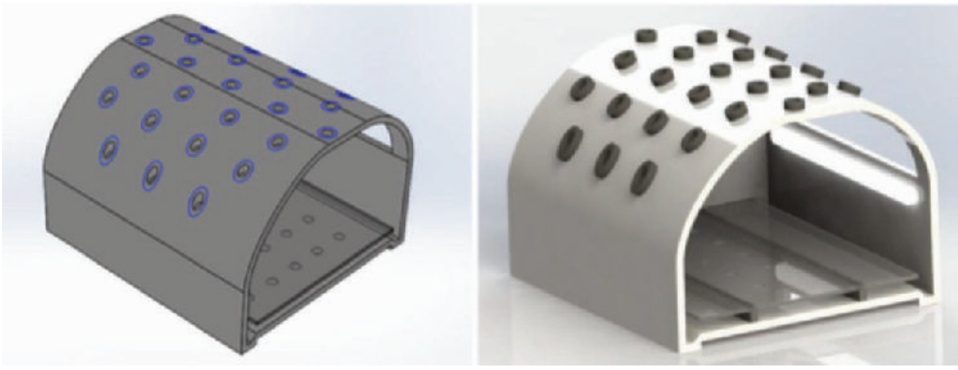
BOX TRAINER FOR SURGICAL SKILL PRACTICE

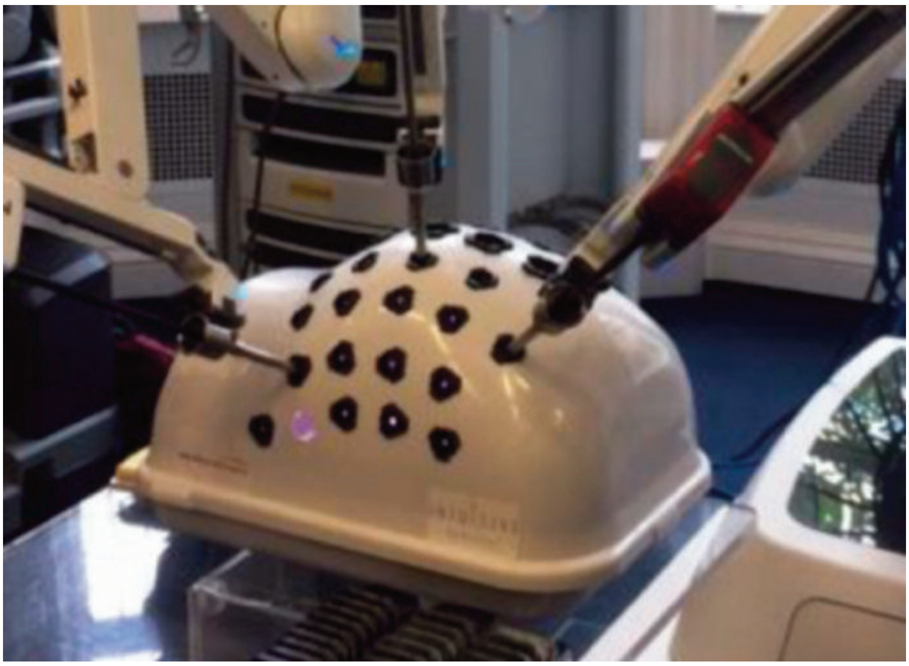


Minimally Invasive Surgery (MIS) has been gaining space for the past 50 years. It has moved surgery from using the tools which are similar to devices used every day (scissors, forcepses, etc.) to tools more sophisticated requiring more dexterity and in general more practice to master. To provide a basic environment for surgeons for out of the operating room practice, box trainers have been created. These basic devices (sometimes literally just a box) are intended to simulate the abdominal and other body cavities MIS is used. Numerous models of box trainers have been proposed, some are intended to stay simple as possible some provide a more realistic image of the human body.
The currently used box trainers are good tools for providing a minimal environment for MIS practice. However, they lack anatomical validity and they are not designed to facilitate precise data collection measurements required in surgical research.

The box trainer developed at the Antal Bejczy Center for Intelligent Robotics has grown out of this need. It was created based on an average of anthropometrical measurements and designed to provide some resemblance of the abdominal cavity. During the design process, port positions were chosen to facilitate multiple surgical procedures (radical robotic prostatectomy, laparoscopic cholecystectomy, etc.).

Our major goal was to make this trainer box not only anatomically correct but to enable the placement of measurement devices (3D optical trackers, force torque measures etc.). We chose an asymmetrical design, which enables optical tracking through a cutoff window on the side of the box as well as the placement of a wide variety of sensors on the bottom of the box.





SURGICAL TRAINING ON A PELVIC PROSTATE PHANTOM

With the rapid advancement of Minimally Invasive surgical techniques and manipulators, it is becoming more and more important that surgeons receive effective and skill oriented training. To satisfy this need, training methodologies were created, evaluated and verified. The first major step for standardized minimally invasive surgery training was the Fundamentals for Laparoscopic Surgery (FLS). It contains tasks in a completely nonclinical setting intending to train surgeon dexterity with the manipulators of minimally invasive surgery. Based on the same concept the Fundamentals of Robotic Surgery (FRS) has been created as well.

The FLS and FRS framework works well in the aspect that it has well-defined tasks on which surgeons can be compared around the globe, however, it lacks the complex anatomical environment surgeons operate in, and therefore its usage in the training of surgical residents is limited.

We created an anatomically realistic surgical phantom of the pelvic cavity intended towards the training of radical prostatectomy. For this procedure, it has been shown that robotic surgery provides not only ergonomic environment for surgeons but also improves patient outcomes and the quality of life after the surgery.

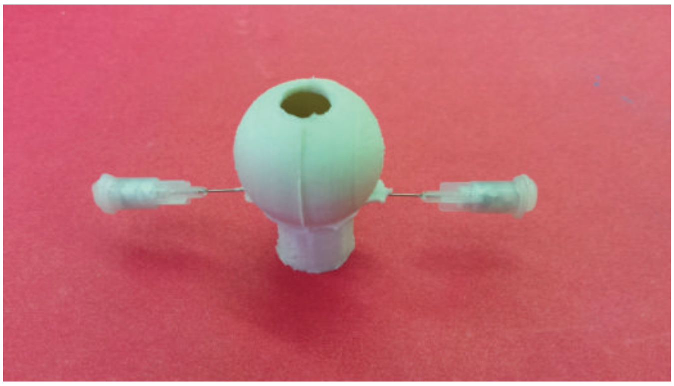
The phantom was created using rapid prototyping techniques: the pelvic ones were 3D printed and the soft tissues of the pelvic cavity were made from silicone using 3D printed molds.

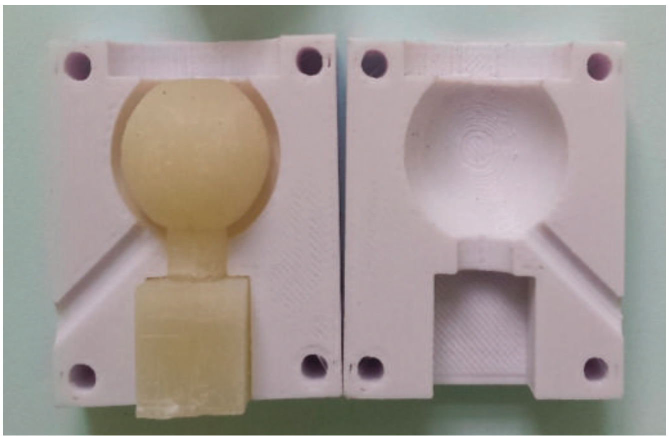
The created model is anatomically correct and easily reproducible. The used test procedure took about 15 min to complete after the phantom could be reset to the original state in about 2-3 min. Surgeons and urologists had a positive take on the model, and were eager to use it in surgical training. Further improvements are necessary to modify the phantom from anatomical correctness to the simulation of in procedure reality.

ROBOT SURGERY RELATED

EYE PHANTOM

An eye phantom model was constructed for a specific retinal vein cannulation surgery. The functional unit of this phantom consisted of a 100 μm diameter tube in a silicone matrix representing a retinal vein in the connective tissue of the retina. This vein as planned to be filled with gallium representing blood in the vein. Gallium was chosen for this purpose because it conducts electricity and stays liquid at room temperature. The needle is inserted into the silicon matrix towards the gallium vessel. When the gallium vessel is reached by the needle electricity can be conducted through the needle and the gallium vessel. Having installed a circuit a LED lights up indicating that the needle is in the right location being inserted in the gallium vessel.





DEVELOPEMENT OF AVG FLEET FOR INTRALOGISTICS

GINOP-2.2.1-15-2017-00097

Start date 10/02/2017 End date: 09/30/2017

The consortium

- GAMMA-DIGITAL Fejlesztő és Szolgáltató Kft. – konzorciumvezető
- Pázmány Péter Katolikus Egyetem
- Óbudai Egyetem

Total grant 724 M HUF

83 M HUF for Óbuda University

Overall goals

- Improve the existing automated intralogistics services to a next level by maximizing the added value from the end-user viewpoint.
- Development of vehicles and navigation strategies that are suitable for both indoor and outdoor operation.
- Full integration of the AGV fleet into the IT services from the ERP to the onboard control level.

iROB responsibilities

- Development of vision-based navigation strategies
  - Support of localization
  - Obstacle recognition and avoidance
  - Other security features
- Optimal sensor fusion for localization
  - Selection of simultaneously operated sensor modalities
  - Development and tuning of optimal filter
  - Smooth transient between in- and outdoor operation

Acknowledgement

The research is supported by the Hungarian State and the European Union under the GINOP-2.2.1-15-2017-00097 project.

SZÉCHENYI 2020

INDUSTRIAL AND MEDICAL CYBER-PHYSICAL **SYSTEM COMPETENCE CENTER**

Organization development in service of intelligent specialization

EFOP-3.6.1-16-2016-00010

Start date 01/01/2017 End date: 04/30/2020

Total grant 392 789 930 HUF

Overall goals

The fundamental goal of the project is the improvement of the research capacities and development of R&D services of the Alba Regia Technical Faculty in Székesfehérvár (OE-AMK) in accord with the National Strategy of Intelligent Specialization (S3). The activities are also focusing on the so-called third mission of the Faculty in order to establish and consolidate the regional “knowledge rectangle” in the Székesfehérvár region.

As the result of the project, the R&D&I potential of the OE-AMK will be significantly improved to serve the social innovation as well as the local industry. Through the 3-year-long period, Óbuda University intensively contributes to the development and maintenance of the renewing intellectual resources and the long-term establishment of the human resource supply in academia in the region.

iROB responsibilities

Through this project, iROB's main mission is the establishment of a Cyber-Physical Systems (CPS) competence center focusing on two main directions, namely the advanced industrial and medical applications.

The medical CPS subproject is aimed at the development of autonomous surgical subtask execution and robot-assisted ultrasound examinations. Within the industrial applications, mainly the collaborative robot applications are considered where high-level, task-oriented programming and intelligent process monitoring is developed through the project.

Both target areas combine the data-driven learning approaches and the analytically established control methodologies, which leads to a powerful combo in real-world applications.

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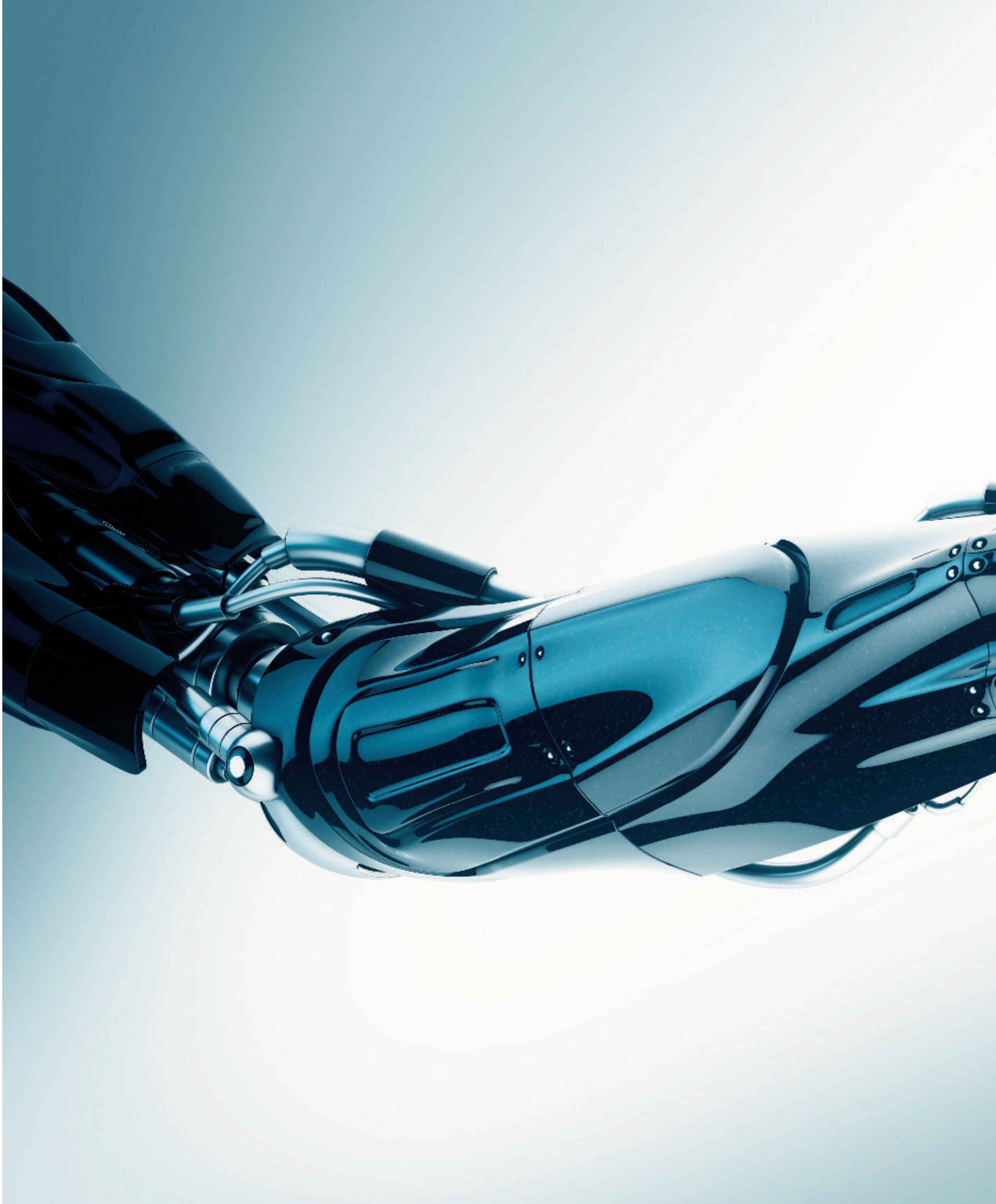

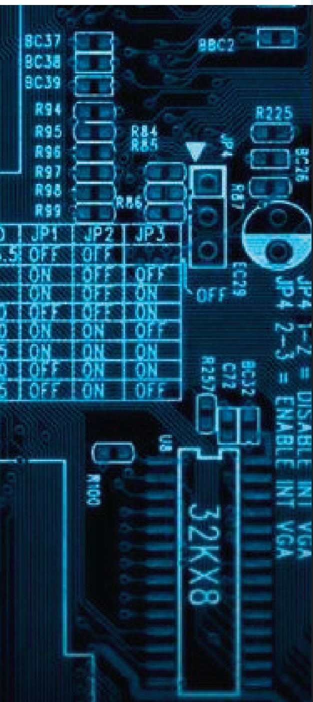

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