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SECTION

ICRA 2011 Full-Day Workshop:

Mechanisms for Surgical Robotics

by Jian S Dai, Nikos G Tsagarakis, Shuxin Wang

ICRA 2011

9th May 2011, Shanghai, China

Welcoming Message

Dear Colleagues and Friends,

It is our great pleasure to welcome you to Shanghai for the **Workshop on Mechanisms for Surgical Robotics** at the **2011 IEEE International Conference on Robotics and Automation** (ICRA 2011).

Mechanisms are fundamental part of surgical robots and constitute the backbone of a surgical robot. In the past 25 years, many new mechanisms were developed for creating the remote centre of motion and many new structures were proposed. Since the first surgical robot was initiated in 1985, the development of surgical robotics has progressed for approximately 25 years with over 1000 surgical robots in regular clinical use worldwide and research and development at over 100 universities. In the next 25 years, surgical robotics promises huge progress comparable to the development of manufacturing robotics in industrial production over the past 25 years. The trend has been clearly indicated by the latest technology that provides superior visuals and enhances dexterity for the surgeon and by the worldwide market value expected to be $5.7 billion by 2011 for medical robots and computer-aided surgery devices and equipment.

The workshop is to review the past 25 years of development of mechanisms and structure study of surgical robots and to discuss the research direction and further development in the next 25 years. This workshop is to reflect the joint effort in cutting-edge research from both surgeons and scientists and from both practitioners and theoreticians. The rich content and wide coverage make this workshop a good forum and a long-lasting reference for both surgeons and scientists working in the field of surgical robotics.

The following topics will be explored:

- Current status of surgical robot development in Europe and the world
- Mechanisms development and surgical instrument development
- Kinematics and dynamics of surgical robots
- Sensors and dexterous manipulation
- Future direction of development in surgical robots.

Welcome to Shanghai and I hope you enjoy the workshop.

With kind regards,

Professor Jian S Dai
Chair in Mechanisms and Robotics

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Dr. Nikos G Tsagarakis
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Prof. Shuxin Wang
Head of School of Mechanical Engineering
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09:00AM - 09:25AM **Medical Robots: Extending Human Capabilities in an Especially Challenging Environment**

Russell H. Taylor

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Abstract: Computer-integrated systems interventional incorporating medical robots will have the same impact in coming decades on surgery that computer-integrated manufacturing systems incorporating industrial robots have already had on industrial production. Working in partnership with human physicians, these systems can improve the precision, safety, and consistency of surgery while reducing invasiveness and enabling new ways to treat disease that would otherwise be impractical or impossible. This talk will first introduce medical robots within the context of computer-integrated interventions. It will then discuss the design of medical robots within the context of the rather special requirements associated with these systems.

Publications: N. Simaan, K. Xu, A. Kapoor, W. Wei, P. Kazanzides, P. Flint, and R. Taylor, A System for Minimally Invasive Surgery in the Throat and Upper Airways, **Int. J. Robotics Research** (special issue on medical robotics), vol. 28- 9, pp. 1134-1153, June 2009.

A. Uneri, M. Balicki, James Handa, Peter Gehlbach, R. Taylor, and I. Iordachita, „New Steady-Hand Eye Robot with Microforce Sensing for Vitreoretinal Surgery Research“, in *International Conference on Biomedical Robotics and Biomechatronics (BIOROB)*, pp 814-819, Tokyo, September 26-29, 2010.

NOTES:

09:25AM - 09:50AM **Single Access Robots for Surgery**

Arianna Menciassi

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on behalf of Paolo Dario
Professor of Biomedical Robotics
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Abstract: The present talk illustrates the current trend of surgical robots in terms of miniaturization of size and limitation of the overall invasiveness and encumbrance. In this scenario, the speaker will present the state of the art in the field with a specific reference to the results of the ARAKNES European Project aiming at developing a set of robots for virtually scarless surgery. A special focus will be on novel mechanisms for miniaturizing surgical arms and manipulators in order to fit accesses with small diameters (between 10 mm and 30 mm).

Publications: M. Piccigallo, U. Scarfogliero, C. Quaglia, G. Petroni, P. Valdastri, A. Menciassi, and P. Dario, Design of a Novel Bimanual Robotic System for Single-Port Laparoscopy. **IEEE/ASME Transactions on Mechatronics**, Vol. 15 (6), pp. 871-878, 2010.

U. Scarfogliero, M. Piccigallo, C. Quaglia, G. Petroni, P. Valdastri, A. Menciassi, and P. Dario, "Bimanual Robot for Single-Port Laparoscopic Surgery with on-board actuation". *The Hamlyn Symposium on Medical Robotics,* pp.27-28, 2010.

NOTES:

09:50AM - 10:15AM **Hands-on Robotic Systems for Surgery**

Brian Davies

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Abstract: The early years of Robotic surgery tended to use Industrial robots, modified for medical use. They tended to be large and were normally used autonomously, i.e. once positioned next to the patient the robot carried out the pre-programmed procedure without further intervention from the surgeon. The concept of hands-on robots, however, involves the surgeon at every stage of the intervention. Here the surgeon holds a force-controlled lever at the tip of the robot to act as a command input. In this way the surgeon is in control of the procedure whilst the robot (a special form of telemanipulator) is used to constrain the surgeon to a safe region whilst allowing complex, but precise, cuts. The author has called this type of control system an Active Constraint Robot, and started a Company, the ACROBOT Company Limited, to exploit the concept. In order to achieve the required robot/surgeon synergy, a direct drive precision low impedance mechanism is required whose features will be described in the workshop.

Publications: B. Davies, Medical robotics - a bright future, **Lancet**, Vol. 368, pp. S53-S54, 2006.

B.L. Davies, F.M. Rodriguez y Baena, A.R. Barrett, et al., Robotic control in knee joint replacement surgery, **Proc Inst Mech Eng H**, Vol. 221, pp. 71-80, 2007.

NOTES:

10:15AM - 10:30AM **Navigation System for Newborns Surgery**

Alícia Casals

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Abstract: In recent years, the development of robotic technology of application in the Operating Room has been possible thanks to the advances in sensing systems capable of referring different reference frames to a world reference.
One of the problems of robotising the operating room is the relatively high cost of surgical robots, compared to industrial robotics. For this reason, surgical robotics progress and application is being much slower.
This work focuses on the introduction of sensors and dexterous manipulation techniques, not directly to robotic systems, but in surgical techniques still done manually, but which benefit from such technology to increase reliability and efficiency. In this sense, this work contributes to improve surgery in a stage between manual and robotic systems, gaining some advantages of robotising techniques but a much lower cost.
The introduction of such robotic techniques to manual interventions contributes to gain confidence in robotic techniques, reducing surgeons' reticence to use them, and allowing its wider introduction as cost is not a so high barrier to surpass.

Publications: Z. Zhang, Iterative Point Matching for Registration of Free-Form Surfaces. **INt. Journal of Computer Vision**, 13(2):119-152, 1994.

Meyer et al., Demonstration of accuracy and clinical versatility of mutual information for automatic multimodality image fusion using affine and thin-plate spline warped geometric deformations, **Medical Image Analysis**. Vol. 1 (3), Pages 195-206, 1997.

10:30AM - 11:00AM **MORNING COFFEE BREAK**

NOTES:

11:00AM - 11:25AM **Design of Mechanical Structures for a Minimally Invasive Surgery Robot**

Shuxin Wang

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Abstract: Minimally Invasive Surgery (MIS) brings many benefits to patients, there are still some drawbacks, such as reduced dexterity, unnatural hand-eye movements, fatigability, etc. for surgeon to perform this kind of operations. To overcome the above drawback, surgical robots are introduced to the operation room. In robot-assisted surgery, robots can provide more degrees of freedom and be used in complex surgery. Surgeons can operate in a comfortable and natural pose in robot-assisted surgery. Robots for minimally invasive surgery have been developed with various mechanical structures. This paper provides a broad overview of design of mechanical structures for a minimally invasive surgery robot. In the paper the mechanical structures of MIS robots are classified into four categories: structure with redundant joints, structure with passive joints, mechanical constrained structure and structure moving inside body. Tendon-driven structure has been designed to develop a novel mechanical structure in the paper.

Publications: S. Wang, L. Yue, Q. Li, J. Ding, Conceptual design and dimensional synthesis of ‘‘MicroHand’’, **Mechanism and Machine Theory**, Vol. 43, pp. 1186–1197, 2008.

S. Wang, H. Wang, L. Yue, A novel knot-tying approach for minimally invasive surgical robot systems, **Int J Med Robotics Comput Assist Surg**, Vol. 4, pp. 268-276, 2008.

NOTES:

11:25AM - 11:50AM **Biomedical Micro/Nano Robot with 3D Motion , 3D vision & 3D Force Sensation**

Koji Ikuta

Contact Details: Professor
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Abstract: Single cell size nano robot driven by the laser bean has been fabricated by the 3D nano fabrication process invented by the speaker. The nano actuation, force measurement and visualization from high speed confocal micro scope are realized in real time and 3D manner. This master-slave nano robot system provide five micron single cell handling in water and nano surgery of a single living cell.

Publications: K. Ikuta, H. Ishii, and M. Nokata, Safety Evaluation Method of Design and Control for Human-Care Robots, **The International Journal of Robotics Research**, Vol. 22, pp. 281-297, 2003.

T. Hasegawa, K. Ikuta, Development of Novel Coupling Method for Biochemical IC Family and Micro Chemical Devices, **IEEJ Transactions on Sensors and Micromachines**, Vol. 124 (9), pp. 305-310, 2004.

NOTES:

11:50AM - 12:05PM **Magnetic Mechanisms for Endoluminal Interventions**

Pietro Valdastri

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Abstract: The progress of endoluminal interventions (including both diagnostic and surgical tasks) depends on the availability of miniaturized components and mechanisms. When scaling down surgical robots size, major constraints are related to the integration of on board powering and actuation systems. This problem becomes more and more important in case of wireless robotic devices.
This presentation illustrates some examples of wireless or softly wired robotic medical devices where novel solutions for powering and actuation have been integrated, especially based on magnetic mechanisms. In particular, three examples will be presented: 1) a robotic platform for capsule endoscopy based on magnetic dragging; 2) a camera system for robotic surgery based on magnetic steering and levitation; 3) a robotic platform for vascular navigation with magnetic propulsion. In all cases, advantages, limitations and typical problems will be discussed.

Publications: M. Simi, P. Valdastri, C. Quaglia, A. Menciassi, and P. Dario, Design, Fabrication, and Testing of a Capsule With Hybrid Locomotion for Gastrointestinal Tract Exploration. **IEEE/ASME Transactions on Mechatronics**, Vol. 15 (2), pp. 170-180, 2010.

P. Valdastri, C. Quaglia, E. Buselli, A. Arezzo, N. Di Lorenzo, M. Morino, A. Menciassi, P. Dario, A magnetic internal mechanism for precise orientation of the camera in wireless endoluminal applications, **Endoscopy**, Vol. 82, pp. 481-486, 2010.

12:05PM - 01:30PM **LUNCH BREAK**

Note that lunch is not included in the registration. The participants should make their own lunch arrangements.

NOTES:

01:30PM - 01:55PM **A Feedback Optimistic Algorithm For Real-Time Robot Drilling**

Tianmiao Wang

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Abstract: In this paper, we present an adaptive feedback simulated annealing optimization framework for nonlinear robot system with unknown execution times and task dependencies. The scheduling issue of periodic tasks with task dependencies and uncertainty is considered. A scheduler with feedback simulated annealing algorithm and performance index is presented. Worstcase response time analysis that affects the real-time deadline miss ratio and task dependency is analyzed. Experiment results show that this adaptive feedback simulated annealing controller can be used in medical robot coordination and path planing. With the given adaptive feedback simulated annealing scheduling algorithm, the system performance and the path planing efficiency can be improved compared with the traditional feedback scheduling algorithms. This feedback framework can meet the unknown requirements for robot path planning and achieve high CPU utilization in real-time control systems without sacrificing the system efficiency.

Publications: K. Sun, M. Wang, Z. Shao, H. Liu, H. Wei, T. Wang, Design and Synthesis of a Multiprocessor System-on-Chip Architecture for Real-Time Biomedical Signal Processing in Gamma Cameras, **J Sign Process Syst**, Vol. 59, pp.71–83, 2010.

C. Meng, T. Wang, W. Chou, S. Luan, Y. Bang, Z. Tm, „Remote Surgery Case: Robot-Assisted Teleneurosurgery“, *Proceedings of the 2004 IEEE International Conference on Robotics and Automation*, pp. 819-823, April 2004.

NOTES:

01:55PM - 02:10PM **The DLR MiroSurge: New Concepts for Robotic Surgery**

Rainer Konietschke

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Abstract: The DLR Institute of Robotics and Mechatronics develops a telesurgery system called MiroSurge. It includes an input (or master) console as well as a teleoperator consisting of 3 surgical robots (MIRO), see Fig. 1. Usually two MIROs carry surgical instruments (MICA) equipped with miniaturized force and torque sensors to capture reaction forces with manipulated tissue. One more MIRO can (automatically) guide a stereo video laparoscope. Both the stereo video stream and the measured forces are displayed to the surgeon at the master console. Thus users are not limited to see but can also feel what they are doing. A customized force feedback device (designed by the company Force Dimension) that allows the display of forces, torques and gripping forces is used as force display.

My talk will present all the components of the MiroSurge system and give some insights to their unique features and the design process. In addition, the integration into a force feedback telepresence system will be shown. As the components of MiroSurge are designed to be versatile, a section of the presentation will be dedicated to additional applications that are already in a prototypic state, such as taking biopsies or performing laser osteotomies.

Publications: U. Hagn, R. Konietschke, A. Tobergte, M. Nickl, S. Jorg, B. Kuebler, G. Passig, M. Groger, F. Frohlich, U. Seibold, L. Le-Tien, A. Albu-Schaffer, A. Nothelfer, F. Hacker, M. Grebenstein, G. Hirzinger, DLR MiroSurge - A Versatile System for Research in Endoscopic Telesurgery. In: **International Journal of Computer Assisted Radiology and Surgery**, 2009. published online first, Doi: 10.1007/s11548-009-0372-4.

R. Konietschke, U. Hagn, M. Nickl, S. Jorg, A. Tobergte, G. Passig, U. Seibold, L. Le.Tien, B. Kuebler, M. Groger, F. Frohlich, Ch. Rink, A. Albu-Schaffer, M. Grebenstein, T. Ortmaier, G. Hirzinger, „The DLR Miro Surge - A Robotic System for Surgery“. In *Proceedings of the 2009 IEEE International Conference on Robotics and Automation (ICRA)*, 2009.

NOTES:

02:10PM - 02:25PM **Robotically Steering Flexible Endoscopes for NOTES**

Sarthak Misra

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Abstract: Manually steering the tip of a flexible endoscope to navigate through an endoluminal path relies on the physician's dexterity and experience. A robotic flexible endoscope steering system was developed that uses the endoscopic images to control the endoscope tip orientation towards the direction of the lumen. Two image-based control algorithms were investigated, one is based on the optical flow and the other is based on the image intensity. Both were evaluated using simulations in which the endoscope was steered through the lumen. The RMS distance to the lumen center was less than 25% of the lumen width.

An experimental setup was built using a standard flexible endoscope, and the image-based control algorithms were used to actuate the wheels of the endoscope for tip steering. Experiments were conducted in an anatomical model to simulate gastroscopy. The image intensity-based algorithm was capable of autonomously steering the endoscope tip through an endoluminal path from the mouth to the duodenum. The steering was compared to manual control in an experiment were five subjects performed the same procedure using the conventional endoscope controls. Compared to manual control, the robotically steered endoscope performed 68% better in terms of keeping the lumen centered in the image.

The developed image processing algorithm was also used in an experimental setup where a flexible endoscope was steered in a ‚shared control' mode. Using this setup, the endoscope was steered using a haptic device, while haptic feedback was given based on the output from the image-processing algorithm. This way, the endoscope could be controlled by the operator and the image-processing algorithm simultaneously. The purpose of this setup was to develop an alternative control method for next generation of complex endoscopes that are currently being developed for Natural Orifice Transluminal Endoscopic Surgery (NOTES). It is not possible to control these endoscopes by a single physician. Hence, robotically steering such advanced endoscopes using our proposed approach could be a solution.

Publications: R Reilink, S Stramigioli, and S Misra, „Image-based endoscope steering", in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 2339-2344, Taipei, Taiwan, October 2010

R Reilink, S Stramigioli, A M L Kappers, and S Misra, Evaluation of flexible endoscope steering using haptic guidance', **The International Journal of Medical Robotics and Computer Assisted Surgery**, 2011. *In Press.*

NOTES:

02:25PM - 02:40PM **Robot-Assisted Percutaneous Cochlear Implantation**

Robert J. Webster III

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http://www.vanderbilt.edu/CAOS/

Abstract: I will discuss the latest advancements in miniature robots for percutaneous cochlear implantation. This image-guided surgical procedure involves drilling to a specific location inside the skull, while bypassing sensitive bone-embedded nerves and blood vessels, the violation of which has catastrophic consequences for the patient. The procedure replaces a tedious and dangerous manual procedure requiring making a pocket in the skull behind the ear with a hand-drill. I will describe the kinematics, mechanical design, and cadaveric experimental results with a miniature bone-attached parallel robot for aligning the drill, and both robotic and manual implant insertion tools. Experiments show accuracies of 0.20mm in phantom studies, and 0.38mm a cadaver.

This involves a number of workshop topics: mechanism development including kinematics and design of several robots, application of evolutionary robots in orthopedic surgery, and future directions including milling pockets and accessing other targets (e.g. deep brain stimulation).

Publications: L.B. Kratchman, G.S. Blachon, T.J. Withrow, R. Balachandran, R.F. Labadie, and R.J. Webster III, „Toward Automation of Image-Guided Microstereotactic Frames: A Bone-Attached Parallel Robot for Percutaneous Cochlear Implantation“, *Robotics Science and Systems 2010: Workshop on Enabling Technologies*, pp.1-5, 2010.

D. Schurzig, R.F. Labadie, A. Hussong, T.S. Rau, R.J. Webster III, Design of a Tool Integrating Force Sensing with Automated Insertion in Cochlear Implantation, **IEEE Transactions on Mechatronics**, pp. 1-9, 2011.

NOTES:

02:40PM - 02:55PM **ROBOCAST and ACTIVE: Advanced Robotics for Neurosurgery**

Elena De Momi, Giancarlo Ferrigno

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www.active-fp7.eu

Abstract: Since 2008 the NEARLab Medical Robotics group has been working on advanced robotics systems for neurosurgery applications. The goal of the ROBOCAST project (FP7 ICT 215190) is to provide a system for the assistance of keyhole neurosurgery. The system combines a human-computer interface (HCI), with an intelligent context-sensitive communication and a haptic-drive capability, a multiple-robot hierarchical chain with redundant degrees of freedom, an autonomous trajectory planner, a high level controller and a set of field sensors. The idea has been developed into a working demonstrator for in vitro tests in the operating room (OR). Using the ROBOCAST platform it is not possible to compensate for any unexpected head movement in case of awake surgery procedures, with the purpose of the mapping of cortical areas and subcortical pathways involved in motor, sensory, language, and cognitive function. Motion compensation is therefore mandatory for avoiding potential damage to brain structures. The ACTIVE project (FP7 ICT 270460) aims to push the boundaries of current surgical robotics by addressing many of the shortcomings of current systems, namely the lack of touch feedback, the need for rigid frames of reference, difficulties with soft tissue manipulations, slow response time and limitations in the control strategies developed to date. It will tackle the traditional drawbacks of robotic systems which enter the operating room (e.g. encumbrance, slow execution, lack of interfaceability, non real-time controllability) working in close cooperation with humans.

Publications: De Momi E., Ferrigno G., „Robotic and artificial intelligence for keyhole neurosurgery: the ROBOCAST project, a multi-modal autonomous path planner“, *Proceedings of the Institution of Mechanical Engineers*, Part H: **Journal of Engineering in Medicine**, Vol. 224 (5), Special Issue on Image-guided Surgery, pages: 715-727, 2010.

D. De Lorenzo, E. De Momi, R. Manganelli, I. Dyagilev, A. Formaglio, D. Prattichizzo, M. Shoham and G. Ferrigno, Force feedback in a piezoelectric linear actuator for neurosurgery, **International Journal of Medical Robotics and Computer Assisted Surgery**, 2011, *accepted for publication*.

NOTES:

02:55PM - 03:10PM **How Clinical Demand can Drive Innovation in Medical Robotics**

Sebastian Schostek

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Abstract: With the advent of minimally invasive surgery, surgeons and engineers have worked together to develop novel technologies to overcome the difficulties associated with the technique, and at the same time to exploit and strengthen the advantages for patients. This field of multi-disciplinary R&D has provided the foundations of today's state of the art in medical robotics, and is continuously paving the way to more effective surgical treatments with minimal patient trauma in novel clinical trends such as NOTES.

In order to bring an innovation process in this field to commercial success, three main stakeholders have to work together: engineers, clinicians and business men. By providing an insight into the innovation process within the scope of European Projects VECTOR and ARAKNES, it is highlighted how the different viewpoints of the three groups can be merged to create innovation in medical robotics.

Publications: M. Quirini, A. Menciassi, S. Scapellato, P. Dario, F. Rieber, C.-N. Hoa, S. Schosteka and M.O. Schurr, Feasibility proof of a legged locomotion capsule for the GI tract, **Gastrointestinal Endoscopy**, Vol. 67 (7), pp. 1153-1158, 2008.

S. Schosteka, M.O. Schurra and G.F. Buessb, Review on aspects of artificial tactile feedback in laparoscopic surgery, **Medical Engineering & Physics**, Vol. 31 (8), pp. 887-898, 2009.

03:35PM - 04:00PM **AFTERNOON COFFEE BREAK**

NOTES:

04:00PM - 05:00PM **Live Transmission** (in arrangement)
Prokar Dasgupta

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Information: Professor Prokar Dasgupta and his team will trasmit a robotic assisted radical prostatectomy live from Guy's Hospital, King's College London.
Dasgupta is Chair of Robotic Surgery and Urological Innovation at King's Health Partners London and pioneered robotic surgery in the UK. His clinical interests include robotic assisted prostatectomy, cystectomy and pyeloplasty. His laboratory interests are based around image-guided surgery, haptics, ergonomics and flexible robotics. He has nearly 500 publications and is Executive Board member of the British Association of Urological Surgeons.

Publications:
D. Zbyszewski, H. Liu, K. Althoefer, C.S. Nunes, L.D. Seneviratne, B. Challacombe, D. Murphy, P. Dasgupta, "Wheel/tissue force interaction: a new concept for soft tissue diagnosis during MIS", *Conf Proc IEEE Eng Med Biol Soc 2008*; pp. 5556-9, 2008.

U. Vivekananda, A. Henderson, D.G. Murphy, K. Althoefer, L.D. Seneviratne, P. Dasgupta, „The science behind haptics in robotic urological surgery", *BJU Int***,** 2009.

NOTES:

Workshop Program At A Glance

Time	Title / Presenter
09:00AM - 09:25AM	**Medical Robots: Extending Human Capabilities in an Especially Challenging Environment** *Russell H. Taylor*
09:25AM - 09:50AM	**Single Access Robots for Surgery** *Arianna Menciassi*
09:50AM - 10:15AM	**Hands-on Robotic Systems for Surgery** *Brian Davies*
10:15AM - 10:30AM	**Navigation System for Newborns Surgery** *Alícia Casals*
10:30AM - 11:00AM	**Morning Coffee Break**
11:00AM - 11:25AM	**Design of Mechanical Structures for a Minimally Invasive Surgery Robot** *Shuxin Wang*
11:25AM - 11:50AM	**Biomedical Micro/Nano Robot with 3D Motion , 3D vision & 3D Force Sensation** *Koji Ikuta*
11:50AM - 12:05PM	**Magnetic Mechanisms for Endoluminal Interventions** *Pietro Valdastri*
12:05PM - 01:30PM	**Lunch Break** Note that lunch is not included in the registration. The participants should make their own lunch arrangements.
01:30PM - 01:55PM	**A Feedback Optimistic Algorithm For Real-Time Robot Drilling** *Tianmiao Wang*
01:55PM - 02:10PM	**The DLR MiroSurge: New Concepts for Robotic Surgery** *Rainer Konietschke*
02:10PM - 02:25PM	**Robotically Steering Flexible Endoscopes for NOTES** *Sarthak Misra*
02:25PM - 02:40PM	**Robot-Assisted Percutaneous Cochlear Implantation** *Robert J. Webster III*
02:40PM - 02:55PM	**ROBOCAST and ACTIVE: Advanced Robotics for Neurosurgery** *Elena De Momi, Giancarlo Ferrigno*
02:55PM - 03:10PM	**How Clinical Demand can Drive Innovation in Medical Robotics** *Sebastian Schostek*
03:30PM - 04:00PM	**Afternoon Coffee Break**
03:30PM - 05:00PM	**Live Transmission** (in arrangement) *Prokar Dasgupta*