ATLAS

ATLAS TRAINING GUIDE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 813782

PROJECT OBJECTIVES

Surgical Fields

COLONOSCOPY
GASTROSCOPY
URETEROSCOPY
ENDOVASCULAR CATHETERIZATION

Many medical procedures these days take advantage of natural orifices and tubular structures that are already present in our body. For example during inspection of the colon or of the urethra, or when a heart valve needs to be replaced, instruments are passed through so-called 'lumens', tortuous canals through which otherwise various substances are transported through the body, but which can also serve as an access route to internal organs.

These Minimally Invasive Surgical (MIS) interventions make use of flexible instruments that can conform to the respective body cavities or lumens. It is now possible to reach locations deep into the body without or with only very small incisions. However, manoeuvring flexible tools in these environments is difficult as the intervention takes place under poor visualization. Since the lumens are fragile, precise control is needed to avoid damaging or piercing tissue. Given that the instruments are long and flexible they remain difficult to reliably control.

The goal of ATLAS is to ease and improve the effectiveness of these kinds of interventions. Hereto, the project will progress the state of the art of robotic surgery and all relevant aspects involved such as: actuation and sensing for flexible instruments, automatic localization of instruments, anatomy and tissue,

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estimation of the surgical workflow and state of the operation, dedicated context-aware control schemes, interfaces and guidance schemes for intuitive operation.

Ultimately the envisioned technology will optimize the patient outcome (higher success, reduced pain and recovery time) and will further reduce the mental load and physical stress of the surgeon which is expected to also benefit the reliability and safety of the intervention.

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THE ATLAS PROJECT

ATLAS is a Marie Curie Innovative Training Network Project, funded by the Horizon 2020 program. The project consortium is made up of seven university research groups that are active in the field of surgical robotics for many years.

The project will establish a dedicated training program raising expert engineers endowed with the necessary skills and capabilities to understand and deal with these complex surgical robotic challenges.

ATLAS Skills

UNDERSTANDING **CLINICAL NEEDS**
MASTERING **ACTUATION TECHNOLOGIES**
DEVELOPING **SENSING TECHNOLOGIES**
DEVELOPING **COMPLEX MODELS**
DEALING WITH **INTEGRATION** ISSUES

ATLAS WPs

WP1: ACTUATION TECHNOLOGY
WP2: INTRA-OPERATIVE SENSING
WP3: 4D MODELLING AND RECONSTRUCTION
WP4: AUTONOMOUS INTRALUMINAL NAVIGATION

This project funds doctoral positions for 15 *Early Stage Researchers* (ESRs). These ESRs will be the first generation trained on these key capabilities while at the same time tackling relevant and highly important research questions. The research activities are grouped into four principal scientific Work Packages (WPs) that cover most aspects of robotic surgery, from the development of flexible instruments and drive technology up to control for autonomous navigation throughout the lumens.

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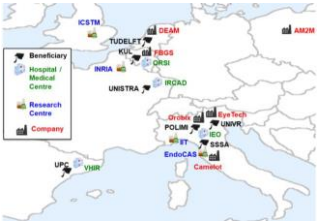
THE ATLAS CONSORTIUM

The training network is hosted by seven universities with complementary and profound knowledge in the field of surgical robotics and intraluminal navigation.



- KU Leuven (KUL, Coordinator)
- Università Degli Studi Di Verona (UINVR)
- Politecnico Di Milano (POLIMI)
- Université De Strasbourg (UNISTRA)
- Scuola Superiore Sant'Anna (SSSA)
- Techische Universiteit Delft (TUDELFT)
- Universitat Politècnica De Catalunya (UPC)

Within the project, each university serves as a Centre of Excellence (CoE) on a specific field. Each CoE is responsible for training along their specialities. In addition to Universities, a strong network of highly valued *partner organizations* has been assembled. They will support the ERSs who get into contact through internships at relevant industries, hospitals, and research centres. The partner organizations bring in e.g. experience in exploitation, clinical practices, and regulatory affairs into the project.

CoE's

UNISTRA: CLINICAL NEEDS AND TRANSLATION
TUDELFT: SOFT ROBOT ACTUATION
SSSA: INTRA-OPERATIVE SENSING
POLIMI: MODELLING AND RECONSTRUCTION
KUL: SYSTEM INTEGRATION AND REAL-TIME CONTROL
UNIVR: DISSEMINATION & EXPLOITATION
UPC: HUMAN FACTORS & ROBO-ETHICS

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KU LEUVEN (KUL)

KU Leuven is the biggest university in Belgium, counting more than 50.000 students in its main and satellite campuses. KUL is ranked in the top 100 of the university ranking in the world. KUL participates with the Robotic Assisted Surgery (RAS) Group, located in the department of Mechanical Engineering, in the lush Heverlee campus, just outside Leuven city centre.

OUR ROLE

KUL focuses on how sensing, both to empower robotic catheters automatic steering, and to reconstruct the global geometry of a lumen. In addition, KUL is responsible for software integration. KUL is the project coordinator.

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OUR PEOPLE

Emmanuel Vander Poorten is currently an Assistant Professor at the Mechanical Engineering Department in KU Leuven, Belgium. He was awarded a Ph.D in 2007 from Kyoto University, in Japan. He is coordinator of the Robot-Assisted Surgery group, has been founder of CRAS, the Joint Workshop on New Technologies for Computer/Robot Assisted Surgery and is also part of the Steering Board Member of ACTUATOR a biennial event bringing together leading experts, suppliers and users of new actuators and low-power electromagnetic drives. Dr. Vander Poorten's research interests include medical device design, haptics, telesurgery, robotic co-manipulation and control of flexible instruments and robotic catheters.

Joris de Schutter is a full professor at KU Leuven and a member of Core Lab ROB of Flanders Make, the Flemish Manufacturing Innovation Network. He is the Head of the Mechanical Engineering deparment. He received the MSc degree in mechanical engineering from KU Leuven, Belgium (1980), the MSc degree from MIT (1981), and the PhD degree in mechanical engineering, also from KU Leuven (1986). Prof. de Schutter's research interests include: robot control and programming based on models, sensors and constrained optimization; human-robot interaction; programming by human demonstration; and generalizing human-demonstrated robot skills to new situations. On this last topic he received an ERC Advanced Grant in 2018.

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Jos Vader Sloten obtained the MSc and PhD in mechanical engineering from KU Leuven in 1985 and 1990 respectively. He is full professor at the Division of Biomechanics at KU Leuven. He founded the Leuven Medical Technology Centre (L-MTC) in 2008. From 2006 to 2012 he served as programme director of the Master in Biomedical Engineering at KU Leuven. His research interests are computer applications in musculoskeletal biomechanics and computer integrated surgery. He is member of the council of the Belgian Society for Medical and Biological Engineering and Computing, and a former council member of the European Society of Biomechanics. In the European Alliance for Medical and Biological Engineering and Science (EAMBES) he served as secretary-general (2003-2004), president-elect (2005) and president (2006). He is Doctor Honoris Causa at the University of Suceava (Romania) and a foreign member of the Polish Academy of Sciences. Between 2014 and 2018 he represented the Faculty of Engineering Science of KU Leuven within the Board of Directors of CESAER. Since 2016 he is Vice Dean for International Affairs of the Faculty of Engineering Science. He is co-founder of the spin-off company Custom8 and member of the board of directors of the companies Materialise NV and Roryco NV and of the non-profit organisation ORSI (robot assisted surgery training and research).

Gianni Borghesan is a reserch expert working in the RAS Group, and a member of Core Lab ROB of Flanders Make. He graduated at the University of Pisa, and was awarded the doctoral degree at the University of Bologna. His main research intrestests are robotic control and software development applied to medical robotics. Dr. Borghesan is doing the daily coordination of the ATLAS project.

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Moloud Ourak is at RAS group as a postdoctoral researcher since 2017. He holds a Ph.D. in Robotics from Université de Franche-Comté (2016). His research interests include surgical robotics, medical robotics design and control, as well as the development of visual servoing and vision methods.

OUR STORY

The Robot Assisted Surgery group is a dynamic research group of the Mechanical Department at the KU Leuven in Belgium. The group established by Prof. H. Van Brussel, is now headed by professors Emmanuel Vander Poorten, Joris De Schutter and Dominiek Reynaerts from PMA for robot design, development, control and micro-mechanical issues and by professor Jos Vander Sloten from BMe for the biomechanical input. Furthermore, the group affiliates 5 Post-Doc researchers and around 15 PhD students. The group works in close collaboration with the University Hospital Leuven. The Robot Assisted Surgery group is also a partner of the Leuven Medical Technology Centre.

The RAS group has participated in several projects focusing on smart catheters and flexible instruments, amongst them the EU-funded projects SCATH and CASCADE. GIFT-SURG an EPSRC/WT funded project on fetal surgery is another high impact project the group is involved in. In addition, the group is active in the field of robotic eye surgery. Throughout the years the group has collected a broad knowledge on flexible instrument design, sensor design, autonomous guidance and software for control and estimation.

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UNIVERSITÁ DI VERONA (UNIVR)

The University of Verona (Italian: Università degli Studi di Verona) is a public university located in Verona, Italy. It is a young and dynamic university since it was founded in 1982. It has already received prestigious national and international recognition, and it is constantly investing resources for further improving. It has currently 22,000 students and 1,500 staff including lecturers, researchers, technical and administrative personnel who work to continually improve and grow the university.

UNIVR participates to ATLAS with the ALTAIR robotics lab, headed by Prof. Fiorini.

OUR ROLE

UNIVR has a long history in education of surgical robotics, since Prof. Fiorini is funder of Biennial School on Cognitive Surgical Robotics (COSUR). In addittion, this group is renowed for the research in the fields of control and enviroment identification, aiming to develop cognitive teleoperation systems and autonomous guidance for complex action sequences in

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uncertain and partially unknown environments, such as endoluminal surgical procedures.

OUR PEOPLE

Paolo Fiorini received the Laurea degree in Electronics Engineering from the University of Padova, (1976), the MSEE from the University of California at Irvine (1982), and the Ph.D. in ME from UCLA (1994). From 1977 to 1985 he worked for companies in Italy and in the US developing microprocessor-based controllers for domestic appliances, automotive systems, and hydraulic actuators. From 1985 to 2000, he was with NASA Jet Propulsion Laboratory, California Institute of Technology, where he worked on autonomous and teleoperated systems for space experiments and exploration. In 2001 he returned to the Department of Computer Science of the University of Verona (Italy) where is currently Full Professor. He founded the ALTAIR robotics laboratory to develop tele-robotic systems for space, medicine, and logistics, focusing on delicate tasks, such as robotic surgery. In the past 15 years he received several European and Italian grants in robotic surgery, addressing accuracy, safety and autonomous capabilities of surgical robots. He also founded four companies in robotic surgery. His activities were recognized by the Entrepreneurship Award at the European Robotics Forum, the Antonio D'Auria award for robotic aids for disabled people, the IEEE Fellowship (2009), and several NASA Technical Awards.

Diego Dall'Alba received the Master Degree with honors in "Intelligent and multimedia systems" from the University of Verona, Italy, in 2010. He received a Ph.D. in Computer Science from the University of Verona in 2014. Since 2008 he is member of the Altair robotics laboratory (Verona, Italy). He has been involved in 5 European projects related to medical robotics: AccuRobAs, Safros, ISUR, MURAB

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and ARS. In 2012, he was visiting researcher at the University of British Columbia (Vancouver, Canada). He is currently working as assistant professor in the Department of Computer Science at the University of Verona, working in the development of enabling technologies for autonomous robotic surgical procedure (funded by MURAB and ARS projects). His main research interests are in the field of surgical robotics (advance sensing and multi-modal data processing), computer assisted and image guided surgical systems.

OUR STORY

ALTAIR Robotics Laboratory at the University of Verona (UNIVR) is an Italian Center of Excellence in the research and development of advanced robotic systems that can interact with the surrounding environment in multiple ways from teleoperation to autonomous behaviours. ALTAIR was founded in 2001 by computer science Prof. Paolo Fiorini and has focused since the beginning on the areas of robotic surgery, human-robot interaction service robotics for elderly and disabled care, search and rescue robotics.

ALTAIR Robotics Laboratory has been awarded several EU and Italian grants including projects on robotic surgery such as AccuRobAs, SAFROS, I-SUR, and EuRoSurge and has developed over the years a wide knowledge in the field of robotic surgery. Current

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projects related to surgical robotics are ARS, SARAS and MURAB.

In 2014 ALTAIR was granted a complete da Vinci Research Kit (dVRK) surgical robotic platform. Thanks to the availability of this system we have started several new lines of research, related to improved hardware designs and advanced control algorithms, with the objective of providing semi-autonomous surgical tasks execution. These activities are carried out by a group of more than 20 people, including 6 faculty members, 4 post-doc, 10 doctoral students and several undergraduate students carrying out their Bachelor and Master theses. Besides the dVRK, ALTAIR is equipped with several robotic devices, i.e. 2 PUMA 260, 1 WAM, 4 Phantom Omni, two Freedom 7 joysticks, and two optical trackers.

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POLITECNICO DI MILANO (POLIMI)

Politecnico di Milano is one of the biggest Italian universities, with more than 30.000 students. In the QS World University Rankings, among Engineering & Technology 2015, Politecnico is ranked 24th in the World and 1st in the Italian rank. The Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB), one of the largest ICT Departments in Europe, counts 240 faculty members and about 450 short-term researchers and Doctoral students.

The Neuroengineering and Medical Robotics Laboratory (Nearlab) was founded in 2008 and is active in the fields of medical robotics, computer assisted surgery, biomechanics, neuroengineering, rehabilitation and assistive devices.

OUR ROLE

POLIMI has an established and successful track record in safe motion planning for steerable and flexible catheters in soft tissue, thanks to the participation to the EDEN2020 project (www.eden2020.eu).

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Computer vision methods and machine learning techniques have been applied for tissue semantic segmentation, 3D surface reconstruction and instruments and tissue tracking using endoscopic images.

In the ATLAS project, POLIMI is in charge of leading the research regarding modelling and reconstruction as well as of overseeing the training and publication activities of the consortium

OUR PEOPLE

Elena De Momi is MSc in Biomedical Engineering in 2002, PhD in Bioengineering in 2006, currently Associate Professor in the Electronic Information and Bioengineering Department (DEIB) of Politecnico di Milano. She is co-founder of the Neuroengineering and Medical Robotics Laboratory, in 2008, being responsible of the Medical Robotics section. IEEE Senior Member, she is currently Associate Editor of the Journal of Medical Robotics Research, of the International Journal of Advanced Robotic Systems, Frontiers in Robotics and AI and Medical & Biological Engineering & Computing. She is responsible for the lab course in Medical Robotics and of the course on Clinical Technology Assessment of the MSc degree in Biom. Eng. at Politecnico di Milano and she serves in the board committee of the PhD course in Bioengineering.

Her academic interests include computer vision and image-processing, artificial intelligence, augmented reality and simulators, teleoperation, haptics, medical robotics, human robot interaction. She participated to several EU funded projects in the field of Surgical Robotics.

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Giancarlo Ferrigno is Full Professor in the Electronic Information and Bioengineering Department of politecnico di Milano. MSc in Electronic Engineering in 1983, and PhD in Bioengineering in 1990. After six years as senior researcher in a private foundation started his academic career at Politecnico di Milano University He chaired the PhD program in Bioengineering from 2001 to 2004. From 2004 to 2006 he was appointed director of the Politecnico di Milano PhD School. From 2007 to 2009 he directed the Bioengineering Department. From 2016 he is chair of Bioengineering division of the Department of Electronics, Information and Bioengineering. In 2008 he founded the Neuroengineering and Medical Robotics Laboratory He has been responsible of grants from Italian Research Ministry, Industrial Companies, Italian Space Agency. In the last years he has been the European Coordinator of three FP7 EU projects in the ICT topic, in the field of the Surgical and Computer assisted Robotics and Assistive and Rehabilitative Robotics and PI partner of two Horizon2020 projects

OUR STORY

Medical Robotic Section (MRSLab) of the NearLab has been founded 10 years ago. Since then, we have been working on developing innovative methods and devices for clinical and surgical applications. Main current research topics at MRSLab are:

- **Pre-operative planning:** Automatic and intelligent planners for neurosurgical keyhole interventions (biopsy, DBS electrodes placements and stereo EEG), using straight electrodes or steerable needles. Advanced vessel visualization classification using machine learning approaches. Advanced biomechanical models for precise drug delivery planning.

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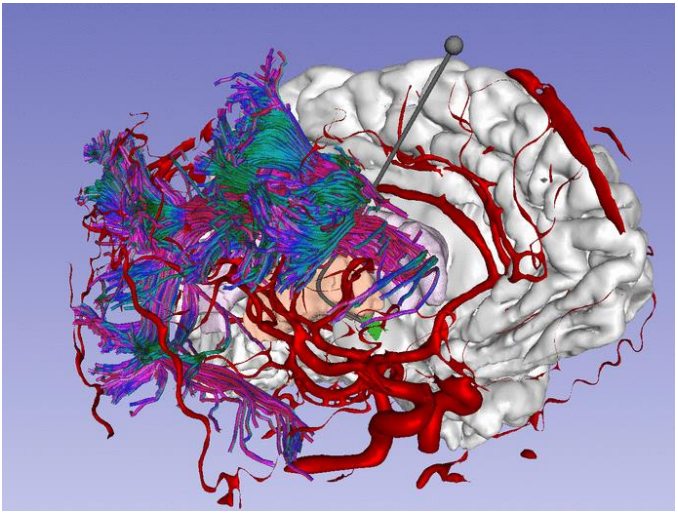
- Surgical robotics (training and interventions): Novel interfaces for improved human robot interaction in surgical applications. Augmented reality (surfaces reconstruction and feature tracking) for increasing the surgical safety in robotic-based interventions using artificial intelligence tools (SMARTsurg). Sensory overlay for improved surgical gestures and surgical training during tele-operation (in collaboration with SSSA).

- Human robot interaction: Safe and improved collaboration between human and robot. Light exoskeletons for improved ergonomics during industrial tasks and EMG-controlled lower limb prosthesis (in collaboration with the Italian Institute of Technology).



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UNIVERSITY OF STRASBOURG (UNISTRA)

The university of Strasbourg is one of the largest French universities, with more than 50 000 students including 20% of international students. UNISTRA participates through the ICube laboratory, a major driving force for research in Strasbourg, and its Automation, Vision and Robotics (AVR) team. The team is situated on the "Hopital Civil" campus, steps away from Strasbourg cathedral and the city centre.

OUR ROLE

UNISTRA focuses on mechatronic design and control of catheters and flexible endoscopes, as well as on enabling cognitive abilities of the robot through camera and OCT-based activity and tissue recognition. We have a longstanding experience of clinical partnerships and translation, which we will make use of as a clinical translation center of excellence in the ATLAS project.

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OUR PEOPLE

Michalina Gora obtained her PhD in 2010 from Nicolaus Copernicus University in Poland. Subsequently, she was a postdoctoral researcher in the team of Prof. Guillermo Tearney at the Wellman Center for Photomedicine, Massachusetts General Hospital and later a junior faculty at Harvard Medical School in Boston. Since 2015, she is a tenure researcher at the French National Center for Scientific Research (CNRS). She is leading a research group in the ICube Laboratory in Strasbourg focused on combining optical methods with robotics for comprehensive diagnosis and improved minimally invasive treatment of diseases.

Florent Nageotte has been Associate Professor at the University of Strasbourg since 2006. He got his master degree and engineer diploma from the Telecom Physique Strasbourg high school in 2000, with a major in robotics control after an internship at the university of Minnesota. He got his PhD thesis in medical robotics from the university of Strasbourg in 2005. He has interest in flexible robot control and on the use of medical images for improving the behaviour and accuracy of these devices.

Michel de Mathelin obtained his Ph.D. in 1993 from Carnegie Mellon University. He is a Full Professor at the University of Strasbourg, Head of the ICube Laboratory since 2013, and former head of the Automation, Vision and Robotics team from 2000 to 2012. Since January 2017 he is also Vice-President of the University of Strasbourg for Innovation and Technology Transfer. His current research interests include medical robotics, image-guided surgery, teleoperation, visual servoing, and adaptive control. He holds 8 patents and is co-founder of Axilum Robotics.

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Nicolas Padoy is a Professor at the University of Strasbourg. He created and is currently leading the research group CAMMA on Computational Analysis and Modeling of Medical Activities, which focuses on computer vision, activity recognition and the applications thereof to surgical workflow analysis and human-machine cooperation during surgery. He completed his PhD jointly between the Chair for Computer Aided Medical Procedures at TUM and the INRIA group MAGRIT in Nancy. Subsequently, he was a postdoctoral researcher and later an Assistant Research Professor in the Laboratory for Computational Interactions and Robotics at the Johns Hopkins University, USA.

Pierre Renaud is a Full Professor at INSA Strasbourg. He received a Ph.D. degree in robotics from the Clermont-Ferrand Univ., France in 2003. He was a Visiting Professor at Stanford University as a Fulbright fellow in 2010-2011. He co-founded Axilum Robotics in 2011 and he is a former head of the AVR team at ICube. His research interests include design and fabrication of medical robotics systems, including continuum robots**.**

Benoit Rosa obtained his Ph.D. in 2013 from Pierre and Marie Curie university, Paris, France. From 2013 to 2015 he was a postdoctoral fellow at KU Leuven, and from 2015 to 2015 a research fellow at Boston Children's Hospital, Harvard Medical School. He is now a tenured researcher at the French National Center for Scientific Research (CNRS). His research interests within the AVR team at ICube, UNISTRA, include design and control of flexible medical devices and continuum robots, using a mixture of vision-based control, mechatronic design, and mechanical modeling methods.

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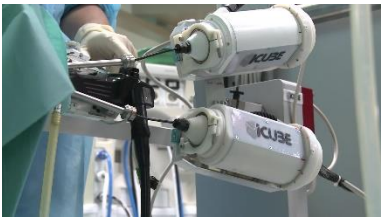
OUR STORY



The Automation, Vision and Robotics (AVR) team is part of the ICube Laboratory in Strasbourg. The team gathers 60 members who design and evaluate novel robotic systems with an expertise on mechatronic design, control, and computer vision. The group has a longstanding experience and international reputation on robotic systems for biomedical applications, with long-term collaborations with clinical partners. The AVR team works in close collaboration with the Strasbourg Hospital, as well as IRCAD and the IHU Strasbourg, and has a wide knowledge and experience in the development and translation of medical research devices. On a national level, the team is a member of the CAMI Labex, a French "Laboratory of Excellence" centred on Computer Assisted Medical Interventions.

The AVR team has participated to several national and European projects focusing on flexible instruments. A notable example is the STRAS project, in which a robotized flexible endoscopy platform was developed. The platform was successfully used preclinically for endoluminal colorectal surgery, and transferred to an industrial partner. Other projects involve a various set of methods, including flexible instrument modelling and control, advanced endoscopic optical imaging, and deep learning methods for the real-time recognition and monitoring of the surgical steps of endoscopic procedures.

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SCUOLA SUPERIORE SANT'ANNA (SSSA)

Scuola Superiore Sant'Anna (SSSA) is a public Italian university for research and advanced undergraduate and graduate education in Experimental and Social Sciences. The mission of SSSA is to pave innovative pathways in education and research, responding to the modernization and innovation of society itself.

The BioRobotics Institute was specifically created to host the research activities of SSSA at the intersection between scientific research and technological innovation It was formally established in 2011 and it gathers the experience of more than 20 years of research carried out by the ARTS and CRIM Labs. For this reason, it has a strong tendency towards integrating heterogeneous knowledge in the field of bioengineering. The BioRobotics Institute has built and consolidated a vast wealth of knowledge and expertise in the fields of surgical robotics, micro-nano-robotics, soft robotics, humanoid robotics, neuro-robotics, neural engineering, biomedical signal processing, marine robotics, service

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robotics and ambient assisted living, educational robotics and studies also their ethical, legal, social and economic implications. At present, the BioRobotics Institute includes over 200 persons, including 16 Faculty members leading 8 Research Areas and 8 Laboratories covering a surface of 6,300 square meters.

OUR ROLE

SSSA focuses on intra-luminal sensing exploring the spectrum of intra-operative sensing modalities and their use for intraluminal navigation. SSSA is responsible for design and implementation of smart flexible instruments with own proprio- and extero-ception.

OUR PEOPLE

Arianna Menciassi is Full Professor of Biomedical Robotics at SSSA, team leader and research principal investigator of the "Surgical Robotics & Allied Technologies" Area at The BioRobotics Institute. She obtained the Master Degree in Physics (summa cum laude, 1995) at the Pisa University and the PhD in Bioengineering at SSSA (1999). She has considerable experience in leading interdisciplinary teams toward successful outcomes. Furthermore, she has a substantial devotion to training and education both at SSSA and at the University of Pisa, having served as preceptor to 12 postdoctoral associates, 27 PhD students and 80 graduate degree recipients. Her main research interests involve biomedical robotics, bio-hybrid systems, microsystem technology, nanotechnology and micromechatronics, with a special attention to the synergy between robot-assisted therapy and micro-nano-biotechnology-related solutions. She is co-author of 419

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scientific publications and 6 book chapters on biomedical robots/devices and microtechnology (H-index is 61 on Scholar and 49 on Scopus). She is also inventor of 35 patents, national and international. In the year 2007, she received the Well-tech Award (Milan, Italy) for her researches on endoscopic capsules and she was awarded by the Tuscany Region with the Gonfalone D'Argento, as one of the best 10 young talents of the region. In 2017 she was awarded with the International Prize Tecnovisionarie by Women & Tech - Association of Women and Technology for the category Women Innovation, intended for researchers and scientists in the field of biomedical and surgical robotics

Selene Tognarelli is PostDoc and Technologist at SSSA where she works both on technical aspects and project management (she served as the Project manager of national and international projects). Her main research interests involve biomedical robotics, microsystem technology and science, with a special attention to the mechatronic aspects of robotic devices. She received the B.Sc. and M.Sc. degree (magna cum Laude) in biomedical engineering at the University of Pisa, Italy and she obtained a PhD degree in Bio-Robotics in 2011. She has a growing track record in biorobotics, and in this field she is co-authoring high-impact publications indexed.

Veronica Iacovacci is currently Post-doctoral fellow at SSSA. She received the Master's degree (with Hons.) in Biomedical Engineering from the University of Pisa (Italy) in 2013 and the Ph.D. in Biorobotics (with Hons.) from The BioRobotics Institute in 2017. Her research activity is mainly focused on microrobotics for medical applications, smart catheters, magnetic systems for targeted therapy, lab-on-chip applications and artificial organs.She is author or co-author of 10 scientific publications on international journals, 18 conference papers and 1 book chapter. She is also inventor

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of 2 international patents. She participated as invited speaker to several international conferences on robotics and microrobotics for medical applications and she was co-organizer of a special session and of a workshop focused on the employment of microrobotics technologies in clinical applications. She was awarded with national prices for her MsC and PhD thesis, with the Zeno Karl Schindler Foundation Doctoral Exchange Grant and with the best presentation award in the framework of the Euspen Challenge 2014.

OUR STORY

Researchers investigate problems, identify enabling technologies and develop solutions for addressing the field of minimally invasive surgery, targeted therapy and diagnosis.

The main scientific problem to address is covering the gap between diagnosis and therapy, by blending together competences coming from robotics and bioengineering and by developing platforms, enabling technologies and components with the ability to treat many pathologies in the human body, including in hard-to reach areas (e.g. in the cardiovascular system, in the abdominal cavities, etc.). Treating chronic diseases with a bio-mechatronic approach is also included in this vision of targeted therapy. In particular, the group is active in the field of Advanced Robotic Devices for Diagnosis and Targeted Therapy. This research line collects all projects devoted to the development of robots, capsules,

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instrumented catheters, and probes able to operate and navigate in the human body for diagnostic and therapeutic applications. The group has participated to the several projects focusing on surgical/diagnostic devices, amongst them the EU-funded projects ARAKNES; ENDOO and SCATH. Therapy and diagnosis can be performed in the human abdomen, in the cardiovascular system, in the gastrointestinal tract, but also in other hard-to-reach districts. The typical size of devices entering the human body ranges between 10 cm and tens of microns, depending on the target area and the patient (which can be an adult as well as a child before delivery). In these years, the group has collected a wide knowledge on flexible instrument design, sensor design and testing.

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TECHNISCHE UNIVERSITEIT DELFT (TU DELFT)

Being the oldest and largest technical university in the Netherlands, TU Delft forms one of Europe's major academic research centres with top facilities for enabling cutting-edge science and realizing technological breakthroughs. TU Delft has over 25000 students and 5000 staff members, all driven by a fascination for science, engineering and design. Conducting multidisciplinary research and design projects of the highest international level, education and research are inextricably linked and form a strong basis for knowledge valorisation. The objectives of the Minimally Invasive Surgery and Interventional Techniques and Bio-Inspired Technology (MISIT&BITE) group of the Dept. Biomechanical Engineering, are to produce the highest level in research and design in the field of technology that enables novel and safe minimally invasive treatments. The MISIT&BITE group has received many valorisation grants from the Dutch Technology Foundation and the research within MISIT&BITE has resulted in eight spin-out companies.

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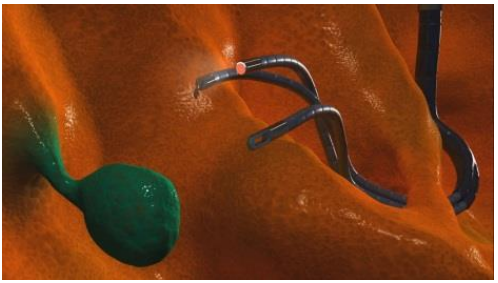
OUR ROLE



MISIT&BITE is a leading group in the mechanical design of innovative surgical devices, including catheters and flexible systems. The design is often inspired by nature, resulting e.g. in a range of novel steerable and manoeuvrable instruments inspired by snakes and squid and in world's thinnest self-propelled steerable needles inspired by ovipositors of parasitic wasps. In ATLAS, TU Delft will support the ESRs with their strong experiences in surgical instrument design.

OUR PEOPLE

Jenny Dankelman is professor in Minimally Invasive Surgery and Interventional Techniques at the Delft University of Technology (www.MISIT.nl). She obtained her degree in Mathematics, with a specialisation in System and Control Engineering at the University of Groningen in 1984 and her PhD at the Delft University of Technology (DUT) in 1989. In 2001 she was awarded the Antoni van Leeuwenhoek chair and shortly after she became head of the Minimally Invasive Surgery and Interventional Techniques group (MISIT). Between 2010 and 2014 she was head of the Department of BioMechanical Engineering and in 2013 she became Medical Delta professor. She was awarded a Royal award and became Knight in the Order of the Netherlands Lion in 2018, and recently she became member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

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Her research focuses on minimally invasive surgery, needle interventions and endovascular interventions. Her research group cooperates with several hospitals such as Leiden UMC where she holds a part time professorship position, Erasmus MC Rotterdam and the AMC Amsterdam. Her interests and research projects are in the fields of designing novel medical instruments, haptics, training and simulation systems, and patient safety, with the focus on minimally invasive techniques. A few years ago she started a number of projects to develop affordable multi-functional surgical instruments and an innovative surgical equipment system that allows minimally invasive surgery without the need for a sterile operating room, which is especially relevant to low-resource settings.

Paul Breedveld studied Mechanical Engineering at TU Delft where he obtained his MSc and PhD degrees in 1991 and 1996, both with honours. Extending his experience in space robotics to the medical field, he continued his research with developing ingenious surgical devices inspired by smart solutions in nature, sponsored by a personal personal research grant from the Royal Netherlands Academy of Arts and Sciences (KNAW). Collaborating with a number of academic hospitals, medical companies and technical and biological research groups, the research within his group BITE (Bio-Inspired Technology) has resulted in a number of patents that are being commercialized by (spin-off) companies. Being member of the BIOKON International Biomimetics Association, having received a number of prizes and awards, and being a leading researcher in a number of (inter-)national research programmes, his research was rewarded in 2012 with a prestigious Dutch VICI research grant on the development of dendritic maneuverable devices for endo-nasal skull base surgery and in 2013 with an Antoni van Leeuwenhoek personal professorship at TU Delft. In 2014, Breedveld became Chairman of the Board of Examiners of the Faculty Mechanical, Maritime & Materials Engineering of TU Delft, as well as board

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member of the “Friends of Reinier de Graaf” foundation of the Reinier de Graaf Hospital in Delft. In 2016, Breedveld was one of the founders of the the PainLess Foundation: a Dutch initiative to find innovative solutions for patients with chronic and incurable pain.

OUR STORY

The objectives of the Minimally Invasive Surgery and Interventional Technique and Bio-Inspired Technology (MISIT&BITE) group of the Dept. Biomechanical Engineering, are to produce the highest level in research and design in technology that enables novel and safe minimally invasive treatments. Examples are thin steerable needles and catheters with multifunctional tips that can be maneuvered in branched blood vessel systems, 3D-Printed multi-steerable instruments suited for snake-like motion in the body, self-propelled steerable needles inspired by wasp ovipositors, and water jet cutting techniques to treat cartilage in narrow joints. Tailored, slender instruments with optical fibers can be used to transmit diagnostic information and to perform local treatment during for example currently challenging oncological and cardiovascular procedures. When slender instruments are inserted through tiny incisions or natural openings in the body, the degrees of freedom are reduced, depth perception is limited due to the 2D view on a monitor, and haptic feedback is inhibited by friction in the instruments. Therefore

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training is required. To support training, we also develop training systems to enable residents to learn without patient risks. These training systems are based on fundamental research into the field of eye-hand coordination, haptic feedback and objective assessment methods for psychomotor skills. Finally, with the introduction of new technology in the operating room (OR), the environment has become technologically complex and prone to errors. To improve the monitoring of the work flow in the OR, we started the DORA Digital Operating Room Assistant, project in which we automatically monitor activities such as instrument and equipment use, and give feedback when hazards occur related to instrument and equipment.

Within the MISIT&BITE we work in a multidisciplinary team to improve minimally invasive techniques. The group consists of mechanical, biomedical, and electrical engineers, industrial designers, and experienced instrument makers working in our high-tech manufacturing workshops. Our group has a long lasting collaborations with clinicians from different disciplines and (university) hospitals.

The MISIT&BITE group has received many valorisation grants from the Dutch Technology Foundation and the research within MISIT&BITE has resulted in eight spin-out companies.

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UNIVERSITAT POLTÈCNICA DE CATALUNYA (UPC)

The Universitat Politècnica de Catalunya · BarcelonaTech is a public institution dedicated to higher education and research, specialized in the fields of engineering, architecture and science. As a leading member of international networks of excellence, the UPC has a privileged relationship with global scientific and educational organizations. The research group on Intelligent Robots and Systems, of the Department of Automatic control and Computer Engineering, focuses its research mainly in medical robotics, in rehabilitation, assistive and surgical robotics. Besides the scientific work, the research group has strong ties with industry, hospitals having created several spin-offs, two of them related to surgical robotics

OUR ROLE

UPC is focusing on the human factor: in layman words, how to design interface with the machine that will make them more effective in the medical practice. In medical robotics, the way a device shall be used is a leading

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requirement. This is much more than designing a graphical user interface: here, different paradigms of human-robot-interaction, up to intelligent shared control, have to be carefully evaluated.

OUR PEOPLE

Alicia Casals is Full professor at the Automatic Control and Computer Dep, UPC and Head of the Robotics and Computer Vision group at the Center of research in Biomedical Engineering of UPC. She is also associated researcher of the Institute of Bioengineering of Catalonia (IBEC). She coordinates several projects in the medical field mainly in surgery, but also in assistive robotics, in tasks oriented to vision/force based robot control, multirobot and human robot cooperation. In the last 7 years the team she leads has created two companies related to the surgical field, from which she is co-founder, dedicated to surgical robots and robotic training platforms respectively. She has been involved in various responsibility positions in IEEE societies (RAS and EMBS).

Manel Frigola was coordinator assistant of the Education and Training activities of the European Robotics Research Network (2002-2008). They recently participated in the EuRoSurge CSA. The research lab is funded by public and private projects in medical robotics (Surgical, Rehabilitation and Assistive Robotics): AURORA project, on rehabilitation and assistive robotics, a coordinated national project, and involved in two projects in surgery in Fetal surgery and Clinical Private funding) evaluation of a Surgical Robot for laparoscopic surgery (National Funding) as well as in other industrial private funding projects. She is co-founder of a company RobSurgical (2012).

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Albert Hernansanz is Computer Engineer from the Autonomous University of Barcelona and PhD at UPC. Post Doc at the Research Center of Biomedical Engineering at UPC where she has steered the research in surgical training and has been the promoter of the creation of a spin-off in surgical training (2015). He did a predoctoral research stay in the University of Verona. He received some recognitions for his entrepreneurship and has three patents. He is currently involved in projects in surgical robotics and surgical training.

OUR STORY

The UPC team in ATLAS is part of the Center of Research in Biomedical Engineering at UPC which involves different engineering specialties applied the medical field. The partner's lab focuses its research mainly in medical robotics, in rehabilitation, assistive and at a great extend to surgery, in which area besides assisted surgery some efforts are also done in the development of surgical training systems. The goal of the research group is the study, evaluation and development of robotic systems based on the incorporation of perception capabilities for achieving more flexibility and a more intelligent behavior. Considering the wide scope of the research in this field, the work of the group is oriented to three complementary lines: the design and development of image processing and computer vision systems, specially oriented to control, guidance and supervision of robotic systems; robotic systems adapted to specific environments, and multiagent systems (robots and persons) with cooperation capabilities.

The research in surgery, applications oriented, implies the integration of multiple systems consisting in

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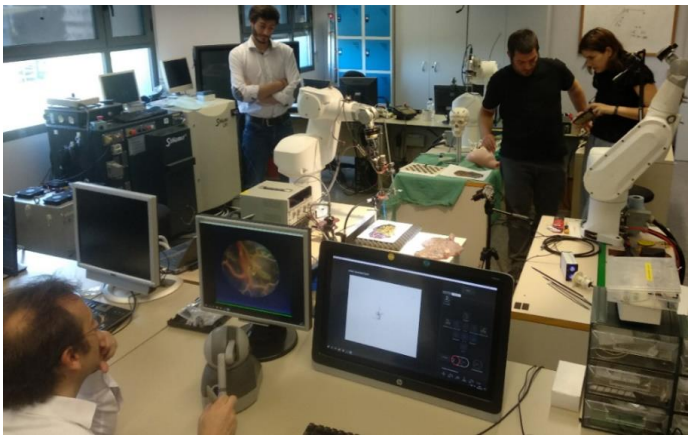
software and hardware developments. At present the main projects are oriented to fetal surgery and to laparoscopic surgery in a multirobot system.



The research has led to the creation of some spin-off companies, the more recent in the surgical field, for the development of a surgical robot, RobSurgical 2012, and Surgitrainer for the development of surgical training systems, 2015.

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THE PARTNER ORGANIZATIONS

ATLAS is supported by a number of partners that help in training as well as in the research activities of the different ESRs. These partner organisation belong to the industrial, clinical, and research world, and will host one or more ESR for secondments. Through these secondments ESRs will immerse into the real-world acquiring key practical insights on relatively short periods of time.

RESEARCH INSTITUTE AGAINST CANCER OF THE DIGESTIVE SYSTEM (IRCAD)

The IRCAD institute was created in 1994 to develop and promote the surgery of the future - surgery that is technology enabled, image based and focuses on less invasive approaches for cost effective care. Fully dedicated to research and to the teaching of the most innovative surgical techniques, over the years, the IRCAD has established itself as a world reference in the field of minimal access surgery.

ORSI

Orsi Academy is a centre for surgical innovation and expertise where industry, clinical and academic partners participate together on training, R&D and data analysis with the purpose of improving best practices in minimally invasive surgery. Established in 2010, it is now amongst the biggest training centre in robotic surgery in the world, and planning to expand its expertise into other subspecialties in minimally invasive surgery. Validation and accreditation of our programs is a key differentiator.

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HOSPITAL UNIVERSITARI VALL D'HEBRON

University Hospital Vall d'Hebron is part of the Autonoma University of Barcelona and the largest hospital in Barcelona and Catalonia. It has large expertise in all areas of patient care as well as in research, with high impact factor in both basic and clinical research. The Gynaecology Department has a large experience in minimally invasive surgery, laparoscopic and robotic approach. Regarding robotic surgery, our experience in gynecological surgery started in June 2009, being one of the first and most specialized centres in Spain to perform basic and complex gynecological surgery. Since 2015 it has the European Society of Gynecological Oncology (ESGO) accreditation in Fellow training.

THE EUROPEAN INSTITUTE OF ONCOLOGY (IEO)

The European Institute of Oncology is a non-profit private-law comprehensive cancer research centre located in Milan, Italy. The Institute integrates various activities involved in the fight against cancer: prevention and diagnosis, health education and surgical training, research and treatment.

INRIA

Inria, the French National Institute for computer science and applied mathematics, promotes "scientific excellence for technology transfer and society". Graduates from the world's top universities, Inria's 2,700 employees rise to the challenges of digital sciences. Research at Inria is organised in "project teams" which bring together researchers with complementary skills to

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focus on specific scientific projects. The team Defrost, located in Lille, focus its research on the new software for deformable robotics. The goal of the team is to address the challenges related to modelling, simulation and control of deformable robots.

FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA (IIT)

The IIT is a Research Foundation with focus on 4 key technological platforms: Life Sciences, Nanotechnologies, Computer Vision, and Robotics. The latter includes medical, surgical, rehabilitation, and assistive robotics. The Department of Advanced Robotics of the IIT was the coordinator of the EU-funded project µRALP and participated to the projects ACTIVE and STIFF-FLOP, all of which are dedicated to robotic surgery.

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

Imperial College of Science, Technology and Medicine was established in 1907 in London's scientific and cultural heartland in South Kensington. Consistently rated amongst the world's best universities, it is a university of world-class scholarship, education and research in science, engineering and medicine, with particular regard to their application in industry, commerce and healthcare.

DEAM

DEAM develops, manufactures and sells instruments for minimally invasive interventions and diagnostic procedures. These are executed on tissue in the body cavities through small holes in the skin (keyhole surgery and catheter interventions) or through the natural orifices (gastrointestinal tract and lungs).

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FBGS INTERNATIONAL

FBGS International NV/FBGS Technologies GmbH is a Belgium / Germany based developer and manufacturer of high strength Fiber Bragg Gratings (FBG) during fiber drawing or using femtosecond based inscription technologies. These automated processes result in very high quality, cost effective Fiber Bragg Gratings with unique characteristics. FBGS' products are suitable for both standard and bespoke applications in industries such as: medical, composite, transport, process, civil & geo, telecom and R&D. Besides the FBG's, FBGS also offers complete sensors and measurement devices.

EYE-TECH

EYE-TECH's core business is the design, development and commercialization of CMOS image sensors. Besides sensor products, EYE-TECH offers a consultancy service for the development of custom sensors and to support customers in the development of complete vision systems based on EYE-TECH imagers. EYETECH's strategy is to propose highly innovative solutions to the market providing each time unique performance in well-defined applications, with a special focus on the biomedical market. The main technological features of EYE-TECH sensors are: Innovative features: Optimized performances in light controlled environment with high dynamic range capability; Implementation features: Data transmission optimized for high distance or wireless applications; Distinctive features: Optimal format and positioning of the sensitive area. The ten-year experience of EYE-TECH founders in the field of CMOS imagers and vision system design, was the starting point for the conceive of application oriented products. The innovative features of EYE-TECH products are patented.

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CAMELOT

CAMELOT is a research-intensive SME focused on the development of innovative software products based on Artificial Intelligence, to make autonomous systems reliable and support them improving our lives. The core strengths of CAMELOT solutions have always been their high-grade flexibility, reliability and efficiency, achieved using innovative, proprietary computational techniques based on State of the Art computer vision, machine learning and optimization theory.

OROBIX

Orobix is an engineering SME focused on machine learning, image analysis, computational geometry, mathematical modelling and software engineering. It was founded in 2009 with a solid background on medical image analysis and modelling for biomedical applications. It currently provides its services to various sectors, including healthcare, pharma, manufacturing and energy & environment. Orobix is a ISO 9001 and 13485 certified company.

ENDOCAS CENTER

The mission of EndoCAS (Università di Pisa) is to develop breakthrough technologies based on engineering and information technologies to improve the current surgical procedures and reduce their invasiveness by means of an optimal use of medical imaging. The research areas addressed by the Centre are:

- Surgical navigation systems for traditional and robotics interventions;
- Surgical simulators development and validation;
- Augmented reality displays and applications;

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AM2M

AM2M is a company established by scientists associated with Nicolaus Copernicus University in Toruń (NCU), Poland in 2011. AM2M offers professional R&D service, provides ambitious solutions in the field of non-invasive imaging, beyond actual state-of-the art. Apart from R&D service AM2M is also working on their own projects. In 2013 AM2M was acknowledged to be Innovation Leader of Kuyavia and Pomerania in microenterprise category for R&D service in biomedical imaging for industry.

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THE ATLAS TRAINING

The ATLAS project has two pillars: one is research, which is mainly conducted by the Early Stage Researchers in the project; the other is the training programme that the different consortium members organise.

TRAINING ACTIVITIES

LTA: LOCAL TRAINING ACTIVITIES
NTA: NETWORK-WIDE TRAINING ACTIVITIES
RTA:RESEARCHERS TRAINING ACTIVITIES

The project considers two types of training activities, next to Local Training Activities that each university organises locally that cover both focused technical topics and soft skills Network-wide Training Activities (NTA) are organised open to all the ESRs. The NTA's will have a slightly broader scope.

In order for ESRs to maximally share their knowledge be it amongst themselves with their colleagues, students, and project partner so-called Researchers Training Activities will be implemented. The different activities are sketched in the following pages.

LOCAL TRAINING ACTIVITIES

The different LTAs that are organised in the context of the ATLAS project are explained in the following paragraphs. In addition, ESRs will be able to participate in general courses (from programming to language) that address the typical needs of PhD students and are organised by the doctoral schools of each university.

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LTA1: MANAGEMENT AND POLICY ASPECTS OF TECHNOLOGY IN HEALTHCARE (KUL, YEARLY)

After this course, the student will be able to understand, to assess and to contribute to policy and management issues concerning healthcare technology. The student will understand the challenges (and supporting decision techniques) for a biomedical/clinical engineer in a hospital context. The student will be able to explain the principles of HTA and will be able to critically read HTA reports. The course is taught by P. Pintelon.

LTA2: SUMMER SCHOOL ON COGNITIVE SURGICAL ROBOTICS (UNIVR, BIANNUAL)

The main objective of the Summer School on Control of Surgical Robots (COSUR) is to introduce the multidisciplinary research field of surgical robotics, with particular focus on the control algorithms used in robotic surgery and the impact of cognition in directing the control. COSUR offers lectures, hands-on laboratory experience, and opportunity for informal interaction with clinicians and leading experts from academia and industry. The school will go beyond the current approach of doctoral schools and will give trainees an in depth understanding of cognition and control in robotic surgery.

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LTA3: ETHICS IN RESEARCH (POLIMI, YEARLY)

This course aims to make participants: a) fully aware on how scientific and technological research have ethical implications; b) to identify ethical issues in specific research cases and procedures; c) to understand how the adherence to ethics standards is essential not only for respecting ethical values and fundamental rights, but also to increase quality and likely impact of research.

LTA4: MICROROBOTICS FOR SURGERY, INNOVATIVE ACTUATION TECHNOLOGY (SSSA, YEARLY)

Microrobotics for surgery: The main objective of the course is to provide students with design rules for the realization of microrobots for medical applications. The main scaling laws from macro-domain to micro/nano domains will be illustrated, together with the main components of micro-mechatronic machines. Each topic covered during the course will be supported by specific examples from the medical sector.

Innovative Actuation Technology: Introduction to the use and of novel materials and novel technologies for the development of not conventional actuators. Smart materials (e.g. piezoelectric actuators, shape memory alloys, etc.) and enabling fabrication and integration technologies will be the main topics of the course.

LTA5: BUSINESS ENGINEERING AND SURGICAL TECHNOLOGIES - BEST (UNISTRA-IRCAD, YEARLY)

BEST is a one-week course led by Silvana Perretta from IRCAD. Students first have to follow a free online course (http://www.best-innovation.eu/on-line-course/), and

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based on this they can be selected for the onsite course (http://www.best-innovation.eu/our-mission/)

The onsite course mixes students and researchers from different backgrounds (business, engineering, medicine). They form teams and get one week onsite training on different aspects (hands-on MIS as well as business for startups and maturation, for instance), and they also have brainstorming sessions to create new ideas and projects. The onsite course in Strasbourg happens every year around the end of August.

LTA6: BIOINSPIRED DESIGN (TU DELFT, YEARLY)

The course Bio-Inspired Design boosts creativity in mechanical design by showing a large range of clever solutions from nature and their applications in bio-inspired instruments and machines, and by combining this overview with extensive training in the ACRREx design methodology that was developed by Prof. Breedveld to enhance creativity in the design of novel mechanical devices.

Examples of bio-inspired topics are: strength at low weight, stiffness with soft structures, robustness and redundancy, storing energy in springs, energetically efficient muscle configurations, biological vibration systems, clamping with hands, claws, suction, glue, dry- and wet adhesion, biological walking, swimming, crawling and flying, locomotion of micro- and single-celled-organisms, and evolution and engineering of living systems. The course Bio-Inspired Design is given once per year in a series of lectures and training sessions from September till December.

LTA7: MEDICAL ROBOTICS (UPC, YEARLY)

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A. Casals, studying requirements of robotics, mechanics, user aspects, different paradigms of human-robot-interaction up to intelligent shared control.

NEWORK-WIDE TRAINING ACTIVITIES

As mentioned before Network wide activities shall be open to all the ESRs and in some cases to external PhDs. Each course is given periodically to give the opportunity to each ESR to participate at least once.

NTA1: MEDICAL DEVICE DEVELOPMENT AND TRANSLATION

One-week course on workflow analysis, clinical need assessment, device development controls, tech transfer, good manufacturing and clinical practices, in close collaboration with IRCAD.

Organisers: **UNISTRA**, UPC

NTA2: SENSING AND ACTUATION FOR SOFT ROBOTICS

Three-day course introducing methods for designing, manufacturing and integrating sensing and actuation in soft robots, hands-on building of common ATLAS research platforms.

Organisers: **TUDELFT**, SSSA, KUL

NTA3: BEST INTEGRATION PRACTICES AND ROBOTIC MIDDLEWARE

One-week course offering basics of data-acquisition, visualisation tools, introducing programming paradigms that helps in lean software development and integration.

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As use case, hands-on control of common ATLAS platforms will be considered.

Organisers: **KUL**, UNIVR, UPC

NTA4: 3D INTRALUMINAL MODELLING

One-week course in pre- and intra-operative techniques for registering, segmenting and reconstructing rigid and deformable anatomies. (**POLIMI**, UNIVR)

NTA5: ATLAS SESSION AT CRAS

The Joint Workshop on new technologies for Computer/Robot Assisted Surgery (CRAS) is held yearly. A special session dedicated to the ATLAS project will allow ESRs to jointly show their advancements.

Organisers: **SSSA**, KUL, POLIMI, UNIVR

NTA6: HANDS-ON ATLAS SESSION AT SUMMER SCHOOL OF COGNITIVE SURGICAL ROBOTICS (COSUR)

During the Summer School on Control of Surgical Robots (COSUR) a special hands-on session will be organized for introducing the student to most important aspects related to actuation, sensing, modelling and integration for soft robotics in medical applications.

Organisers: **UNIVR**, SSSA, TUDELFT, KUL,

NTA7: SOFT SKILLS FOR SOFT ROBOTICS

A three days course offering basic aspects on ethics, with a wide scope ranging from the analysis of risks so as a safe procedure can be planned, to aspects related to information to the user, adequacy of treatment and patient accompanying. The course will also consider the

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ethical and regulatory aspects related to knowledge diffusion, as open access, data management, and data privacy.

Organisers: **UPC**, UNIVR, UNISTRA

NTA8: TECH TRANSFER FOR SURGICAL ROBOTICS

Course on managing Intellectual Property Right, entrepreneurship, and how to individuate and leverage funding opportunities for technological transfer.

Organisers: **POLIMI**, UNIVR, KUL, UNISTRA, TUDELFT

NTA9: ADVANCED BIOENGINEERING METHODS, TECHNOLOGIES AND TOOLS IN SURGERY AND THERAPY

The XXXVIII Bioengineering School is aimed at presenting the emerging bioengineering technologies and practices in surgery and therapy. Advance image-based patient modelling, machine learning-based diagnostics, augmented reality, navigation solutions and surgical robotics are examples of technologies which are reshaping the future of care. In such a process, technology professionals, and particularly biomedical engineers, are pivoting the innovation.

Terms like evidence-based medicine and personalized medicine have progressively entered into medical language and mostly rely on our capability to extract and elaborate information from diagnostic tools and translate them into specific clinical strategies and approaches. There is indeed a strong need for an interdisciplinary approach and biomedical engineer is asked to manage.

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Organisers: **POLIMI**, SSSA

RESEARCHERS TRAINING ACTIVITIES

These activities focus on establishing an improving the direct contact and collaboration between ESRs and partners (mainly conducted via video-conferencing), and with local master students. Periodic activities – as explained next - are organised roughly every two weeks, when no other training activity is present.

RTA1: CAPITA SELECTA

A delegate from the industry (e.g. partner) or alternatively a representative of the clinical field will provide a talk on a selected topic relevant for ATLAS. One ESR is made responsible for introducing the talk and for moderating the discussion.

RTA2: JOURNAL CLUB

Two ESRs introduce a seminal work within their domain to the other ESRs. One ESR moderates the discussion and gathers feedback.

RTA3: MASTER THESIS GUIDANCE

Each ESR will be involved in guiding a master thesis at another beneficiary institute, together with a local ESR that provide local guidance.

RTA4: REVIEW OF SCIENTIFIC PAPERS

ESRs will team up with an ESR from another institute to conduct at least two reviews of international peer-reviewed scientific papers. ESR's advisors will provide feedback on the conducted review. Before submitting

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original ATLAS work, other ESRs will be asked to proofread and comment. This will prepare ESRs for future R&D positions by promoting critical thinking.

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