Bono Serena

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Surgical Robotics with Kanako Harada, Tim Luth, Catherine Mohr, moderated by Paolo Dario.

Surgical robotics is the result of an historical evolution: incredible results in ancient times. Laparoscopic surgery: the role of imaging. Robotics Surgery begins in the 80's with pioneers daring to move robots in the brain or in the prostate. The colloquium is covering some issues, like the state of art of the current robotics surgery scenario, the most exciting developments and how Covid-19 has encouraged the evolution of robotic surgery.

Professor Kanako Harada from Tokyo University talks about surgical robots for microsurgery. Surgical robots can go beyond human precision, some of their medical interventions would be unfeasible without robot precision, some are even invisible to the naked eye. The latest developed robot for surgery is called "Smart Arm", it has application on neurosurgery, pediatric surgery and many more. The number of patients for micro-surgery is small, but the versatile design guarantees the application of Smart Arm to other robotics surgery fields. The top five challenges in robotics surgery are robotic interface, automation, is cyber-physical integration, customization, and contribution. Most of the robotics interfaces employ a master-slave control, it easy to do dexterous task, but inserting and removing robotic tools is hard and expensive. The solution would be to develop a common interface, the robot will switch the control modes. Also process the information to feed back to surgeons. The second challenge is automation: robotics aims at providing smart tools for surgeons, for example automatic tools to detect and avoid collisions. Regulation on efficacy and safety. The third challenge is cyber-physical integration: virtual simulation to optimize robotic control, training the surgeon to use the new tools and providing a dataset for artificial intelligence. The fourth challenge is customization, assistant so that the robot can go beyond the limit of the surgeon. Contribution is the last challenge, not much of the surgeon robotics has been applied to nonsurgical robotics. Surgical robotics can be used in super clean or super dirty environments, it can be helpful during the covid-19 pandemic, many companies are developing robots to test or assist doctors.

Engineer Tim Luth argues that surgical robotics nowadays consists of patient imaging and intervention, mostly invasive and non-tactile. Assistance of robots to human is of three different types: Robotics Technology, Navigated Instrument Technology, Navigated power Control Technology (something in between robotics and navigation). Regarding robotics technology, there are Off-Line Programmed Sequence robots which run pretrained off-line tasks which are adjusted by real-time sensoring, Hand on Robotics robots which help the surgeon guided by his hands and finally Telemanipulated robots which are tip by the surgeon hand motion. Navigated assistance for Clinical Intervention is subdivided in Hard Tissue Registration, Soft Tissue Registration and Blood Vessel Registration. Blood vessel registration allows to monitor the inside of the vessels, the lecturer believes a lot of robotics will be applied to this field soon. The five challenges that robotics will have to address in the upcoming years are: automatic design of robots, solve medical hot issues, train engineers as doctors and doctors as engineers, research teams that want to make an impact and finally a cheap robot arm teachable by everybody. The lecturer remarks on the first challenge that our robot design is too slow: a PHD student designs one robot, if fails there is not second chance. What Tim desires to develop is a robotic device to clean vessels from the inside. Finally, what concerns Tim about Covid-19 is the urgent need of cheap robot arm operated by non-experts to maintain distances.

Catherine Mohr, head of Intuitive Foundation, presents some work of her foundation claiming it represents robotics state of art. One of the main challenges of micro-robotics in surgery nowadays is interface: take what the surgeon wants to do, without processing it into a game controller. A lot of the robots being

developed perform macroscopical operations simulating doctors, those have relatively easy interface, for microsurgery is much more difficult. One of diseases more in need of robotics help is lung cancer: most of the times it is found very late, even the best trained robot cannot change the fact that the patient have a 50% chance of surviving 5 years. Trying to cope with this requires integrated images: the camera eye view integrated with navigation tools enables to get real time images without getting lost in the lungs. It is also possible to integrate florescence imaging able to tag molecules that fluoresce in the near infrared. The five challenges for Catherine are of a more managerial nature: regulation, economics, training, privacy, and global support chain fragility. The way in which the regulation is set up, play tremendous role in the possibility of small companies being able to set out their robots: many years of medical rial and millions of dollars. The robots purchase increases the cost inside the operating room, it saves downstream costs in terms of avoiding other exams, though it is very difficult to measure the cost saved downstream. The professionals must be trained to use machinery which evolves and changes overtime. The machinery needs data to train AI and perform better, this comports a privacy issue. And finally speaking from a time of global pandemic, the process of building a robot requires components of different provenance, the support chain could be slowed down or even stopped during this time.