Richard Satava, Int J Robot Res Appl Autom. 2019
DOI: dx.doi.org/10.18689/IJRA2019.a1.005

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International Conference on
ROBOTICS AND AUTOMATION ENGINEERING
October 23-24, 2019 | Rome, Italy

# Surgery Beyond Robotics: The 5th Generation of Surgery is Directed Energy for Non-invasive Surgery

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Non-healthcare industries have used a wide spectrum of energy-based systems for literally all different purposes, from microchip manufacturing to artist creations, whereas only a small portion of these commercially available systems have been exploited by surgeons. Although many of the technologies are large and sophisticated image-guided systems that provide precise targeting at the molecular and atomic level, numerous other technologies are small, hand-held portable systems. Thus, many time-honored surgical procedures will be performed as outpatient or office procedures with small, hand-held directed energy devices. Within the full spectrum of energy, one of the best opportunities is in photonics, with numerous existing and emerging technologies that are being accepted by the clinical realm.

Even as laparoscopic surgery matures, and the fourth revolution in surgery in 25 years (robotic surgery) is gaining in popularity, a much more disruptive change is beginning with the next revolution: Directed energy for diagnosis and therapy (DEDAT). This advance takes the minimally invasive surgery (MIS) to the final step – non-invasive surgery. Building upon the success of MIS, and combining experience in lasers, photo-biomodulation, image guided surgery and robotic surgery, there are new energy-based technologies which provide the control and precision of photonic energy to begin operating (non-invasively) at the cellular and molecular level.

The evidence that has been building from the multiple disciplinary field of photonics, computer assisted surgery, genetic engineering and molecular biology communities (Radiology, Surgery, Plasma Medicine, Molecular Biology, the Human Genome) will be presented, and includes additional technologies beyond photonics such as high-intensity focused ultrasound (HIFU), terahertz imaging and the rapeutics – to name a few. Though still in its infancy, DEDAT presages the emergence of the non-invasive approach to medicine and surgery with these pioneering techniques, which are but the tip of the iceberg that heralds the transition to non-invasive surgery. Such systems are based upon the premise which directed energy, robotics and biomolecular technologies can bring – precision, speed and reliability - especially as surgery 'descends' into operating at the cellular and molecular level. Nobel Laureate Richard Feynman was right – there is "plenty of room at the bottom"!

## Biography

Richard M. Satava, MD FACS, is Professor Emeritus of Surgery at the University of Washington Medical Center (Seattle). Prior positions include Professor of Surgery at Yale University, military appointment as Professor of Surgery (USUHS) Walter Reed Army Medical Center and Program Manager at Defense Advanced Research Projects Agency (DARPA) and Senior Science Advisor at US Army Medical Research and Materiel Command in Ft. Detrick, MD. Undergraduate training was Johns Hopkins University, medical school at Hahnemann University of Philadelphia, internship at Cleveland Clinic, surgical residency at Mayo Clinic with a Master of Surgical Research. During 23 years of military surgery he has been an active flight surgeon, an Army astronaut candidate, MASH surgeon for the Grenada Invasion, and a hospital commander during Desert Storm, all the while continuing clinical surgical practice. He has served on the White House Office of Science and Technology Policy (OSTP) Committee on Health, Food and Safety. He is on numerous committees of the American College of Surgeons (ACS), is past president of many surgical societies, on the editorial board of numerous surgical and scientific journals, and active in numerous engineering societies. He has been continuously active in surgical education and surgical research, with more than 200 publications and book chapters in diverse areas of advanced surgical technology, including Surgery in the Space Environment, Video and 3-D imaging, Plasma Medicine, Directed Energy Surgery, Tele presence Surgery, Virtual Reality Surgical Simulation and Objective Assessment of Surgical Competence and Training and the Moral and Ethical Impact of Advanced Technologies.

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