Defence Global

Land, Sea, Air and Security

August 2018 Edition

Foreword by Rt Hon Gavin Williamson, Secretary of State for Defence

The Center for Advanced Surgical Technology (CAST) at the University of Nebraska Medical Center

The UNMC Center for Advanced Surgical Technology is a collaborative research and development community consisting of a multidisciplinary group of surgeons, engineers, and computer scientists from the University of Nebraska Medical Center and the University of Nebraska. Established in 2005, CAST has been building upon expertise within the University of Nebraska system by assembling subject matter experts to build a nationally prominent biomedical research center focused on advancing surgical technology. CAST also offers a research infrastructure conducive to creating projects for training in advanced surgical technologies.

Improving Combat Casualty Care Outcomes
Many combat-related deaths occur within 30 minutes of initial injury. Immediate diagnosis and triage is required, but difficult to administer at site of injury. Practical and efficacious methods must address conditions encountered in combat as well as prove useful in treating both penetrating and blunt abdominal traumas. Miniature, inexpensive, in vivo robots have the capability to provide basic diagnosis and triage of internal injuries in forward and other military environments. Such robots could be used externally or inserted into the patient and controlled by a surgeon from a remote location. The device will transmit live video images from a distant site, allowing the surgeon to diagnose the trauma and serve as a "remote first responder." Eventually, a group of in vivo robots, that will provide diagnosis and therapeutic care, can be deployed widely with the goal of enhancing the outcomes of military medical care.

Mini-Surgical Robots
Recent research advances at CAST include the creation of highly versatile, miniature, minimally invasive surgical robots that can be remotely operated by a surgeon at a console. This mini-robot is designed for general surgery abdominal procedures with an initial focus on colon resection. Unlike today's large, mainframe-like robots that reach into the body from outside the patient, this advanced robot platform features a small, self-contained surgical device that is inserted through a single midline umbilical incision in the patient's abdomen. This robotic technology is designed to utilize existing tools and techniques familiar to surgeons, and yet does not require a dedicated operating room or specialized infrastructure. Because of its much smaller size, this mini-robot is expected to be significantly less expensive than existing robotic alternatives for laparoscopic surgery. It also holds the promise of enabling a minimally invasive approach to surgeries performed now by open approaches.

UNMC CAST Research Projects

Artificial Intelligence for Telesurgical Robots – Developing semi-autonomous capabilities for surgical and trauma robots deployed to remote locations having limited bandwidth or interrupted connectivity.

Non-invasive Measurement of Intracranial Pressure – Developing a portable episcleral venomanometer as a method to measure intracranial pressure for diagnosis and triage.

Oxygenated Microbubbles (OMBs) – Partnering with the Air Force Surgeon General and the National Strategic Research Institute to develop a life-saving solution for traumatic lung injury. Oxygenated microbubbles are engineered to release oxygen into the abdomen, providing the patient with the oxygen they need to survive while bypassing damaged lung tissues. This kind of technology would allow for the treatment of multiple warfighters with minimal equipment and could be scaled in the event of a mass casualty event.

Robotic Telesurgery Research – Bringing mini-surgical robots to the battlefield. Developing surgical robots, in partnership with the U.S. Army Medical Research Command, for use by military personnel in the treatment of combat casualties.

Mini Surgical Robots for Space – Bringing mini-surgical robots to space. Developing surgical robots, in partnership with NASA's Human Research Program, for use by astronauts during medical emergencies on long-term missions.

Robotic Surgical Education Training – Developing tools for training to provide intuitive, ergonomic, and information-rich user interaction, robotic control, multifunctionality, and dexterous motion that help overcome major limitations currently shackling the progress of surgical intervention technology.

Teleoperable mini-robotic technology will eventually allow clinical diagnosis and treatment to occur on the battlefield, in space, or at any location where the patient and surgical expertise are separated due to distance or accessability constraints. These mini-surgical robots can contribute to reducing surgical invasiveness, decreasing hospitalization time, and reducing mortality and/or complications due to delays. While not yet commercially available, the researchers have already used the robot in a successful first-in-human procedure.

This collaborative work led by Dr. Oleynikov, Dr. Farritor and the UNMC/UN team on the use of miniature robots for general surgery is internationally recognized as a disruptive technological change to robotic surgery. Their technology has been featured in multiple journals as well as on CNN, Wired Magazine and The Economist. Collectively, members of CAST have published more than 100 peer-reviewed articles on the development of surgical robotics and over 35 on surgical outcomes. These research activities have been supported by funding from the U.S. Department of Defense, NASA, National Strategic Research Institute, National Institutes of Health, and the National Science Foundation. Successful collaboration between medicine and engineering teams has already led to cofounding a startup company (Virtual Incision Corporation) which is commercializing miniature robots for surgical applications. Headquartered on the University of Nebraska – Lincoln campus, this company has raised $18 million in venture-capital for further development and FDA trials of the miniature surgical robot.

Future Plans

In the Spring of 2019, the CAST research lab will expand into new space in the UNMC Davis Global Center, a state-of-the art simulation training and research facility (192,000 sq.ft.) currently under construction on the UNMC Health Sciences Campus. This world class facility will offer CAST researchers access to fresh tissue capabilities, 3D virtual immersive environments, as well as a wide range of clinical simulation technology. URL to iEXCEL **(www.unmc.edu/iEXCEL).** Designed as a center to transform the training of health care professionals and as a clinical test bed, the Davis Global Center along with the CAST Lab will also provide access to simulation experts in a truly interdisciplinary highly technical environment.

CAST Leadership

The mini-surgical robot technology is being developed under the leadership of Dmitry Oleynikov, M.D., Professor of Surgery, University of Nebraska Medical Center, and Shane Farritor, Ph.D., Professor of Mechanical and Materials Engineering, University of Nebraska-Lincoln.

Dmitry Oleynikov, M.D., Director of CAST and Professor of Surgery at UNMC, has published over 200 peer-reviewed articles and holds 28 patents in the area of surgical robotics and surgical outcomes research. His projects have had continuous external funding for the past 12 years, totaling over $12 million. The premier surgical society for laparoscopic surgeons, the Society of American Gastrointestinal and Endoscopic Surgeons, where he serves on its Board of Directors, has recognized him for his achievements with an award in Excellence in Leadership.

Shane Farritor, Ph.D., Professor of Engineering, NU-Lincoln, has many research interests including: Robotic Highway Safety Markers, Miniature Surgical Robots, Real-Time Measurement of Track Stiffness and Planetary ChM Descent using Cooperative Robots. He serves as Chairman and Chief Technology Officer at MRail Inc. and is Co-Founder and Chief Technology Officer of Virtual Incision Corporation. Dr. Farritor holds a Ph.D. from Massachusetts Institute of Technology.

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