Space Station inspired robot to help heal sick children

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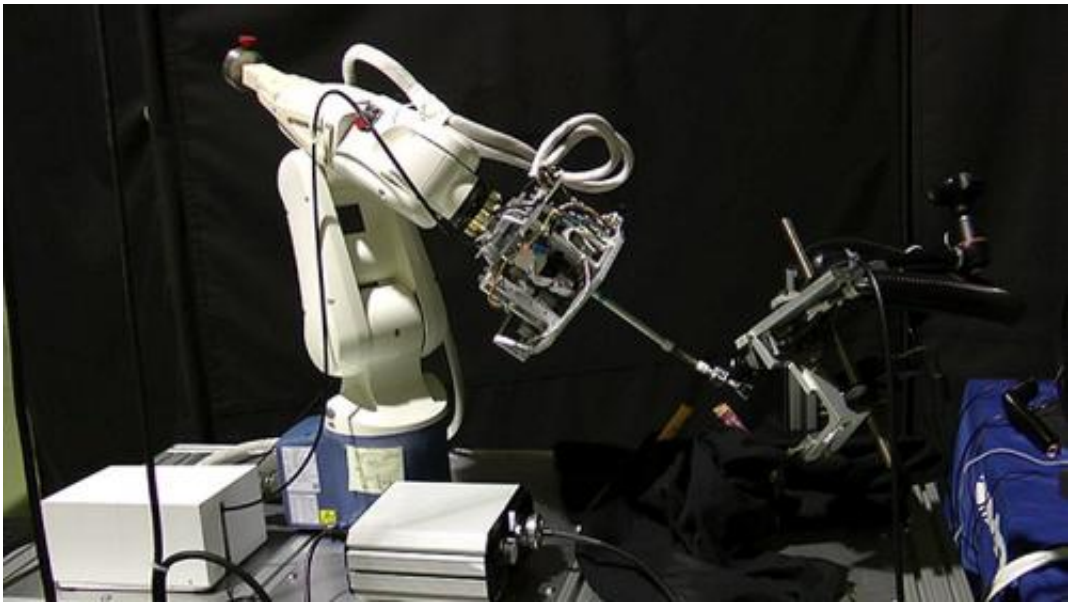


The KidsArm platform with biopsy tool attached. Credit: MDA and CIGITI

Children love robots. In all shapes, sizes, "personalities" and "smarts," these electronic wonders have been found under Christmas trees by kids and unwrapped on birthdays for years.

The gift of space-inspired robotics now goes beyond toys. They are lending a helping arm to pediatric doctors for children who require intensive surgical care.

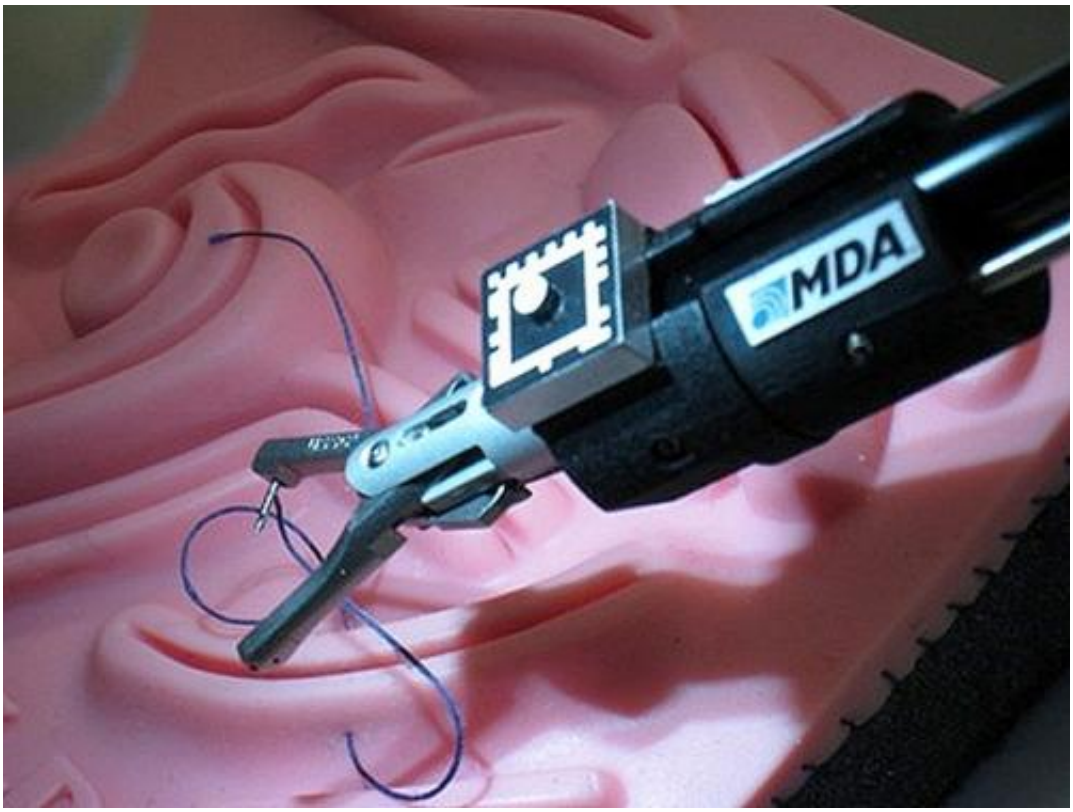
The same companies which developed the robotic arms that helped astronauts build the International Space Station have now created a new research platform. Called KidsArm, this robot allows surgeons to quickly navigate to surgical sites in the body. It has an advanced imaging and control system that makes it extremely precise, and it is designed to explore the potential for automating certain demanding tasks in minimally invasive pediatric surgery—a challenge before without the tool's assistance.

"Our tests indicate we can operate on tiny structures such as blood vessels without damaging them," said Thomas Looi, the project director for one of the partners that developed KidsArm at the Hospital for Sick Children (SickKids) Centre for Image-Guided Innovation & Therapeutic Intervention (CIGITI) in Toronto, Canada. "The goal of robotic arm is to help doctors perform certain procedures many times faster than if they were only using their hands and with increased accuracy. Some of this would be done autonomously. While we are not quite there yet, KidsArm is able to perform three to five suture points autonomously."

To develop KidsArm, SickKids partnered with MacDonald, Dettwiler and Associates Ltd. (MDA), the Canadian company that was behind the space shuttle's robotic arm and built the robotic system aboard the space station for the Canadian Space Agency (CSA). These space robots—Canadarm, Canadarm2 and Dextre—are a line of computerized heavy lifters and maintenance performers, which were crucial for building the space station. They now are critical for maintaining the space station and docking other spacecraft with the orbiting laboratory.

The platform is being tested at SickKids in a research environment to develop technologies related to minimally invasive automated anastomosis—the union of tubular structures such as blood vessels to each other or to surfaces. This testing involves camera-based tracking of tissue and desired suture points, automated positioning and application

of sutures. These studies are being used to advise the next stages of development.



The suturing tool demonstrates image-guided anastomosis, which means the connecting of parts such as vessels. The target on the top of the tool is used to lead the tool's tip. This is the same technology used to track the robotic systems on the space shuttle and the International Space Station. Credit: MDA and CIGITI

KidsArm is the first robotic surgical arm specifically designed for delicate pediatric specialties, including cardiac surgery, neurosurgery, fetal surgery, urosurgery and general surgery. Surgeons operate the tabletop tool using a pair of hand controllers in conjunction with high-precision, real-time imaging technology. The images allow doctors to

pinpoint the area of concern so it will be easier to reconnect delicate vessels.

"Advanced technologies such as imaged-based tissue-tracking and robotic platforms help us select suture points and [follow] these points so that we can compensate for the tissue motion that sometimes makes these surgeries difficult," said Looi. "A stereo camera generates a 3-D point cloud. This is a set of data points that guide the tool tip and apply a series of sutures. KidsArm pushes the envelope using advanced imaging to identify suture locations. This allows the surgeon to automate suturing small vessels and other microsurgical tasks."

A key element of the KidsArm platform is the vision-based system that can function in an autonomous manner. This acts as the eyes and brains of the platform and is the focus of the research efforts.

The platform also consists of two other elements: an external positioning system that is on the outside of the patient and a surgical arm that reaches inside the patient. The external system uses a human arm-scale industrial robot that has been customized to support a highly automated surgical arm and suturing device. The surgical arm is the only element that would reach inside a patient. It is as small as possible while containing all the functionality needed for dexterous positioning and deploying the sutures.

Eventually, KidsArm can lead to more consistent outcomes for patients, and the ability to intervene earlier or perform manipulations on a smaller scale than current practice. Any of these abilities can result in cost savings, but further development is required to determine how this advanced technology can provide the greatest value to the health care system.

"The collaboration of leading medical researchers at SickKids and the

engineers at MDA has enabled the rapid creation of a platform to explore one possible way we can make the next big leap in less invasive treatment," said Dr. James Drake, chief of neurosurgery and lead for the CIGITI. "It is especially exciting that this work is most relevant to children. Our belief is that this kind of teamwork is important to enable the creation of clinically relevant solutions that often require the latest in technology. It's incredibly satisfying to see technology that originated with the space program be brought to bear on issues that are so close to home.

The space shuttle Endeavour's robotic Canadarm hands off the Alpha Magnetic Spectrometer-2 (AMS) to the International Space Station's Canadarm2 to complete the installation on the station's starboard truss. The Japanese Kibo complex is at left. Credit: NASA

"The application of advanced sensing and the integration of this

information into a platform to enable precise action is an exciting way to accurately improve healthcare delivery," he added. "KidsArm will continue to evolve this concept."

The CIGITI team recently presented a paper on KidsArm at the Institute of Electrical and Electronics Engineers Inc./Robotics Society of Japan International Conference on Intelligent Robots and Systems (IROS), a robotics conference in Tokyo. The topic was selected by the awards committee as one of the top five application papers out of more than 900 submissions, bringing it a step closer for future commercial use.

SickKids is one of many research enterprises in Canada collaborating on this technology. MDA helped to create the University of Calgary's neuroArm, the first robot in the world capable of operating inside an MRI. It successfully completed its first operation in 2008. The next generation of neuroArm is currently under commercial development and testing. MDA also partnered with the Centre for Surgical Invention and Innovation (CSii) to detect early diagnosis and treatment of breast cancer with the Image-Guided Autonomous Robot (IGAR). IGAR is currently undergoing clinical testing.

"From the heights of the space station, to the hospitals here on Earth, we are excited that this space technology is making its way to better the lives of our families," said Gilles Leclerc, director general of Space Exploration at the Canadian Space Agency. "There are so many ways that station science and technology has and will continue to touch our daily lives. Those of us who work in the space station program are very proud to be making a difference here on Earth."

Not only can a robot help improve the life of a child in ways such as simple play, but now there's one on the road to improve health and give hope to children and let them be just that: children. Healthy ones who play. Perhaps with robots.

Provided by NASA