From Orbit to Operating Rooms, Space Station Technology Translates to Tumor Treatment

Powerful robotic arms developed by the Canadian Space Agency for the International Space Station and a delicate surgical tool, dubbed neuroArm, make "wonderful things" happen when experts from different disciplines work together.

HOUSTON, TX, November 23, 2013 **/24-7PressRelease/** -- People commonly use rocket science or brain surgery to refer to something incredibly complex and difficult. No wonder, then, that combining the two could result in something wonderful.

Powerful robotic arms developed by the Canadian Space Agency for the space shuttle and International Space Station - Canadarm and Canadarm2 - and a delicate surgical tool, dubbed neuroArm, are examples of the "wonderful things" that can happen when experts from different disciplines work together, says Garnette Sutherland, M.D.

Sutherland, a neurosurgery professor at the University of Calgary in Canada, used the first-generation neuroArm to conduct a clinical trial on 50 patients. That work, the subject of a paper recently published in the Journal of Neurosurgery, concluded that surgical robots such as this one improve precision and accuracy during brain surgery.

"A machine is inherently more precise and accurate than a human, as it can move in increments of microns while humans move in increments of millimeters," said Sutherland. "The registration parameter of a robotic machine can be set to a specific patient and so is very accurate. It can do motion scaling, meaning if you move your hand an inch the machine might move one-twentieth of an inch, according to the scale you set. It moves much less and so is more precise." Robotics also can filter out the tremors and shakiness that everyone has in their hands, further increasing the precision of the tool.

The surgical robotic arm was designed to work in conjunction with an MRI machine, as well as actually inside an MRI. This gives surgeons the ability to continually monitor their progress through detailed, three-dimensional images. A surgeon operates from a remote workstation that recreates the sight, sound and touch of surgery.

"When the tool tip hits tissue, it sends force back to the hand controller so the surgeon can feel what is touched," Sutherland said, somewhat like the vibration players feel in a videogame joystick, only much more realistic. The robotic sense of touch also allows surgeons to create a defined area within the body so that the tool encounters resistance if it reaches the edges of that area. The surgeon can see the operation through high-resolution, three-dimensional screens and hear it through a headset. Theoretically, the machine can even give surgeons the ability to see what they normally could not through the use of fluorescent markers and feel what they cannot normally feel, as the robotic arm can detect forces smaller than those normally appreciated by humans. In essence, the robot amplifies the surgeon's innate abilities.

The surgeon remains a critical part of the process, according to Sutherland. In between the hand controller and the surgical robotic arm is a computer. Computers are linear processors, needing all the data before they can execute a motion independently, and they can't rely on past experience. A surgeon, based on past experience, can anticipate or guess what might happen during surgery. "Computers can't guess and humans can," he adds. "The human brain is a parallel processing unit, capable of responding to incomplete data, resulting in fast and smooth motion. A machine is slower, but more certain." Another benefit of collaboration.

The leap from a large and powerful robotic arm in space to a small, precise one in the operating room wasn't as great of a stretch as it might seem at first, said Sutherland. "Many years ago, MacDonald, Dettwiler and Associates Ltd (MDA) received the contract to build Canadarm and [the Canadian Special Purpose Dexterous Manipulator] Dextre on the [space station]. They hired a pile of engineers to go through the process of building these robots. When we had the idea to use a robot for neurosurgery, we gave MDA the requirements, and those same engineers with decades of experience building robots for space began to translate that work into this one."

Similarities between the Canadarms and neuroArm include the control mechanism and the joint architecture, albeit on a smaller scale. The surgery tool incorporates other features of its larger counterparts, such as the strong, lightweight materials developed for the space station, including non-magnetic polymers, because materials used inside an MRI must be non-magnetic.

NeuroArm has been approved for use in operating rooms as an experimental device in Canada. In the U.S., the technology has been transferred to IMRIS Inc. of Minnetonka, Minn., and an application will be submitted for approval from the Food and Drug Administration.

In July, Sutherland was recognized at the second annual International Space Station Research and Development Conference for Advancing Neurosurgery through Space Technology, with neuroArm named a Top Medical Application from the International Space Station for 2012. The award recognizes the translation of technology developed specifically for one field--space--into an unrelated field in a unique and practical fashion. Looking towards the future, Sutherland notes that this robot/human collaboration potentially can benefit any kind of operation requiring precision. "It's built for micro-surgery, whatever that might be." Either way, it's still rocket science.

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