Robotic Surgery on the Brain

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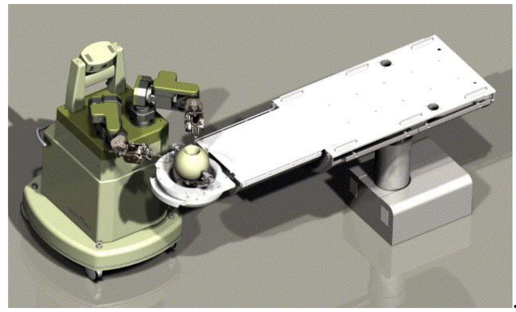
***Abstract*—Human ability is limited when concerning microscopic surgery on brains, impelling researches and hospitals to progress to the ability of robots. Robotic surgery solves the problem of human error and invasiveness during brain surgery. Brain surgery includes brain tumor removal and treatments for Parkinson's disease, Epilepsy, Aneurysms, Brain Hemorrhages, skull fractures, and Hydrocephalus.**

I. Introduction

EXPLORATION on robotic neurosurgery was launched in the 1980s when scientists could no longer advance traditional human neurosurgery. In 1985, Advanced Research & Robotics created the PUMA. Using the PUMA, the surgeon inputs x-y coordinates and uses programs, which calculates the stereotactic coordinates in frame based surgeries. Integrated Surgical Systems created the Neuromate in 1987, which uses preoperative images and passive robotic arms. In 1991, the University of Lausanne developed Minerva. Minerva employs real time images from a CT scan allowing the surgeon to change markings during the procedure. NASA constructed RAMS in 1995. Unlike the Minerva, the RAMS produces 3-D MRI images during surgery in order to give the surgeon a clear picture of the brain. Faced with the problem of hand tremors, John Hopkins University built the Steady Hand System in 1995. The Steady Hand System is able to detect the amount of pressure a surgeon generates ensuring safety. Shinshu University School of Medicine engineered the Neurobot in the early 2000's. The Neurobot is comprised of an endoscope with twin tissue forceps, a camera, a light source, and a laser.

II. Methods

In today's world, there are three major groups of robotics systems for brain surgery. The first one is Supervisory-Controlled Systems. In these systems, the surgeon performs the motion before the surgery and the robot repeats motion on the patient while the surgeon observes. The second group is the Telesurgical Systems where the surgeon uses haptic interface (tactile and visual feedback) and a joystick controller to control the robot. Finally, the third group is the Shared-Control Systems. In these systems, surgeon and the passive robot share the surgery. There are two newly developed systems, the NeuroArm and the Cyberknife, which have been used successfully, but have not been mass-produced. The NeuroArm is comprised of two arms, two cameras, and a workstation. The workstation contains a computer processor, hand controllers for robotic arms, a joystick controller for cameras and lights, 3 different displays (video, MRI, and control panel) and recorders shown below: .
The NeuroArm also has safety precautions such as force sensors and tremor filters. The first complete brain tumor removal by the NeuroArm was performed on 21-year old Paige Nickason in Calgary, Canada on May 12, 2008. The second newly developed robot, the Cyberknife, is a robot that delivers radiotherapy to a specific part of the brain using an accelerator and a robot arm while looking at real-time images from an x-ray scanner.

III. Results

Since the first surgery, there has been 31 successful surgeries performed by the NueroArm.

IV. Discussion

There are a few limitations regarding robotic neurosurgery. The most limiting factor is the cost of these modern robots. The most widely used robot, the Neuromate, costs 362,430 dollars and the newest robot, the NeuroArm, costs approximately 30 million dollars. Besides cost, finding space for these massive systems in the already cramped hospitals is very difficult. In general, robots produce problems such as technological accidents since they do not have a human brain and have no grasp on human feelings. Hopefully, through research and funding, researchers will be able to lessen these limitations. In the future, I believe that researchers can make vast improvements on detecting tumors, perfecting the NeuroArm and Cyberknife, using simulations, making the robots more human-like, and finding ways to cure other brain diseases. The NeuroArm can be more compact and less costly. Researchers can create a more human-like robot by engineering a robot that can sense what the surgeon is thinking. Scientists can also continue research on how to cure other diseases like Alzheimers.

References

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