A pioneer in neurosurgical robots

Through CLINICAL AND INDUSTRIAL COLLABORATIONS, a Beijing-based research team has broken new ground in neurosurgical robotics.

Remebot, China's first neurosurgical robot

The incision made in the skull for conventional brain surgery leads to considerable trauma, and a slower recovery period for patients. Minimally invasive procedures are therefore preferred. A technology for robot-assisted neurosurgery, developed at Beihang University, has improved precision and reduced the trauma of brain surgeries.

The technology was the result of years of work by a team led by Tianmiao Wang, the honorary director of Robotics Institute at Beihang. Wang set up a research team on medical robotics in Beihang in 1997, soon after he returned to China from studying abroad. That same year, he started working with hospitals to pilot robot-assisted stereotactic neurosurgery. "We benefit greatly from our close ties with hospitals," said Wang. "They help us understand urgent clinical needs, so that we can adjust our design."

Collaborating with clinicians, Wang worked on accurate positioning for minimally invasive neurosurgery. While a robot can help improve accuracy, stereotactic radiosurgery requires attaching a frame to the head with pins, which can cause pain and may alarm patients. In 1999 he piloted a technology for robot-assisted stereotactic neurosurgery without using a head frame, a breakthrough in robotic navigation and orientation for neurosurgery. This led to the Remebot, China's first neurosurgical robot to be approved by the National Medical Products Administration (NMPA).

Equipped with a CT/MRI compatible visual imaging system, the robot is capable of automatic positioning based on imaging data to help surgeons locate a diseased site. Use of artificial intelligence (AI) technologies has allowed for image identification and processing, accurate mapping, and an optimized surgical plan. An algorithm has enabled the robot to learn to identify and avoid obstacles, navigating in an unstructured environment. The robot's six-axis robotic arm allows for flexible movement, also improving precision.

Wang attributes the successful development of the robot to Beihang's solid strengths in basic research, including biomaterials and smart materials, micro- and nano-electromechanical systems, automation control, and AI technologies. "An emphasis on these basic research areas drives our growth," he said.

After years of research and clinical trials, the robot was updated several times, and has been used for clinical procedures including brain biopsy, draining brain hematoma, and implanting electrodes. Its use in a remote operation in 2003, a national first, won the team the second prize of the National Science and Technology Progress Award.

Commercialization of the technology was advanced by Wang's student, Da Liu, who founded the Beijing Baihui Weikang Technology Co., Ltd. in 2010, and led to the robot's NMPA approval in 2018. The Remebot robot is also China's first home-grown robot used in deep brain stimulation surgery. Its latest version has achieved positioning precision at 0.5mm, guided by an independent optical navigation system.

The Beihang team is also exploring robotic manipulation systems for surgeries on soft tissues. Led by another student of Wang, Junchen Wang, an associate professor at Beihang University, researchers are working on intelligent modelling of surgical environment, visual navigation, and precise manipulation, leading to many publications and patents.

A robotic system for transurethral surgery is being developed, and has been tested successfully in animal studies. ■

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