

Robotic aided surgery in full knee replacement

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Abstract

Every year, thousands of patients suffer from joint diseases, such as rheumatoid arthritis or osteoarthritis, and need total knee replacement (TKR) surgery to recover their normal functions. Presently, the positioning of prosthetic components in surgeries mainly depends on clinic experiences of doctors and special surgical guiding devices.

To avoid the limitations of jig-based TKR systems, we devoted to develop a robot/computer assisted surgery system, which can obtain a better operation precision and surgical quality. The system that we developed is a CT-free visual navigated robot assisted TKR surgery system called WATO-II. In WATO-II, both the infrared stereo cameras and the cutting tool are fixed on the end-effector of the robot. During the surgery, WATO-II automatically determines the position of cutting planes and establishes the mechanical axis according to the infrared markers, then guides the robot complete the surgery.

In this talk, the methods of system calibration, the surgical planning and navigation are discussed. We proposed an integrated calibration algorithm for the cameras, the stereo rig and the robot hand-eye, the infrared probe calibration algorithm, the tool calibration algorithm and physiological point based femoral and tibia positioning and calculation algorithm. WATO-II makes use of the physiological characteristics of the knee and the stereo navigation system, can get high-accurate locations of the femur and the tibia and achieve high-precision cutting of the bone, which fulfills the requirements of cadaver trials and is very meaningful toward clinic applications.

A lot of experiments, including gesso bones and human bones experiments, are conducted to test the efficiency and accuracy of the system. The experimental results show that WATO-II system can provide much high surgical accuracy and efficiency than manual operations.

About the author

Yuncai Liu is a professor at Shanghai Jiao Tong University, P. R. China.