Abstract

Omar Shalash

Design and development of autonomous robotic machine for knee arthroplasty

Robotic aided surgery has become mainstream in many fields of medical science. Two systems have been developed to assist unicompartmental knee arthroplasty. One of these systems is the Blue Belt system which is a hand-held robotic tool designed to remove the damaged surfaces of the patient’s knee to aid the surgeon during knee replacement surgery. Another more expensive system is the Mako Rio robot, it provides better accuracy and precision and is haptic. However, both the Blue Belt and the Mako Rio robot are expensive which is an obstacle for widespread adoption in the field. These systems are also manually driven by an operating surgeon for historic medico-legal reasons. In this research, a Novel system was developed to provide the required accuracy and precision but in a more affordable automatic system. It was guided by an OptiTrack motion capture navigation system. A CNC machine was built to drive the cutting burr across the knee joint. Multiple software applications were developed to enable the operation of the system such as communication with the navigation system, cluster marker identification and tracking, path planning, wireless communication, and CNC control. The system can perform the cutting phase in the surgery autonomously. The system has been tested on two sets of tibia and femur artificial bones and then the cut shape was analysed. The mean error of the cutting process was 1.9 mm with standard deviation of 0.55 mm for the tibial bones. The femoral bones also showed improved surface finish.