

An Efficient Algorithm for Recovering Distal Holes' Axes in Intramedullary Nail

Jackrit Suthakorn¹, Paweena U-Thainual² and Banchong Mahaisavariya³
¹*Center for Biomedical and Robotics Technology, Mahidol University, Thailand*
²*Department of Biomedical Engineering, Mahidol University, Thailand*
³*Department of Orthopaedic Surgery, Mahidol University, Thailand*

ABSTRACT

Computer-Integrated Surgery (CIS) is currently gaining its popularity among biomedical engineering researchers. Medical navigation is a major subdivision of the CIS. Even though 3D imaging systems, such as MRI or CT, are widely used for these days but they are useful only for pre-operation stage. In the intra-operation stage, most surgeons have performed operations depending on standard 2D X-ray images. Therefore, highly skilled surgeons are required in most complicated operation. Important reasons to develop surgical guidance system are to augment surgeons in long-period or highly radiating exposed operation.

Our study is to develop a navigation system for aiding surgeon for orthopedic applications. An orthopedic operation, called "Closed Intramedullary Nailing of Femur (Closed Nailing)," is one of the frequent cases of orthopedic surgery. This surgery also requires accurate positioning and orientating of the implant, and an important effort is to find the pose of two distal holes on the intramedullary nail after being inserted into intramedullary canal. During the conventional surgery, surgeons require high experience, and a number of trial-and-error adjustments to correct the path for inserting the screws through those distal holes. The process can be done by gradually adjusting the shooting angle until the projection of the two distal holes is seen as circular as possible on the X-ray image. Therefore, both surgeon and patient are continuously exposed by a great amount of X-ray exposure from the fluoroscopic imaging system.

This paper describes a new algorithm to recover the pose (position and orientation) of distal holes in the intramedullary nail by using only two X-ray imaging projections, such as, AP (anterior/posterior) and lateral views. The algorithm is based on inverse kinematics approach. The paper includes mathematical modeling, algorithm formulations, simulation and experimental results and conclusion of the algorithm performance.