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A Fast, Accurate and Easy to Implement Method for Pose Recognition of an Intramedullary Nail using a Tracked C-arm

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Abstract. A C-arm is a mobile X-ray device that is frequently used during orthopaedic surgeries. It consists of a semi-circular, arc-shaped arm that holds an X-ray transmitter at one end and an X-ray detector at the other. Intramedullary nail (IM nail) fixation is a popular orthopaedic surgery in which a metallic rod is placed into the patient's fractured bone (femur or tibia) and fixed using metal screws. The main challenge of IM-nail fixation surgery is to achieve the X-ray shot in which the distal holes of the IM nail appear as circles (desired view) so that the surgeon can easily insert the screws. Although C-arm X-ray devices are routinely used in IM-nail fixation surgeries, the surgeons or radiation technologists (rad-techs) usually use it in a trial-and-error manner. This method raises both radiation exposure and surgery time. In this study, we have designed and developed an IM-nail distal locking navigation technique that leads to more accurate and faster screw placement with a lower radiation dose and a minimum number of added steps to the operation to make it more accepted within the orthopaedic community. The specific purpose of this study was to develop and validate an automated technique for identifying the current pose of the IM nail relative to the C-arm. An accuracy assessment was performed to test the reliability of the navigation results. Translational accuracy was demonstrated to be better than 1 mm, roll and pitch rotations better than 2° and yaw rotational accuracy better than 2–5° depending on the separate angle. Computation time was less than 3.5 seconds.

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