College of Engineering
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Mechanical Engineering
Transformative Science and Technology Engineering Lecture Series

TOWARDS CLINICALLY RELEVANT SHAPE MEMORY ALLOY ACTUATED ACTIVE STEERABLE NEEDLE

Abstract: Minimally invasive surgical procedures are gaining popularity and gradually replacing open surgeries because of their benefits, such as, small incision area, less complications to patients, and reduced recovery time. One example is a percutaneous procedure, where inner organs or tissues are accessed by puncturing the skin with a surgical needle. This procedure is commonly used in interventional radiology for biopsy, brachytherapy, and tissue ablation. The major factor that undermines the efficacy of these procedures is the error in needle reaching an assigned target. The limitation in trajectory correction to reduce this error during the tissue insertion has motivated researchers to develop actuation mechanism in surgical needle. Shape Memory Alloy (SMA) wire actuators in needles have gathered significant interest in the past decade because of their high strain density, shape memory effect and biocompatibility. The goal of this project is to design and develop a true-scale, single SMA wire actuated active steerable needle that can steer in 3D space during tissue insertion. The needle consists of an active stylet and a compliant collet. The stylet tip bends by actuating the SMA wire installed on the bending region of the stylet with a dc power supply. The bending region is composed of a polytetrafluoroethylene (PTFE) polymer structure attached to the machined portion of the stylet. PTFE has low stiffness and high thermal and electrical insulation that are suitable for active needle applications. Preliminary test results showed that the active needle tip can be deflected up to 6.35 mm in air for a 41.27 mm needle length. Furthermore, an FEA simulation of the needle actuation was performed and showed a tip deflection of 7.5 mm, which is in reasonable agreement with the test results. Another design feature is that the proposed needle design allows stylet to rotate inside the collet and achieve steerability in 3D space inside a tissue. With single SMA wire installation, manufacturing of a true-scale active needle could be achieved. Future work includes development of a control strategy for the active needle steering and evaluation of needle insertions into animal tissues to assess the viability of the proposed active needle.

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Zoom Meeting ID:
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Bio: Sharad Acharya is a PhD candidate in the Department of Mechanical Engineering pursuing his PhD under the guidance of Dr. Parsaoran Hutapea. His research focuses on the study of mechanics of medical devices. Currently, he is working on a project involving the application of Nitinol-based Shape Memory Alloy (SMA) actuator for bending of surgical needle. He holds a BS degree in Mechanical Engineering from Tribhuvan University, Nepal. He has worked as a lecturer in Kantipur Engineering College, Nepal and as a design and operation engineer at Devighat Hydropower Station, Nepal Electricity Authority before joining the PhD program at Temple University in the Fall of 2018.