# The Field Robotics Center

# Seminar Series

**Friday, 4th August** **NSH 1305 10:00 – 11:00am**

Food will be served

**Timothy Lee**
M.S. Student
Robotics Institute

## State Estimation and Localization for ROV-Based Reactor Pressure Vessel Inspection Using a Pan-Tilt-Zoom Camera

**Abstract:** Nuclear reactors require periodic maintenance and inspection to ensure continued and safe operations, and automation of inspection tasks through robotics can minimize the duration of reactor inspection outages in a safe and cost-effective manner. State-of-the-art reactor pressure vessel inspection leverages remotely operated vehicles (ROVs), which are teleoperated, submersible robots. In order to inspect the reactor core, ROVs are subjected to extreme radiation exposure that destroys sensitive, commercial-grade electronics that would otherise enable localization. The lack of viable radiation-hardened sensors motivates the development of novel localization methodologies that overcome these limitations to enable efficient, autonomous inspection campaigns. This work explores the use of an external pan-tilt-zoom (PTZ) camera to address the challenges of sensing and localization in this hazardous, irradiated environment. By decoupling the sensor from the platform, the PTZ camera provides high optical resolution imagery that can be used for ROV localization while limiting radiation exposure, thereby providing a viable path to the automation of reactor core inspection.

In this talk, a state estimation framework that leverages an extended Kalman filter will be presented to enable ROV localization within the reactor through the use of a pan-tilt-zoom (PTZ) camera. The accuracy and uncertainty of the framework for subscale and platform experiments will be discussed. An online initialization methodology for the framework that imparts greater system utility and robustness will also be presented. The talk will conclude with implications of the work that open new avenues for improving the efficiency and utility of reactor pressure vessel inspection, such as automation of ROV-based inspection through camera-based navigation and building rich, dense reconstructions with the camera for high-fidelity visual review.

**Speaker Bio:** Timothy E. Lee is a M.S. in Robotics graduate student at Carnegie Mellon University, advised by Prof. Nathan Michael. Timothy's field robotics research seeks to enable robust, efficient, and autonomous inspection of critical infrastructure. Specifically, he is working towards improving the efficiency of nuclear power by enabling camera-based navigation of underwater robots to autonomously conduct precision inspection of nuclear reactors. Prior to CMU, Timothy received M.S. and B.S. degrees in Aerospace Engineering from the University of Maryland, as well as a Graduate Certificate in Artificial Intelligence from Stanford University.




For further information please contact: Michael Kaess, kaess@cmu.edu

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