MAE 4270/6270 Experimental Robotics

I -- Catalogue Description

Mechanical design and build of a robot complete with sensors and actuators. Install Robot Operating System (ROS) and operate. Communication using ROS. Integration of microcontrollers and onboard computers. Object recognition. Simultaneous Localization and Mapping (SLAM) of the environment.

ADP TITLE: Experimental Robotics

II - Learning Objectives

- Design robot platforms,
- Integrate a robot platform with sensors and actuators,
- Employ appropriate techniques for perception and localization in autonomous robots,
- Operate a robot platform using appropriate human-machine interface,
- Evaluate the performance of autonomous robots

III - Justification

Recent years have seen accelerated interest in autonomous robots, which have the ability for self-control even in highly dynamic unstructured environments. Autonomous robotics has thus evolved beyond the framework of traditional control theory and been built upon Bayes theorem where uncertainty stemming from environmental complexity is handled in accordance to the theory of probability. University of Virginia students are not currently given the opportunity to leverage such knowledge and skills, extensively design and build an advanced autonomous robot and experimentally evaluate its performance. The real world is so complex that students will not be able to predict the capabilities and limitations of the autonomous robot they designed without the lab-based learning. This limits our ability to transition the knowledge to the next generation of engineers and scientists.

The course will apply advanced, extensive and in-depth knowledge that builds on undergraduate learning such as mechatronics with advanced robot hardware and software. Students will develop the ability to independently

1. design and build a robot with intelligent perception via an array of sensors and actuators;
2. program and implement perception and localization capabilities into the robot; and
3. operate and experimentally evaluate the performance of the autonomous robot.

In addition to the above, the course will also give students opportunities to complete a project and to present and write technical reports on the project.

IV - Prerequisites

None

V - Texts and Special Teaching Aids

A. Required

Furukawa, T. (2017). *ME 5874 Experimental Robotics – Course Notes*, 85.

B. Recommended

Fiset, J.Y. (2008). *Human-Machine Interface Design for Process Control Applications*, Research Triangle Park, North Carolina, ISA – Instrumentation, Systems and Automation Society, 171.

Kelly, A. (2013). *Mobile Robotics – Mathematics, Models and Methods*, New York, New York, Cambridge University Press, 701.

Madhavan, R., Tunstel, E., Messina, E. (Eds.). (2009) *Performance Evaluation and Benchmarking of Intelligent Systems*, New York, New York, Springer Science+Business Media, LLC, 351.

Thrun, S., Burgard W. and Fox, D. (2005). *Probabilistic Robotics (Intelligent Robotics and Autonomous Agents)*, Cambridge, Massachusetts, MIT Press, 667.

VI - Syllabus

Topic	Percent of Course
ROS operation	15%
Interface of intelligent sensors, advanced actuators, microcontroller and high-performance onboard computer	15%
Human machine interface for autonomous robots	10%
Autonomous robot design and integration	20%
Perception and autonomy	15%
Localization and mapping by autonomous robots	10%
Performance evaluation of autonomous robots	15%
Total	100%

Note that graduate-level students taking MAE 6592 will be required to work through additional problem sets and projects that are not required of the undergraduates concurrently taking the MAE 4502 version of this course.