Micro-mouse Project: EEE3097S, EEE3098S, EEE3099S

This document will be revised as the course proceeds.

For motivation: https://www.youtube.com/watch?v=ZMQbHMgK2rw.

Learning onramps

Course 1: MATLAB Onramp
Course 2: Simulink Onramp
Course 3: Stateflow Onramp.

Resources

Some relevant video lectures are here: Student Competition: Mobile Robotics Training. Related resources: Mobile Robotics Training Toolbox and Student Competition - Mobile Robotics Training.

There are some nice videos on the Engineering Educator Academy YouTube channel's Robotics playlist. For example, Equations of Motion for Differential Drive Robots and Control of Differential Drive Robots for Path Traversal.

Matlab Simscape modelling might be a bridge too far, but this playlist from Gavin Nielson on YouTube is interesting to see how realistic physical components can be modelled in software. Gazebo is also a popular and fully functional simulator for robotic systems.

Repositories

https://github.com/EEEUCT/Micromouse
https://github.com/JesseJabezArendse/MicroMouseTemplate

Objectives

The EEE3088F course taught you design principles and gave you some experience in designing and implementing a subsystem for a micro-mouse. This course continues with procedural design but expands the scope to system-level design and synthesis. It is a practical course but with a significant simulation component. The final objective is to systematically design, build, and test a software control strategy to enable the micro-mouse to autonomously map a maze and subsequently get from a starting point to a designated target point in the maze as fast as possible. You will need to provide evidence of using formal design methods in your development.

The course will use Matlab, Simulink, and Stateflow. In this framework the required algorithms are specified via Stateflow process flow diagrams (in the form of ".slx" files), which you will design and implement. These process flows will be developed using the design principles you've been taught, and will likely involve system identification, subsystem modelling, simulation in Simulink, and comprehensive testing. The Matlab embedded coder can then convert these ".slx" descriptions to low-level code that gets flashed to the micro-mouse, where physical testing can be performed. In response to physical tests, one typically revises the simulation and repeats the cycle.

Assessment

The course will involve submitting two reports that document the design process used to achieve a solution to specific tasks chosen by you. The required structure and format will be provided. These reports must collectively provide evidence that you have met the level required for the ECSA design graduate attribute. If the necessary evidence is not present in either report then a final opportunity to revise and resubmit will be granted.

Subject to change, the intention is to develop an autograder to assess simulated procedures and physical runs of the micro-mouse. Simulink/Stateflow ".slx" submissions will be assessed by simulating model runs under model perturbations that span the expected variability in the micro-mice, to determine robustness of the solution. A mark will be assigned accordingly. This evaluation is intended to ensure that a trivial feed-forward solution based on an individual model of your own mouse is not used.

To evaluate physical performance each student will submit a sensor log file of the mouse executing the required task, along with video evidence. This will be used to assign a mark that assesses the quality of the solution.

Milestone 1

Task: Move a specified distance in a straight line.

Design, implement, and test a system for moving the micro-mouse a specified distance (for example 2m) in a straight line. This will involve actuating the motors to turn the wheels and using some measurement to estimate actual movement and generate control feedback.

This milestone will be assessed via simulation in software, and a hardware demonstration of the actual mouse in action. Separate from but in addition to that a GA report will be evaluated that documents a chosen design task.

Submissions:
1. A ".slx" file that specifies the control strategy developed.
2. A micro-mouse sensor log file from a physical run using the submitted ".slx" file, along with a video recording of the attempt.
3. A GA report, in the required format, documenting a selected design task.

Milestone 2

Task: Explore a maze in simulation.

In simulation, Design, implement, and test a system for making the micro-mouse completely explore a maze. This will involve determining the requirements, simulating all subsystem components required to achieve the task, and implementing the required logic and control strategies.

This milestone will be assessed via simulation in software. Separate from but in addition to that a GA report will be evaluated that documents a chosen design task.

Submissions:
1. A ".slx" file that specifies the control strategy developed.
2. A GA report, in the required format, documenting a selected design task.

Final demonstration

Task: Micro-mouse physically explores a maze.

This milestone will be assessed via a hardware demonstration of the actual mouse in action.

Submissions:
1. A ".slx" file that specifies the control strategy developed.
2. A micro-mouse sensor log file from a physical run using the submitted ".slx" file, along with a video recording of the attempt.

Competition

The overall goal of the course is to design, implement, and test a process for making the micro-mouse explore and map a maze, and then run a route from start to a target point as fast as possible. At the end of the course, students who think they can do this will be invited to a live competition where they can execute their attempt.

If, in the view of the judges, a mouse fully succeeds in this task, then the student will be awarded 100% for the practical component of the course (i.e. the simulation and hardware demonstration parts). This is justified on the grounds that it would be impossible to achieve this without robust design and testing of many separate components, and making effective use of simulation tools.