Bullets

- No prerequisites are required; all necessary skills are included in the course.
- Focusses on learning to think and communicate like an engineer or scientist.
- Helps prepare students for university undergraduate engineering programs by introducing students to the tools and techniques they will encounter.
- Employs an industry standard embedded computer and teaches how to program and debug it.
- Teaches basic C/C++ programming and the use of both hobby and professional integrated development systems (IDEs).
- Introduces simple mechanical and optical sensors emphasizing the physics employed.
- Familiarizes students with both real time and store and forward telemetry techniques to upload data for subsequent scientific analysis.
- Instructs students in the use of both dead reckoning and metrology-based programming to control motion.
- Introduces students to multi-threading and multi-core programming considerations.

Description

This is a weeklong course that is targeted at high schoolers. It is targeted at students who are considering studying engineering or science at university.

Preferably, students will be paired, in teams, although a student may choose not to be paired, but to work on their own. Students working on their own will be at a disadvantage, however, as teamwork makes both troubleshooting and recognition of conceptual and understanding errors easier and quicker. Students working as a member of a team will be compelled to develop a method of working in which cooperation, listening, and respect all play a part.

Monday

The first class begins with students building, using detailed plans, a small Lego® Technic® robot that is equipped with motors, a variety of sensors, and a battery powered embedded computer (that is more capable than a Lego® Mindstorm® computer).

Once construction of the robot is complete, it will be inspected. The inspection will include, from a small height, a drop test.

The students will then begin to program their robots, using the C/C++ programming language, to drive through a simple obstacle course. The students are likely to encounter situations where their algorithms or the design of the robot result in the robot either getting stuck in one place or entering an endless cycle in which the robot successively visits the same few locations, and they will be expected to make changes to prevent this behavior. Students will be provided with sample code that they will need to modify and expand.

Instruction in coding and debugging will be provided throughout the course as new programming techniques become necessary.

Tuesday

The second class will focus on the use of a pair of infrared reflectance sensors, the analysis of the signals generated by these sensors, the use of telemetry technology to capture those signals and upload them to a PC for analysis, and, finally, the creation of a program that uses data from those sensors to modulate the energy input to a pair of DC motors such that the robot navigates along a line as it meanders around a four-foot by four-foot MDF panel.

Sample code, that students will need to modify and expand, will again be provided.

Students will explore how the robot's infrared sensors "see" the black line. This work will include using code to upload data from the robot to a PC and to graph it. The students will also learn how to display the data on the computer's LCD panel.

Students will then explore the programming needed for a robot to navigate along the line by detecting the line and maneuvering such that it travels along the line without deviating so much that it can no longer "see" the line.

Students will discover that speed is a significant factor and will have the opportunity to make changes to the robot's gear train to achieve different speed ranges.

Wednesday

The focus of the third class will be the use of rotary encoders to measure the movement of the robot. This work will entail the use of multi-tasking code and will require an understanding of hysteresis.

The robot's drive train includes rotary encoders. Students will learn how these encoders work and will write code to upload data from those sensors to a PC and display and analyze it there. They will initially use a single thread programming technique but will transition to a multi-thread programming technique and will learn the benefits and drawbacks of the use of multi-thread and multi-core technology.

Students will then create programs to drive the robot along a specified course using data from those encoders in conjunction with an understanding of gear ratios and wheel and tire geometry.

Thursday and Friday

Thursday and Friday are devoted to preparing the robots to compete in a competition and then actually competing.

In the interest of "Surprise!" no details of the competition will be revealed here.

However, the competition will require the students to employ new techniques.

The first part of Thursday will be devoted to explaining the competition to the students. They will then be encouraged to conduct a series of experiments to better understand the techniques needed to solve the competition's main problem. Advice and help from the instructors will be freely available during this process.

During the remainder of Thursday and during all of Friday afternoon, the students will be expected to design, build, and program a competition robot.

The competition will take place on Friday afternoon, after a late lunch. Parents and guardians are encouraged to attend.

The competition will comprise two events, each of which will be timed. Students will be permitted, taking turns, as many attempts as they desire, up until a deadline near the end of the day. The times for each attempt will be recorded with the shortest time for each robot for each of the two events being carried forward and then being combined to form a total time. The robot with the lowest total time will be declared the winner. In the event of a tie, the final result will remain a tie, i.e. ties will not be broken.

Throughout the course, from time to time, as appropriate and relevant, the instructor will introduce a real-world science or engineering project, incident, or accident and discuss its connection with the current class activity. The intent of this being to illustrate that the knowledge and skills being imparted in this course are relevant to the real world.