IEEE SoutheastCon 2017 Hardware Competition Robot

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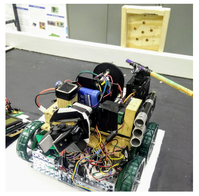
PURPOSE

The IEEE SoutheastCon Hardware Competition provides students with an opportunity to apply technical knowledge of programming and electronics together with design strategy and teamwork to build a fully autonomous robot that can complete four separate tasks successfully. Students develop skills in the growing field of robotics while competing against other designs. The competition simulates a real-world environment because each team must meet given specifications and compare the results to competitors, much like different proposals compete for a bid.

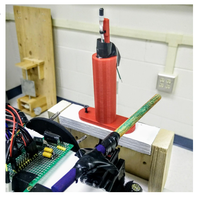
THE COMPETITION

TASK 1 - Component ID



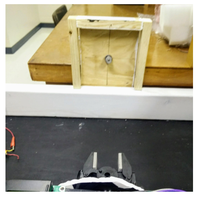
- Five copper pads are arranged in a pentagon.
- Each pad is connected to one of five passive electronic components in random order.
- Robot must probe the pads and detect the order in which the passive components are arranged.
- A 5-digit code is generated based on the order of the components and is displayed on an LCD.

TASK 2 - Magnetic Field Sensing



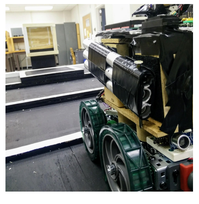
- The lightsaber is equipped with a vibration sensor.
- An electromagnet is mounted beneath the lightsaber.
- The robot must detect when the electromagnet turns on and strike the lightsaber at that moment.
- Points are awarded if the lightsaber is struck or vibrated when the magnet is on; points are deducted if it is struck when the magnet is off.

TASK 3 - Knob Turning



- A simple rotary encoder knob serves as a combination lock.
- The robot must rotate this knob according to the 5-digit code generated in Task 1.
- Points are awarded for each number in the sequence that is entered correctly.

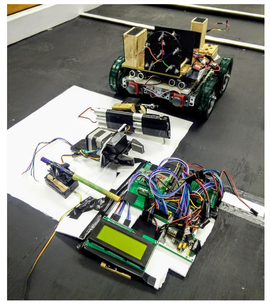
TASK 4 - Fire Darts



- A portal exists at the end of the arena.
- The robot must fire three Nerf darts into the portal.
- The darts can be simply dropped through the portal; however, the robot will have to drive up several steps to reach it.
- Points are awarded for each dart that goes into the portal.

METHODS - MODULAR DESIGN

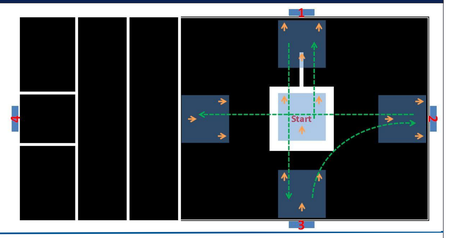
The team decided to divide the robot into 5 distinct subsystems in order to isolate each function of the robot. Doing so allowed for points to be collected for each task despite not all of the subsystems functioning at full capacity. The modular design also prevented hardware errors in one task from stopping progress in another. As a result, our robot was able to move from one task to the next regardless of whether or not the task was completed saving the team many points in the final competition.



SUBSYSTEMS

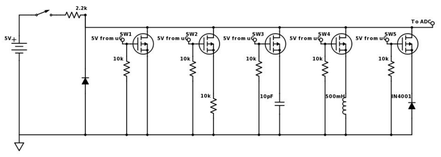
Navigation

- Uses sensor feedback
- Ultrasonic distance sensors
- Infrared sensors for line following
- Integrated motor encoders
- Touch sensors



Task 1 - Component ID

- MOSFET switch array isolates each component.
- Measures transient voltage response to a 5V input.
- Averages eight ADC values.



Task 2 - Magnetic Field Sensing

- Digital magnetometer transmits magnetic field strength over I2C bus to microcontroller.
- Averaging and Standard Deviation Algorithm generates thresholds based on the initial magnetic field readings.
- Magnetic field strength is monitored during the thirty second lightsaber duel and if any readings are above the generated threshold, a servo arm responds and strikes the lightsaber.

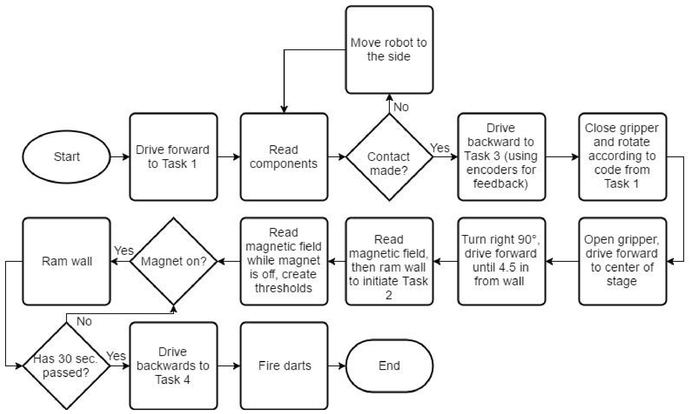
Task 3 - Knob Turning

- Controlled from Task 1's microcontroller.
- Gripper turns knob using code.
- Relies on accurate navigation.

Task 4 - Fire Darts

- Custom-made spring-loaded launching tubes.
- Nails attached to fishing line are pulled with a DC motor.
- Fires from 4ft away.

SYSTEM CONTROL FLOWCHART



RESULTS & LESSONS LEARNED

Competition Preparation

- Practice trials on the arena allowed us to correct the following flaws:
  - Task 1 alignment by raising the mount by ¼".
  - Task 2 lightsaber weakness by choosing to ram the wall instead.
  - Task 4 misalignment by rewriting navigation code.
- By addressing these problems before the competition, the team saved over 500 points.

Competition Performance

- As a result of adequate preparation, the robot performed well on each of the 3 competition rounds, increasing its score on each round
  - Task 1 read three out of five components
  - Task 2 had false triggers on the first run and was corrected to score more points on the 2nd run and max points on the final run.
  - Task 4 shot two out of three darts into the portal on the final 2 runs.

Competition Results

- The team placed **2nd** out of 8 teams in the open division, and **9th** overall out of 51 teams.

Lessons Learned

- Modular design allows for rapid problem solving when testing
- The 'next best alternative' method works when all specs can't be met

ACKNOWLEDGEMENTS

Special thanks to Mr. Nick Schmidt for the dart launcher design concept.