The Spicy Boy Rover: Designing an Autonomous Robot
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Abstract
The goal for our team was to design a small autonomous robot with the ability to navigate through the Mars-like terrain of Colorado’s Great Sand Dunes National Park. For the robot to move efficiently, it needed the capability to drive on inconsistent surfaces and detect obstacles in its path. Due to the Sand Dunes unexpected changes in weather, the robot's electrical components needed to be protected from the elements. To address the motion of the robot, our team created digital and hand-drawn layouts. Flaws in the layouts were improved upon through the design process. This process led to the production of a semi-elastic suspension system that allows flexible movement when driving over rocks and through low points. The design included ribbed 3D printed wheels to improve traction when driving in loose packed sand. To attain autonomy, sensors were programmed for obstacle detection and avoidance. The robot incorporated Radio Frequency communication for navigation. In order to protect the electrical components, a removable cover was designed to prevent water damage to the motherboard, motor driver, battery pack, and navigation system.

Goals
General Requirements for the robot:
- Must be autonomous
- Under $500
- Under 4.0 kg
- Built to be the size of a cat

Team Goals:
- Protect components from sand and elements
- Design a flexible suspension
- Incorporate 3D printed elements
- Program obstacle avoidance
- Keep it simple

Materials
- PVC Pipe
- Plexiglass
- 3D Printed wheels
- Lewansoul Lx-16a bus servo motors
- Lewansoul motor board
- Arduino Mega board
- SparkFun Fio
- Xbee communication
- Ultrasonic sensors
- Liio Battery packs
- General: hardware and wires

Design
- Design Process
  We started with an initial design of a robot with a flexible six wheel suspension. However, we only had the budget for four bus servo motors and determined that sand would impede the central wheel. After reverting back to the design process, we created a flexible four wheel suspension.

Sensor Testing
During initial testing of the ultrasonic sensor (Figure 1), the data received was estimated to be accurate approximately 70% of the time. In order to troubleshoot the accuracy of the sensor, a test was set up to find the minimum and maximum distances at which an object could be detected. A program was written to take the average of the minimum and maximum distances. These data values were used for the obstacle avoidance program.

Figure 1. HC-SR04 Ultrasonic distance sensor and Arduino Mega Board

Figure 2. AutoCad design of the Spicy Boy Rover by Guadalupe Alvarez

Figure 3. 3D printed wheel designed and printed by Guadalupe Alvarez and Ayah Baydoun

Conclusion
During our testing phase, we were able to pinpoint potential areas of improvement in the design. We found that due to the inconsistent data received from the ultrasonic sensor, future designs would benefit from the inclusion of additional object detection sensors. Moreover, the initial design of six wheels may allow for better mobility and traction, if including additional motors were a feasible option. Participation in this competition has given our team valuable experience in the design and execution of building an autonomous robot. Furthermore, this experience has strengthened our ability to work together in a team. We look forward to incorporating this experience into our future professional and academic endeavors.

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- Wheels
  The wheels were designed with a cross brace in the center, and outer ridges. This design helps to maintain stability, support weight, and offer traction in loose packed sand.