ME4405 Final Project Proposal
Spring 2020

Names of team members:
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Project title:
In-door Obstacle Avoidance Patrolling Vehicle

Problem statement and goals:

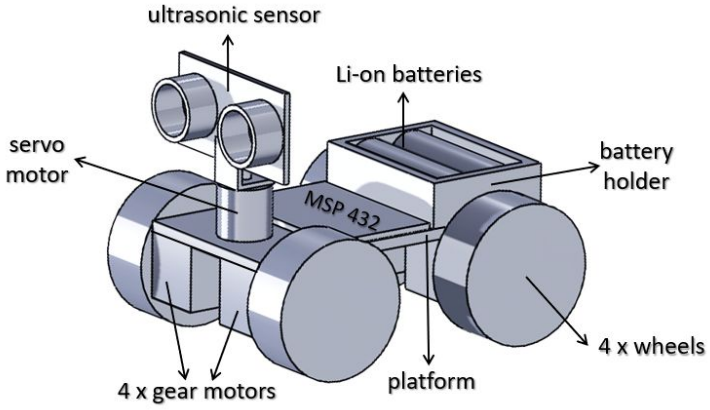
Household chores are tiring, boring and time-consuming. Many housework such as floor sweeping and mopping include repetitive labor in an indoor scenario. In a well defined indoor area, many of these tasks could be carried out by a ground vehicle platform patrolling the floor and perform different actions.

In our project, we aim to design a system capable of effectively covering the floor in an indoor scenario while avoiding collision with obstacles and walls. The system will scout its surrounding environment with ultrasonic sensors to pathplan and steer according to the feedback. ~~The system is designed to cover 80% of the ground area and maintain a cruising speed of 1mph.~~

Breakdown of the project components:

- **Mechanical design:**

  The figure below shows the preliminary design of our mechanical system:



  This system will require the following major mechanical components:
  A gear motors and wheels set, a 3-d printed or laser-cut platform.

- **Electrical design:**

  This system will require the following major electrical components:

  An ultrasonic sensor, a servo motor, a motor driver, a motor encoder, Li-ion batteries, a battery holder, an MSP432 microcontroller, a voltage regulator, and some jumper wires.

- **Software and Control Theory:**

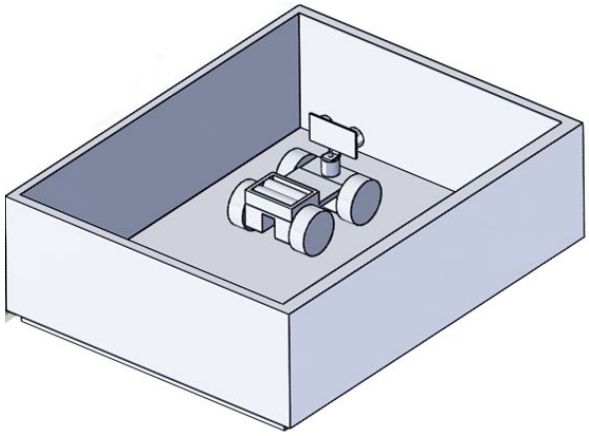
The control of the system will be comprised of two major parts- a sensing module and a path planning module. The sensing module will actively detect its surrounding area with an ultrasonic sensor and compare the measured distance to a set safety distance to make leeway for the system to steer and maneuver. The path planning module will take feedback from the sensing module to determine the best route to avoid the obstacle ~~cover the rest of the ground area~~ and output PWM signals to servos. There also exist complex scenarios that would need to be tackled, including irregularly shaped floor plans and layouts with multiple indoor obstacles.

List of project milestones:

- **Stage 1:** Sourcing and building basic hardware for the system, including the sensors, motors and other electrical components.
- **Stage 2:** Validating the successful operation of the electrical systems, and proving that sensors are providing proper feedback that can be read by the system.
- **Stage 3:** Designing an operating system that works in an obstacle-free scenario, executing basic steering maneuvers and being able to stop properly in front of obstacles.
- **Stage 4:** Fine-tuning of the steering action, ensuring proper facing direction after steering ~~and improving ground area coverage during operation.~~
- **Stage 5:** Solving challenges posed by more complex obstacle layouts, challenge courses, and interferences.

Method of evaluation:

Our mechatronics system will be evaluated based on its ability to accomplish the following tasks: move at a reasonable speed, accurately detect and properly stop in front of obstacles (wall), decide which direction to turn to avoid the obstacle, fine-tune the steering action to ensure proper facing direction~~, decide when to stop and which direction to turn to maximize its ground area coverage~~. Its ability to avoid obstacles ~~and plan path~~ will be tested in a setup like the figure shown below:



Some potential failure modes may include:

- The vehicle may deform permanently after crashing into the obstacle. This can be eliminated by controlling the gear motors to turn at a reasonable speed and building a simple and sturdy mechanical system
- The vehicle may fail to execute proper facing direction (90°) after steering, this could be mitigated by selecting a proper time delay for the servo motor through repeated testing
- The sensor may keep reporting distances below threshold distance and trigger another turning command after the vehicle has detected the obstacle and started turning, this could be mitigated by controlling the vehicle to move backward before turning