CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Thirty Gallon Robot Design	
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Project Overview:

Figure 1: Artist's Conception of a 30-Gallon Robot

In recent years, technology manufacturers have continued the ever-increasing trend of packing more and more computing power into ever smaller and cheaper packages; other components like accurate motors, batteries and sophisticated sensors have become cheaper and available on the consumer market as well. As a result, it has now become feasible to construct simple, relatively cheap robots with a surprising amount of sophistication. The project sponsor has been following this trend with interest, with particular focus on developing a flexible, cost-effective robotics platform to use within college level programs for educational purposes. The aim of this project is two-fold:

a) Develop a simple robot that is, in principle, capable of leading tours of the engineering building for visitors. Thus the robots will need to be able to navigate hallways, the elevator, and (perhaps calling on human assistance if locked) doorways; it will not need to be able to manage stairs. This task and all of its implications represents the core specific functional goal of the project.

b) More generally, the aim is to create a prototype that can be widely communicated, and can thus be easily implemented as "a recipe" by other schools or individuals to create their own low-cost robots.

To keep the design simple and low-cost, the project will be based on using a 30-gallon barrel as the initial structure of the robot; this is sturdy, easily-available, and provides plenty of room for components. Future refinements to the design can then focus on re-working a successful design into more compact or elegant packages. Some key aspects of this project include:

1. This is essentially a novel robotics project that can bring together students from two disciplines – Computer Science and Electrical Engineering to build a foundational product. The project will be designed to continue as a vehicle for other robotics projects that can extend this initial one with interesting additional capabilities. The potential future extensions will need a solid, reliable device that they can use and the target here is to build that unit from the ground up.

2. This robot must be reliable and robust, with the ability to move down hallways in our Engineering building without being harmed by students bumping into it and/or it bumping into students and other things. The foundational robot must have basic hazard and obstacle avoidance capabilities and some level of navigational ability to accomplish this first level challenge.

3. The difficulty building a robot such as this one from the ground up lies in correctly analyzing available technologies to figure out power system size and capacity, identifying the correct driving motors or units, implementing some fundamental turning and maneuvering abilities, and then finally synthesizing

management of the whole system. Some of this background research has already been conducted in summer 2018, but there will need to be some testing and potentially iterative research, design, and implementation to bring the unit up to the desired capabilities.

4. Upon completion of this project, the robot should be constructed from a plastic 30-gallon barrel, should be able to navigate in at least a primitive way, should be able to move around the Engineering building hallways without harming itself, and should be designed in such a way that others can either replicate the building process and/or develop extended capabilities that will allow the robot to become more autonomous in its movement and capable of taking on further challenges such as conducting tasks or providing guidance or tours to others in the building.

5. Some key features of this project will include:
    a. a detailed design specification that others could use to create their own robots
    b. information on the types of batteries, motors, and other controlling components to support others' efforts
    c. a fully assembled robot that meets the key features mentioned above
    d. ability of the robot to avoid obstacles or conditions that could cause harm to the unit
    e. ability of the robot to navigate, initially by wire or wireless control from a remote controlling system, a laptop, and/or a mobile app

6. Most robots are too small or too slow to be much more than novel toys that can run around the kitchen or office. This robot is meant to be robust enough to navigate a real-world environment such as an office or school building. With this fundamental problem solved, future students can use this robot as a vehicle to learn about improved navigation, interactions with people and parts of the building, and potentially conducting actions managed by machine learning.

Knowledge, skills, and expertise required for this project:

- Abilities to research the best power components such as batteries, motors, and controllers
- Ability to work with a small-scale processor such as an Arduino system
- Ability to work with sensors such as ultrasonic or laser devices, and any other sensors necessary to meet the given specifications
- Ability to program at a higher level when developing obstacle clearance and navigational software

Equipment Requirements:

- Arduino processor/system and interface/IDE
- Motor controller(s)
- Battery(s) and power systems
- Driver motors, and possibly other steering motors or devices
- Thirty-gallon barrel
- Higher level computing abilities for developing and implementing obstacle avoidance and navigation

Note that equipment not free or immediately available will be purchased and/or facilitated by the sponsor

Software and other Deliverables:

- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development and/or extension of the product.
- Code base posted on Github or other version control system, as well as stored on a local USB drive
- Assembled and functioning thirty-gallon robot