ECE 6780 MINI-PROJECT PROPOSAL

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Overview:

In this project we are building a rover with two tasks to complete:

1. Obstacle Course- Our rover will need to navigate a course with objects placed as obstacles throughout. We will need to steer the rover through the course without striking the obstacles and without being able to see our rover.
2. Drag Race – Our rover will attempt to drive as fast as possible to a finish line and stop as close to the finish line as possible, again, without us being able to watch the rover while it drives.

In addition to the two tasks mentioned above; the obstacle course and the drag race, we also have to design our rover with the following constraints in mind:

1. Our only connection to our rover is a wireless USART or RS232. This may allow transmission of a low resolution visible spectrum camera (only 10x10 pixels) at a low frame rate of approximately 2fps to act as a backup to the autonomous capabilities and stop or back up the rover in case of emergency.
2. Our rover must incorporate at least three topics we have covered in labs out of the following list: GPIO, Interrupts, Timers, UART, I2C, Analog, and PID.
3. Because we are a graduate group we are required to use PID along with three other options.

Design Vision:

Our current idea is to use an STM32F072 discovery board as our main controller. The topics we will implement at minimum, in addition to PID, from the labs will be GPIO, I2C, Analog, UART, and Interrupts. In general, the GPIO will be used as the main interface for the sensors. We will use interrupts that are tied to the input from the sensors to aid in obstacle avoidance. I2C will be used to talk with the color sensor, Analog will be used to talk with the IR sensors (their output is an analog voltage), and UART will be used to talk with the ultrasonic sensor's UART output. We will incorporate PID with the motors to control the acceleration of the rover both for speeding up and down during the drag race and while avoiding obstacles.

For the body of the rover we will use a prebuilt chassis (see BOM below) with two wheels that will be hooked up to motors/motor drivers and a third universal stabilizing wheel will be used on the front of the rover. We will place the IR sensors on the sides of the chassis and the ultrasonic sensor on the front of the rover for obstacle detection. We will also place the color

sensor on the bottom of the rover for detecting the finish line for the drag race. We will power the rover using a battery pack that can be found below in the BOM.

Proposed Bill of Materials:

Item	Quantity	Price Per Unit	Link
20 mm Caster Bearing wheel	1	1.95	https://www.adafruit.com/product/3948
DC Gearbox Motor	2	5.90	https://www.adafruit.com/product/3777
Aluminum Chassis	1	14.95	https://www.adafruit.com/product/3796
Battery Holder	1	2.95	https://www.adafruit.com/product/3859
4 AA Battery pack	1	5.99	https://www.amazon.com/Duracell-CopperTop-Batteries-All-Purpose-Household/dp/B00000JHQ6/ref=asc_df_B00000JHQ6/?tag=hyprod-20&linkCode=df0&hvadid=309789297054&hvpos=&hvnetw=g&hvrand=6607104218528133970&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9029755&hvtargid=pla-637193815171&psc=1
IR Sensor	2	29.90	https://www.adafruit.com/product/164
Ultrasonic Distance Sensor	1	6.95	https://www.adafruit.com/product/4019
Color Sensor	1	7.95	https://www.adafruit.com/product/1356
Wheels	2	3.00	https://www.adafruit.com/product/3763
STM320F Discovery board	1	N/A	N/A
Motor Drivers Plan A: Our group's Motor Drivers Plan B: Commercial	2	Plan A: N/A Plan B: 6.95	Plan A: N/A Plan B: https://www.adafruit.com/product/2448
Breadboards	1-3	~ 5	N/A: (purchase from stock room)
Wires/Solder/Misc.	N/A	~ 5	N/A: (purchase from stock room
Total:		**$123-130**	

(Block Diagram is included at the end of the proposal)

Project Schedule:

Milestone 1 (Mar 17): At this stage we will have ordered all of our parts and have come up with a schematic based off of our components' datasheets. We will also have ordered any backup/contingency parts, purchased necessary parts from the stockroom, and ordered any last minute parts we forgot

about during planning stages. And finally we will have chosen the pins on the STM32F discovery board that we will be using and identified which register values we think we need to modify for correct function.

Milestone 2 (Mar 24): At this stage we will have assembled our board or in the worst case have the layout ready so we just need to insert any parts that haven't arrived yet. We also will have done some initial testing with our different components to see if replacement parts need to be purchased.

Milestone 3 (Mar 31): At this stage we will have figured out how to communicate with each of the sensors and made sure that we have figured out the code necessary to communicate with the discovery board.

Milestone 4 (Apr 7): At this stage we will have figured out how to operate the rover and have tested our obstacle detection abilities on a variety of obstacles.

Milestone 5 (Apr 14): At this stage we will have tested our drag race ability and finalized our obstacle detection abilities and have the rover at a basic working level.

Milestone 6 (Apr 21): At this stage our goal is to have optimized our approaches for both events and have our best solution finalized.

Risks, Unknowns, and Potential Problems:

1. We do not know how sensitive any of our sensors will be in practice and will have to trust the advertised values for right now.
    a. Plan: Assume that the sensors will not work perfectly and underestimate their ranges
2. In addition to not knowing the sensitivity, we are not sure how well the color sensor will pick up the line for the drag race and how well the proximity sensors will detect the obstacles.
    a. Plan: Test the sensors early on with a range of obstacles/lines to make sure that the sensors work as planned and have back up sensors selected
3. We also do not have extensive collective experience in this type of project and will be working with difficult topics without having experience outside of the lab.
    a. Plan: Ask for help and review lab handouts thoroughly throughout coding process
4. We have not yet received our motor driver boards and we do not know if any of our boards will be operational.
    a. Plan: If our boards aren't working early on order commercial options quickly and start testing them/working with them early on
5. In addition, if we need to purchase new motor driver boards we will need to learn how to have them work with the discovery board
    a. Plan: Order commercial boards as a back up and test them out early on to see if they will work

6. Parts could take longer to arrive than expected or mistakes in the orders could occur.
    a. Plan: Check with the stock room or other local hobby shops to see if they have similar parts
7. Software makes a few assumptions that a black line will be used to mark the finish line of both the obstacle course and drag race. That the obstacles will be largely spaced(0.5 meters apart), not navigating a maze.
    a. adjustments will be made as more details are disclosed.

Software Block Diagram: