SANTA CLARA UNIVERSITY	ELEN 123/MECH 143 Winter 2015	Andy Wolfe

Final Project

PROBLEM STATEMENT

Build an autonomous robot that performs the listed set of tasks on its way to the David Letterman show.

PROBLEM DESCRIPTION

1. Robots must move from the starting line to the Velcro wall performing the following tasks along the way:
    a. First – you must cross the George Washington Bridge. The bridge is 16" wide and 36" long. It has a 1" wide black stripe along the middle. You must stay in your lane or you will get stuck. The other lanes are closed for an undisclosed reason not at all related to the Governor's office.
    b. At the bridge exit ramp, you will experience a 0.75" drop due to poor road maintenance. In response to this drop, your robot will respond like any New Yorker. You will immediately stop, blocking traffic, flash your lights in anger and obnoxiously honk your horn or make another noise at least 3 times.
    c. Once your robot calms down, it can proceed along the marked path to the Ed Sullivan Theater. In order to get in, you must identify yourself to the security station on your left. Note that there is a 12" wide x 10" high white wall in front of you as you approach the security station.

       The security station is 5.5" wide and 14" tall. It has a 3" diameter window that is centered at 12" high. To get your security code, you must direct 3 infrared pulses into that window, each 200ms in duration with 200ms between them. In response, after about 500ms, you will receive from 1 to 5 infrared pulses from the window, once again 200ms in duration and 200ms apart. This is your PIN number. You then respond by sending back the PIN number, i.e. between 1 and 5 IR pulses 200ms in duration and 200ms apart. You will get a long IR pulse as an acknowledgement. If you do not get the proper responses, you can wait 5 seconds then try again.
    d. After passing security, you must follow the path to the studio and line up in front of the Velcro wall.
    e. Your robot will be carrying a man (baby) in a Velcro suit. It must be placed on the 10x10 bulls-eye on the Velcro wall.
2. You can backup and retry as much as you want.
3. Teams will be given two runs on competition day; a strict time limit will be enforced.

GENERAL RULES

1. The competition will be held at the scheduled final exam time for the course: Thursday, March 19th, 9:10-12:10. All team members are required to be in attendance and on time to the event.
2. Robots will be inspected prior to competing to ensure they meet the rules and specifications. We will arrange for a pre-inspection during office hours if you have anything you want evaluated in advance.
3. You can get credit for any part of the lab except for the Velcro wall if you demo that to Dr. Wolfe, or one of the lab TAs more than 24 hours prior to the final competition or if you perform these tasks during the final competition.
4. Teams/robots that do not follow the rules and specifications will be disqualified.
5. Changes to competition format, rules, and/or outline will be posted to Camino.
6. Competition scoring and judgment will be final.
7. Questions about the competition and/or rules can be emailed to awolfe@scu.edu.
8. This document and the project rules are subject to minor changes at the discretion of the TA's and professor as needed.

ROBOT DESIGN RULES

1. Robots must be autonomous. This means that the robot cannot receive any input from team members or devices not aboard the robot. This includes, and is not limited to, any forms of wireless transmission.
2. Only one robot is allowed per team.
3. It is the team's responsibility to design, build, and test the robot.
4. Your robot can be any size. It must fit through the field. You can cut the platform or substitute for it if you wish.
5. The power supply for the robot's motors must be the provided 9.6V battery, which must be carried on-board. You may use the 9V battery to power other components.
6. The robot should not damage the arena or anything in it.
7. Use of toxic, flammable, or otherwise harmful/dangerous substances is strictly prohibited. Non-toxic, non-combustible gasses or liquids (i.e. water, compressed air, CO2) can only be used with prior approval from Dr. Wolfe. Approval will require:
    a. Documenting all components that will be under pressure
    b. Presenting a complete design for all hydraulics
    c. Getting a signed note from a Mech. E. professor stating that he/she has reviewed your design and does not find it to be a safety hazard.
8. Use of Lego®, K'NEX®, or other off the shelf kits is not allowed. Gear and pulley assemblies are an exception to this clause (check with professor/TA's).
9. Teams need not spend any money on their robots. Scrap parts are fine. If you do spend money, teams shall spend no more than $300 on their robot. Teams will need to submit any and all receipts for outside parts used in their robots. You can pro-rate purchases based on what is used in the robot. Scrap or junk counts as free.

10. Any and all of the components provided in the lab portion of ELEN 123/MECH 143 may be incorporated into the design (and count as free). Extra copies of these parts may be available. Check with the TAs/Prof.
11. Lab parts cannot be physically modified or damaged without express permission. Teams and/or individuals responsible for damage or modification without permission bear the responsibility of replacement.
12. The robot cannot leave anything behind on the arena (i.e., no detaching parts).
13. Judges reserve the right to terminate a robot's run, declare disqualification, or give instruction when necessary (e.g. if an unsafe event develops, or if the arena is in jeopardy).
14. The robot must start with the push of a single button. You can perform a calibration procedure prior to starting.

ARENA

1. The arena floor is an unpainted wooden surface with black lines. It is generally flat, but may have minor anomalies such as tape. It is 45" wide and 93" long. It will get dirty.
2. A measured drawing of the field is at field sketch 2015.pdf. Since I am building them by hand, all measurements are approximate.
3. A 1" wide black making tape line will mark a route as shown in the field sketch. Note that there are places where the line splits or where there are perpendicular alignment marks.
4. The finalized arena with the security station will be available to students for practice and testing purposes during posted lab build hours; during office hours, and whenever you can talk someone into letting you into the Maker lab. We expect to get the final fields assembled by 3/2.
5. Robots will be expected to navigate turns that are both curves and angles up to and including 90 degrees.
6. Robots must deal with lighting conditions present at the competition venue. (indoor classroom lighting)

COMPETITION RULES

1. The order of teams on competition will be decided at random, and posted the morning of the competition.
2. Robots will undergo inspection prior to competing. Finalized BOM's and receipts must be presented at inspection time.
3. Each round is 5 minutes long, *maximum.*
4. Each team will run their robot in Round 1, after which there will be a 10-minute break.
5. Following the 10-minute break, Round 2 will commence with teams competing in the same order as Round 1.
6. Only the best round for each team will be scored.
7. Teams *will* be allowed to repair, modify, tweak, or otherwise change their robot when not competing (i.e. after/in between runs).
8. Teams must be at the arena two minutes prior to their specified start time.

9. If a robot fails to move for one minute at any point of its run, it will be disqualified for that round. Useful movement of actuators other than drive wheels counts as moving.
10. Robots found to damage the arena will be disqualified for that round.
11. Teams will not be allowed to modify the arena in any way at any time.
12. Teams will be allowed to position their robot at the **START** prior to a run, and press the start button when the judge starts the timer. All other actions of the robot must be autonomous.

SCORING

Competition scoring:

Competition scoring will be based on the following criteria:

1. **Line Following** - The robot platform must follow the black line on the competition surface. 5 points will be awarded for following the black line from its beginning to the security station and another 5 points for following the black line to the Velcro wall.
2. **Complaining** – The robot must stop, flash lights, and make sounds immediately after falling off of the bridge. 5 points. Partial credit if the reaction is late.
3. **Wall Positioning** - The robot platform must position itself in front of the security station. 5 points will be awarded for pointing a sensor into the security station window.
4. **Security Code** – Getting the security code and repeating it to the security station is worth 5 points.
5. **Velcro Wall** – Get your man to the Velcro wall. 5 points if he touches the wall. 10 bonus points for a bulls-eye. 5 bonus points for the center ring or 3 bonus points for the outside ring. 5 bonus points if no part of your robot crosses over the back of the 1.5" security wall that is 10.5" in front of the Velcro wall.
6. **Time** – All teams will be ranked in order of time required to complete a run (lowest first) and bonus points awarded as follows: 1st place: 15 points, 2nd place: 10 points, 3rd place: 6 points, 4th place: 4 points, and 5th place: 2 points. All others receive zero (0) bonus points. Note: teams who do not successfully complete the challenge (this means hitting the Velcro wall or at least coming within an inch or two) will not be ranked for time.

Penalties: Major violations of the rules will result in disqualification of the run and a loss of points.

DELIVERABLES AND SUGGESTED MILESTONES

Date	Suggested Milestone	Deliverable
2/17/15	Wall positioning	Positioning robot a fixed distance from a wall (Lab 7)
2/24/15	Drive motors; wheels, "third wheel", battery; H-bridge, and Arduino permanently mounted.	
2/28/15	Develop overall plan for robot	
3/2/15	Circuit schematics including assigning Arduino pins for all sensors and actuators. List of components and supplies to beg, borrow, make or buy. Mount all sensors in final locations.	
3/3/15	Mechanical drawings for all additional components. Plan for fabrication and/or assembly.	Demonstrate Basic Line Following (Lab 8)
3/7/15	Security Station Protocol Tested	
3/10/15	Line following code completed and tested for actual field layout.	
3/12/15	Detect bridge drop-off and complain	
3/15/15	Follow entire path on the field	
3/17/15	Velcro Man working	
3/19/15		Final Demonstration Receipts BOM

Note: One set of deliverables per team is sufficient.

SAMPLE VIDEOS

Below are some videos of similar competitions done by undergraduate mechatronics classes.

http://www.youtube.com/watch?v=hG9tZ9O60dA
http://www.youtube.com/watch?v=1hk-LV1laK8&feature=related
http://www.youtube.com/watch?v=SKRm2R38Flg

Some potential sources of materials and parts:

Amazon Small Parts:
http://www.amazon.com/exec/obidos/tg/browse/-/16310091/ref=16310091

Digi-Key:
http://www.digikey.com/

Mouser Electronics:
http://www.mouser.com/

Halted Electronics:
http://www.halted.com/
3500 Ryder Street
Santa Clara, California 95051

McMaster Carr
http://www.mcmaster.com/

TAP Plastics:
1212 The Alameda
San Jose, CA 95126

Lowes:
1115 Coleman Ave
San Jose, California 95110

Grainger Industrial Supply
1190 Kern Ave
Sunnyvale, CA 94085

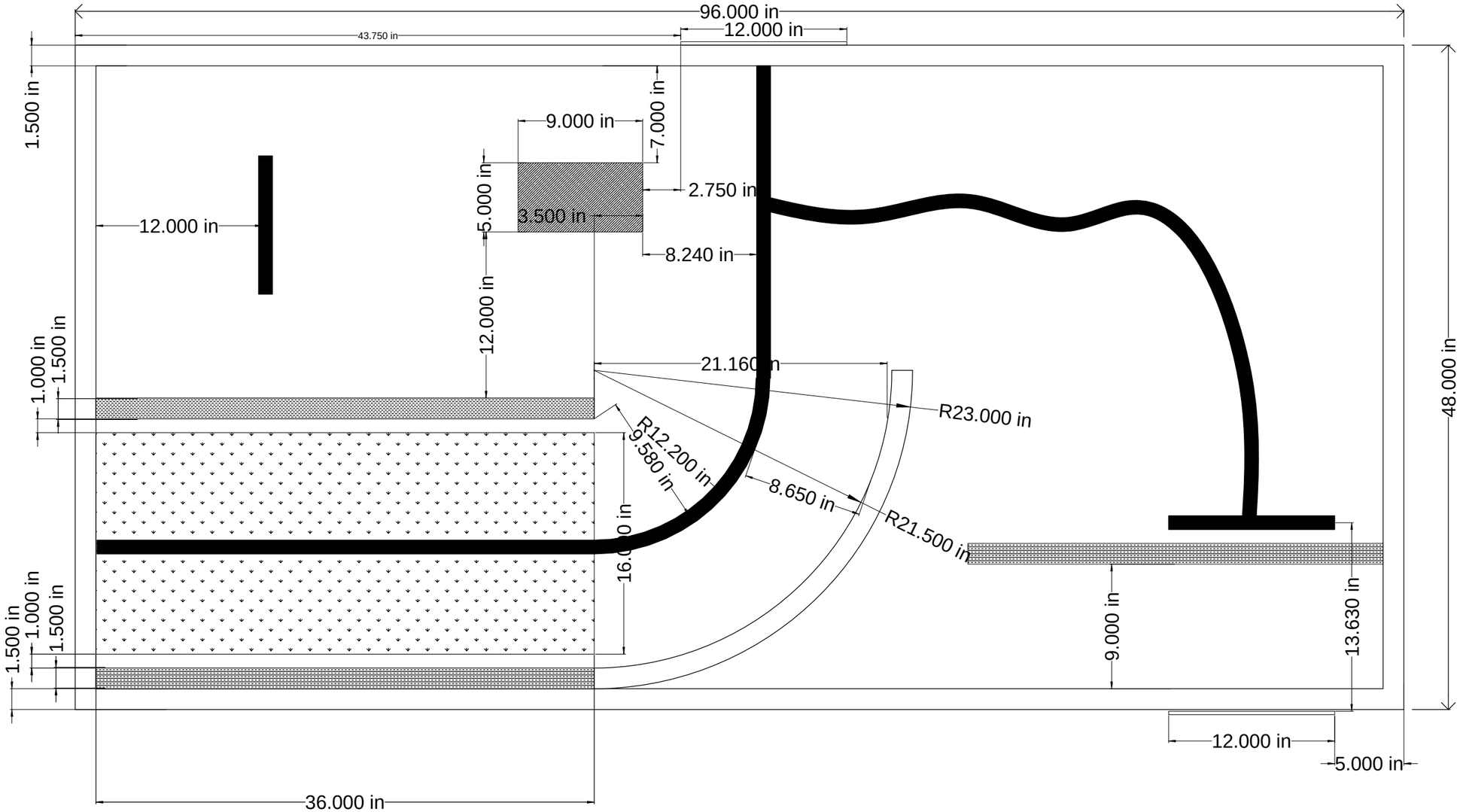
Polulu Electronics
https://www.pololu.com/

Solarbotics
https://solarbotics.com/

Adafruit
http://www.adafruit.com/

Parallax
http://www.parallax.com/

Sparkfun
https://www.sparkfun.com/



3.5" high

0.75" high

12" high

Black Tape

2.5" high