ENGR 121 – Project 2
Pill Robot

Project Description

Your team's job is to design, develop and build an ***Arduino Robot*** that you will demonstrate to the class. Your main goal is to have your robot deliver medication to a specific location in each room. The idea for this project comes from hospital robots.

Project Deliverables

Design Proposal

You will create a report up to four pages long. Use the same format as in the Project 1 report. There is a sample document in Canvas Week 4 module.

Design Progress Memo

The design progress memo should be in a technical memorandum format and style. The content requirements for the memo are listed below:

- An updated problem specification with project concept statement and revised constraints/objectives.
- Results from the preliminary testing. Is it performing as you expected in your design proposal? Why or why not?
- Assess the performance relative to each objective in your problem specification.
- Identify the areas where you can improve the performance. Discuss how these modifications will improve performance in the context of your design objectives.
- Give some detail on the design modifications and additional testing you plan to make to improve your design's performance before the final test date. Be specific – you may want to include a figure showing proposed changes to your design.
- Limit your memo to three pages ***not*** including your Arduino program code.

Alpha Testing and Poster Presentation

- Your alpha prototype will be your robot used in the competition.
- The following web site has some helpful tips for creating a poster.

  http://www.craftofscientificposters.com
- Your poster should generally communicate your design and outcome by:
  - Attracting Attention
  - Provide a Brief Overview
  - Initiate a Discussion and Questions
  - Include your Team Name and Team Member Names
  - Describe why this robot is applicable to treat and find patients in need of medication.

- Your poster should use diagrams, flowcharts, pseudocode, etc. to represent your Arduino program code. ***Do not just copy and paste your program code onto your poster.***

Poster Printing:

- *I can have posters printed up to 24"x36". If you would like your poster printed, it must be submitted to Canvas by the due date along with printing instructions.*
- *Please save your poster in a* ***.pdf*** *format for printing. Applications like PowerPoint and Publisher will allow you that save them in a .pdf format.*

Robot Competition Rules

The following outlines the robot competition and requirements.

Arena Details

The arena is shown in Figure 1 with a typical floor plan. The location of the doors in ***Rooms 1*** and ***4*** will differ on each trial as described in the trial procedures below.

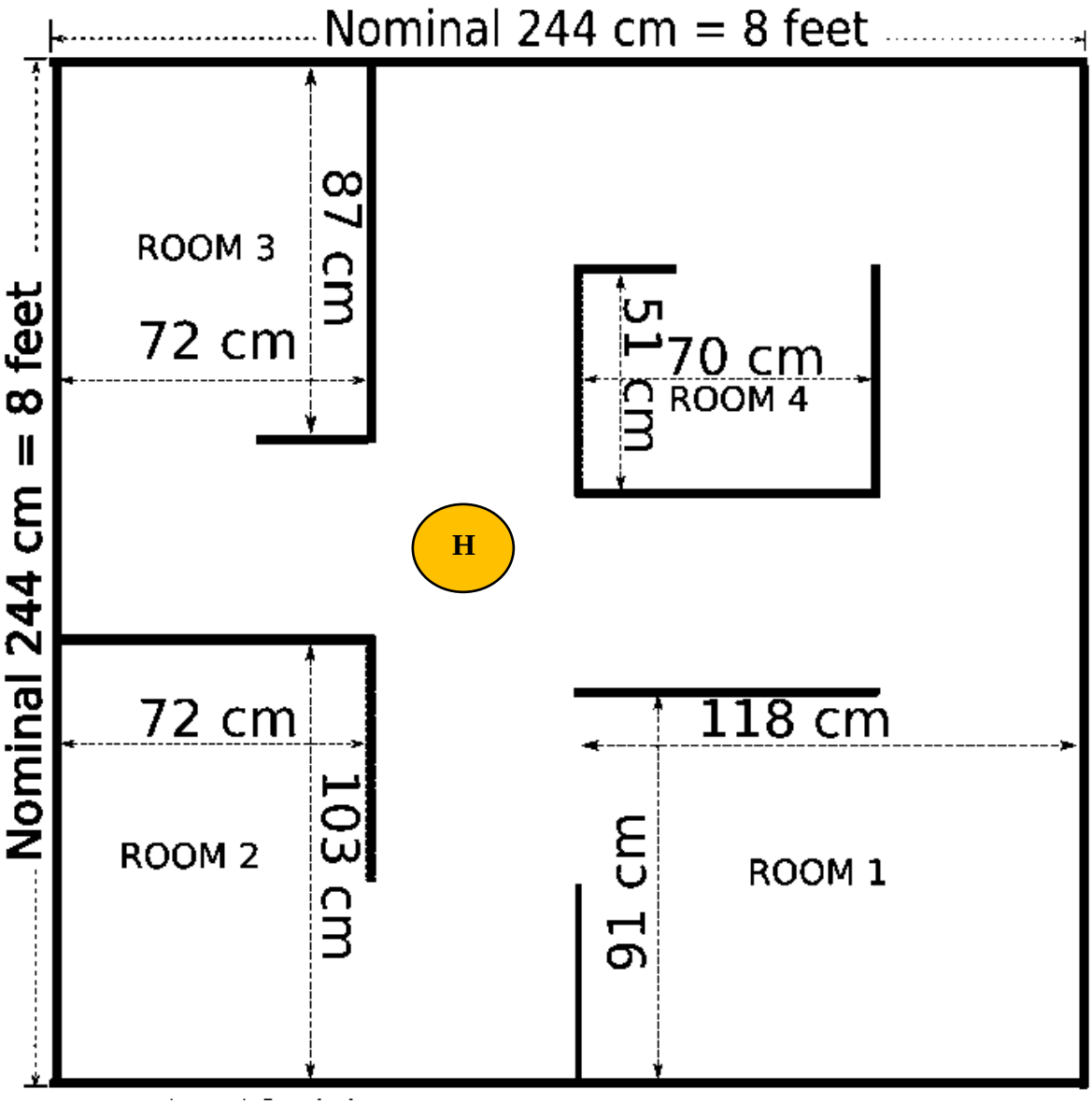

Figure 1: Arena with example floor plan layout.

Some additional dimensions:

Hallway Width: 46 cm
Door Opening: 46 cm
Walls: 1.9 cm thick, 27 to 34 cm tall

Door openings do not have doors and are marked by white tape on the floor across each door opening. The tape is 2.5 cm wide, extends across the entire door opening, and is aligned with the walls on each side.

NOTE: Dimensions are not exact and may vary by as much as 2-3 cm. It is strongly recommended that your robot design and control strategy not depend on precise dimensions.

Materials and Finishes

- The arena floor consists of plywood, painted flat black. Arena walls consist of medium-density fiber (MDF) board, painted flat white.
- Angle brackets supporting a wall may extend about 4 cm into the hall or room, with screws into the wall and floor.
- The white tape marking the doorways has a semi-gloss finish. It will become scuffed and discolored during the contest, thus your robot must detect the difference between a black floor and a white tape line regardless of their cleanliness.

NOTE: Remove your shoes before stepping into the arena! Shoes produce hard-edged dust marks on the floor that may be mistaken for white tape. Stockings produce soft-edged marks that reduce the overall floor contrast. In either case, the arena will be as clean as you leave it.

Trial Procedure

Starting Position

- The robot will start at the home circle labeled with the H in ***figure 1*** above. The testing team will place the robot in the home circle with the front of the robot aligned in any orientation.
- The clock for the trial will start when a member of the testing team says "***GO***" and presses the start button on their robot.
- Once turned on, the robot must be autonomous (***self-controlled without any human intervention***).
- A robot may bump into or touch the walls of the arena as it travels, but it cannot mark, dislodge, or damage the walls in doing so.
- The robot must not leave anything behind as it travels through the arena unless it can pick dropped items up.

- It must not make any marks on the floor of the arena that aid in navigation as it travels. Any robot that, in the Judge's opinion, deliberately damages the contest arena (including the walls) will fail that trial. This does not include any accidental marks or scratches made in moving around.
- A robot may not intentionally extend above walls for navigation and sensing purposes.

Rooms 1 and 4 Variations

- Room 4 may be rotated 180 degrees from its position shown in Figure 1.
- Room 1 can have the wall on the left shifted to allow for a door at the "top" or "bottom" (in Figure 1 door is at the "top").

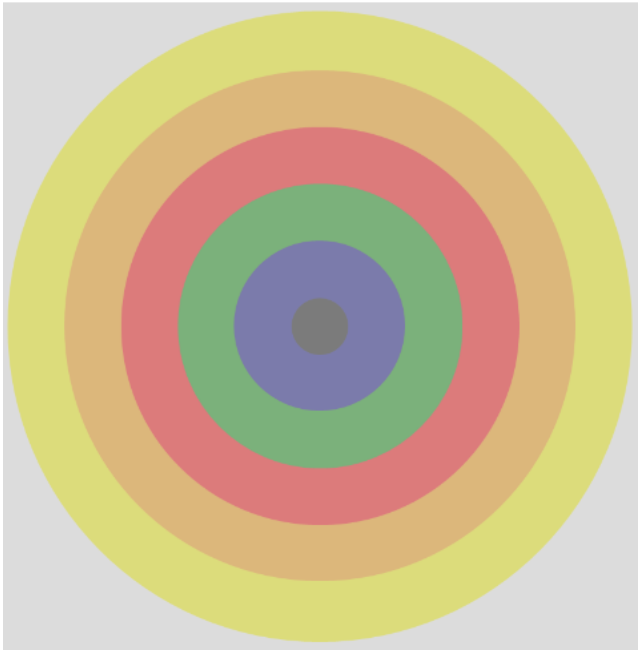

Figure 2: Drop zone circle showing color point zones.

Trials 1 and 2

- The drop zone, see Figure 2, will be placed randomly inside each of the rooms in the arena.
- Drop zones will not be placed in a hallway, but it might be placed just inside a doorway of a room.
- The drop zone ***circle*** will not touch the doorway line and this means that the front of the robot will be able to move at least 20 cm into the room before it encounters the drop zone

NOTE: The drop zone circle will be anchored to the arena floor using double sided tape.

Trials 3 and 4

- Trials 3 and 4 will follow the same basic format as trials 1 and 2 with the modification that several obstacles will be placed at various positions in the arena.
- The objects will be a stuffed bunny and small boxes or models to simulate furnishings. Your robot can touch the obstacles to sense them, but must navigate around the obstacles. Moving an obstacle by more than the 1 cm that may result from incidental or sensor contact will result in a time penalty.

Medication Rules

You can have up to 6 pills on your robot for each trial. Pills are either cubes or cylinders

Trial Rules

- Robots may not exceed cost of $250. Approximate costs for items.
- It is the responsibility of the team to inspect the condition of the arena before starting their robot to be certain that everything is in order. Once a team presses or pulls the start mechanism, the run counts as an official trial and may not be done over.
- The order of testing will be determined by random draw.
- While the preceding team is on the arena for a trial, the on-deck team must have their robot ready to run immediately after the previous team completes their trial. Each team will have one minute to begin a trial after being called.
- All teams will be called for a trial in a current round before any teams begin the next round of testing.
- At the beginning of a trial, all robots must be **12"x12"x12"** or less. The robot may unfold, expand, etc. to any size after the start of the trial run. Robot sizes will be tested with the measuring box prior to each team's first run and in subsequent runs if requested by the judges. Team members will be responsible for placing the measuring box over their robots. If a robot fails to meet the size constraint the judges will assess a penalty proportional to the severity of the violation.
- If a robot fails to move once the start button is pushed, the team members may work on their robot to get it moving but the time will continue to run from the time when the "***GO***" command was given. If the robot has not moved within 60 seconds, a default score will be assigned for that trial.
- A trial will end when any of the following actions occur:
    - The robot is stuck in a part of the arena and the testing team determines it will not get out.
    - Seven minutes have elapsed from the start of the trial.
- Between trials, five minutes will be given for teams to make changes or repairs to their robots

- ***Teams may not make practice runs during the Exhibit Session or after the start of the Trials.***

Scoring

- The judges will record the actual trial time (**AT**) in seconds and apply factors for the patient room factor (**PRF**) and bonuses (**BF**). Then penalty points (**PP**) are added as follows to determine a final score (**FS**):

$$FS = AT \times M1 \times M2 \times M3 \times M4 \times BF + PP$$

- A robot that does not cool down the patient within the six-minute limit will start with an actual time of 700 for the purposes of the final score calculation.
- The team with the lowest final score wins.

Dropping the Medicine in Room Factor (M1, M2, M3, M4)

- The medicine drop in the room adjusts the actual trial time based on the location of the medication drop. Ideally once your robot enters a room, it should find the drop zone and drop the medication in the center of the drop zone. If your robot enters the room and drops the medicine, you will receive a default multiplier of 0.9.

The multiplier is calculated based on:

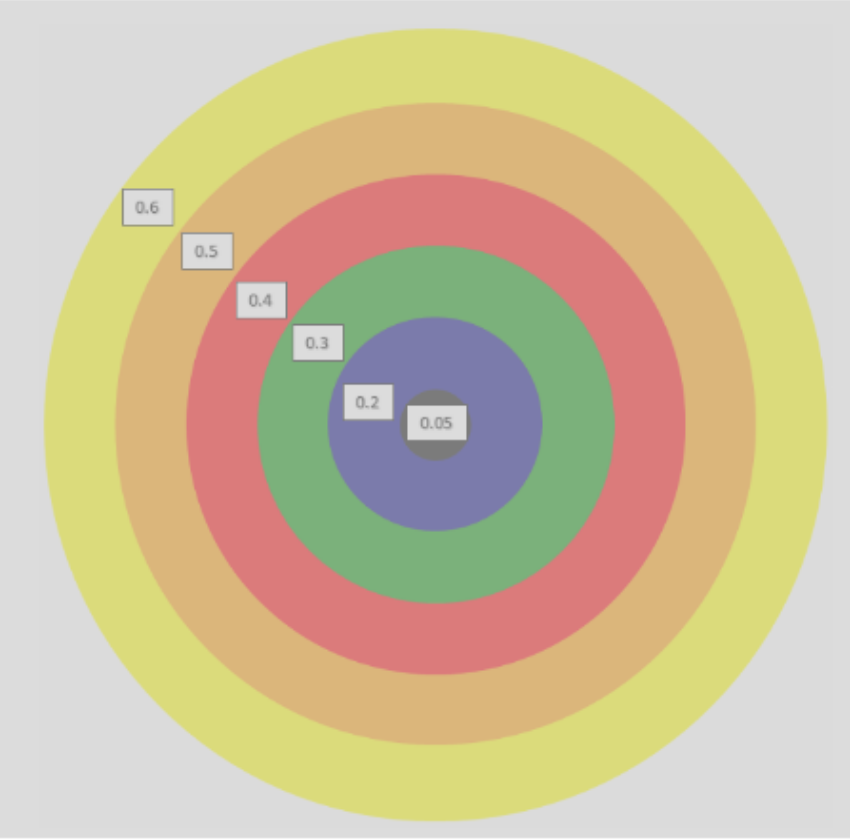

Figure 3: Drop zone circle showing color point zones and associated scores.

Bonus Opportunities (BF)

- *Return Trip* (**BF**= 0.75): The robot must return to the home circle within two minutes after dropping the last medication. The additional time for the return trip is ***not*** included in the actual trial time.

Penalties (PP)

- ***Continuous Wall Contact*** (**PP**= (contact cm)/2): Any robot that slides along a wall will be assessed one penalty point for every 2 cm of wall contact (approximate and determined by judge). A robot may touch a wall and minimally slide to orient itself without penalty. There is no penalty for sliding along the wall on the return trip to the home circle if going for that bonus.
- ***Bonking the Bunny*** (**PP**= 50): Only in trials 3 and 4 -- Any robot that moves the stuffed animal obstacle more than 1 cm will have this penalty added to its score for **each instance**. The robot may touch the Bunny with a sensor probe, as long as the probe does not move the Bunny.
- ***Bonking the Furniture*** (**PP**= 50): Only in trials 3 and 4 -- Any robot that moves the furniture obstacle more than 1 cm will have this penalty added to its score for **each instance**. The robot may touch the furniture with a sensor probe, as long as the probe does not move it.

Requirements

Robot must contain:

- *(5 pts)* Five functions in the code where each group member must develop at least one of the functions. ***This means all group members must write code!***
- *(5 pts)* Three Inputs
- *(5 pts)* Meaningful display. This can be with the LCD, LEDs, etc. Your team can decide what and how to display, but it must be relevant to the robot and event.
- *(5 pts)* Medicine Drop System
- *(5 pts)* Navigation Program
- *(5 pts)* Calibration Procedure
- *(40 pts)* At least drop meds in each of the rooms over the four trials.
  For example, this would complete the points:
  Trial 1 - Room 1 and 4
  Trial 2 - No Drops
  Trial 3 - Room 1 and 3
  Trial 4 - Room 2

Good Luck and Have Fun!