FINAL PROJECT DESCRIPTION

Your team has been assigned the task of designing and building an autonomous robot that deposits spherical waste containers in a borehole. Your prototype vehicle is expected to locate between 2 and 4 containers that have been randomly located on a flat playing field, and deposit those containers in the borehole.

1 Playing Field

Robots will operate on a 7 ft. x 7 ft. plywood playing field that has been painted white, as illustrated in Fig. 1. A circular black line approximately 5 ft. in diameter may be used for vehicle guidance; this line will be created with 3/4" wide electrical tape. Red lines indicate raised curbs; no portion of an autonomous vehicle is permitted to extend beyond the region denoted by these curbs. Robots will begin operation in the indicated corner. Side rails will be placed around the perimeter of the field to prevent robots from rolling off the playing surface.

2 Spherical Containers

Spherical containers will be simulated with 11 inch circumference softballs, which have a diameter of approximately 3.5 inches, weigh around 6 oz (170 g), and are yellow-green in color. Between two and four of these objects will be randomly placed on the playing field prior to the initiation of vehicle operation. Robot vehicles are to deposit the containers into the borehole as quickly as possible.

3 Play and Scoring

Once a robot is placed in its starting position, a single team member may briefly make contact with it to push a button, or flip a switch, so as to initiate autonomous operation. Thereafter, the robot must operate entirely of its own accord. If robot movement does not commence within 15 seconds after being touched by a team member, the trial will be terminated. A timing clock will begin recording elapsed time as soon as robot movement begins. "Movement" includes any visible change in the location, appearance, or configuration of the robot.

Each vehicle is to locate the spherical containers, transport them to the borehole, and drop them into opening. It does not matter whether the containers are moved individually, or in multiples. All containers are to be deposited into the borehole within one minute (60 seconds) following the start of vehicle movement. A team is given one point for every container deposited into the borehole during the allotted time. No credit is given for containers that do not drop fully into the borehole.

Except to prevent damage to people or equipment, team members are not to touch the containers, playing surface, or vehicle during the 60 seconds of autonomous operation. Robots are permitted to grasp and move the containers in any manner that does not mar or damage the containers (softballs). Containers must remain inside the red curbs that denote the playing field boundaries at all times. Pushing or tossing containers outside of the red curbs will result in immediate disqualification.

All scoring decisions will be made by the course instructor, who retains the final say in all matters of the competition. The instructor may add or remove rules in an attempt to ensure a fair and enjoyable competition.

4 Competition

Each team will be given the opportunity to make three runs, and will retain their highest score. The two highest scoring teams will go to a head-to-head playoff, with each team making one more run. The team with the higher score in this playoff round will be declared the winner.

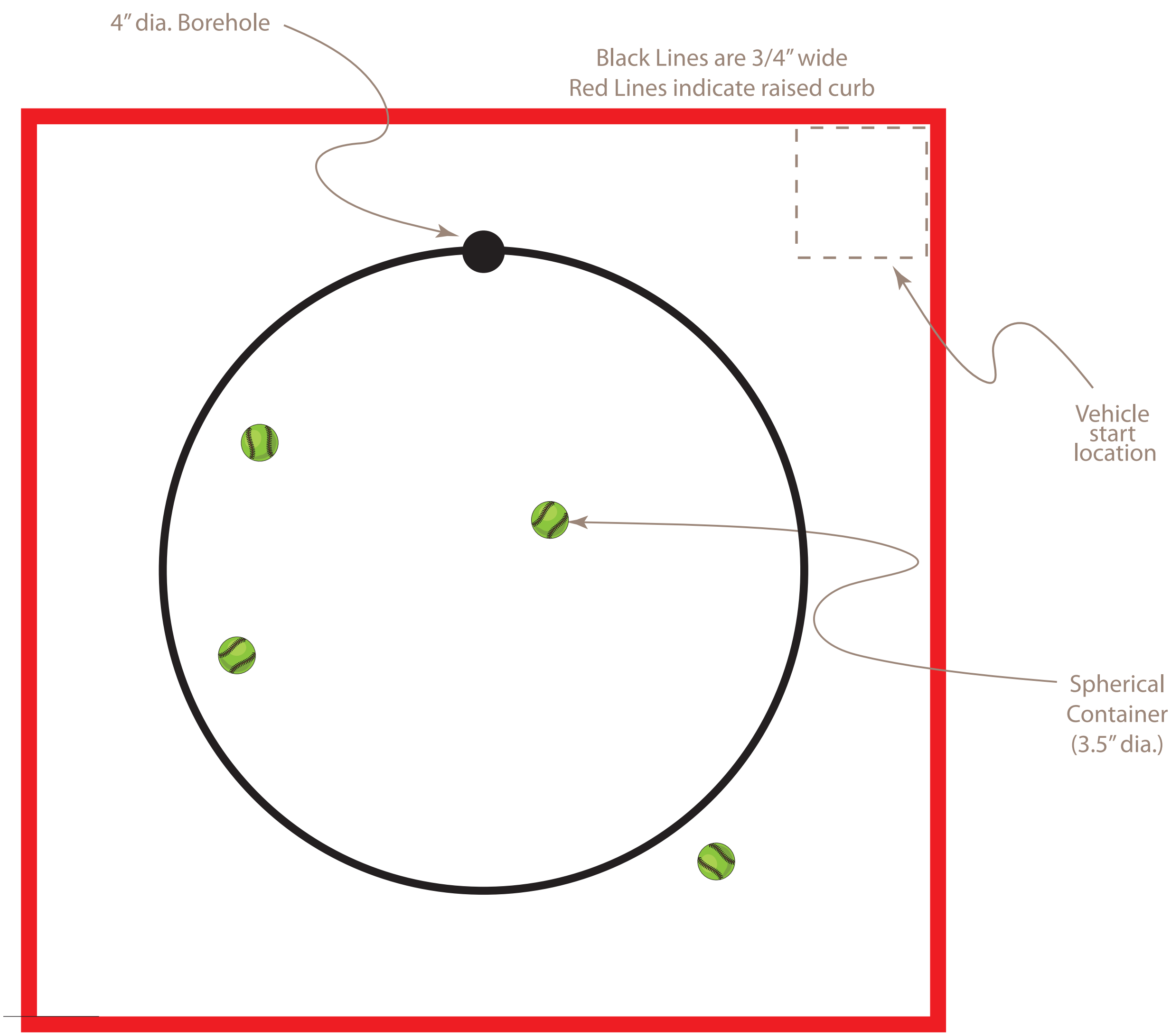

Figure 1: ME 588 Competition Playing Field for 2015

5 Requirements

1. Robots must be autonomous. No human intervention or tethers permitted.
2. Robots must fit within a 12 in. x 12 in. x 12 in. cube as operation is initiated.
3. Robots should deposit 2–4 waste containers, randomly placed on a flat 7 ft. x 7 ft. test area, in less than 60 seconds.
4. Robots must not affect the color, texture, moisture content, or friction coefficient of the playing area.
5. Robots must not affect the shape, color, texture, moisture content, or friction coefficient of the containers (softballs).
6. Consideration should be given to the bad things that might happen in real life if your robot were to accidently knock into waste containers, thus rolling them across the concrete surface.
7. Robots will be allowed three attempts at clearing the test area.
8. Total cost of each robot is to be less than $400. The course budget provides up to $200 per team and the team members may contribute additional parts up to $200 in value. Current market value is to be used in determining contributed item expenditures, not your personal acquisition cost.

6 Purchasing

1. Parts may be ordered through Manish, and we will try to make two orders each week.
2. Each purchase request must include a vendor with contact information, part names, part numbers, unit pricing and quantity to be ordered.
3. The University will not reimburse sales tax.
4. PLEASE TAKE INTO ACCOUNT SHIPPING AND BACK ORDER TIME!

7 Deliverables

1. **Interim Progress Reports**: Each project team is responsible for making short presentations about the progress of their final project during the second half of the semester. These presentations will take place during normal lecture periods, with odd-numbered teams presenting on Tuesday and even-numbered teams presenting on Thursday. You will be responsible for at least one of these presentations on behalf of your team. After making a 3-5 minute oral presentation, you will be asked to field questions from the audience.

   A PowerPoint template for these interim reports can be found on the course website. While you are free to customize the provided template, you will be limited to three slides containing text: 1) an “introductory” slide with team information, 2) a “status” slide with current progress, and 3) a “future” slide that highlights changes your team will be making as the project moves forward. You may include additional slides that contain photographs, illustrations, or charts (but not text!). Following the oral presentation, the instructor and fellow class members may ask questions for another 3-5 minutes. Thus, the total duration of an interim progress report should be no more than ten minutes.

   Your final score for the interim progress report will be based on 75% of your interim report score, and 25% on the average score of your teammates. Thus, you are encouraged to work with your team to ensure that all team members make presentations that are complete, concise, and well-planned. It is up to you and your team to decide the order in which each of you will make your interim presentation.

   It is not necessary that you attend a presentation period if you are not delivering an interim report. However, you may wish to show up to see what problems other teams have encountered, ask questions of teams that have solved problems that you are currently facing, and to support your teammates in making strong presentations.

2. **Final Report**: There is no length specification for the final report, but try to keep it concise. Your final project grade will consider both the final report and the presentation/demonstration. You are writing for two audiences: 1) readers who want to find out if your solution will solve a similar problem; and 2) readers who want to reproduce what you have done. The report should be in a standard engineering report format, including:
   - Title - should be descriptive and short.
   - Abstract - capsule description of what's in the report. (In many cases the title and abstract are published without the rest of the report, so they need to stand on their own.)
   - Introduction - what you are trying to do and why; your choice of a solution method.
   - Body - one or more sections describing how you solved the problem.
   - Results - description of experiments done and data obtained.
   - Discussion - relate the results to the objectives.
   - Conclusion - succinct statement of what was accomplished and what to do next.
   - Appendices - relevant material not needed by the average reader.
3. **Code**: Your final Arduino code needs to be submitted in an electronic format. Include all library files and all necessary code files. Code should be clearly commented! Compress code into a single ZIP file prior to submission.
4. **Drawings**: Final circuit diagrams are to be submitted in an electronic format. You can use EAGLE, Fritzing, or any other circuit drawing tools. The diagram should be clear enough for another person to recreate your circuit and have enough details to test and debug the circuit. Compress drawings into a single ZIP file prior to submission.
5. **Final Presentation**: Each team will prepare a short (5 minute) technical presentation of the project design. Following the prepared presentation, vehicle performance will be reviewed and the team will have an opportunity to respond to questions regarding the design. Submit the presentation in PowerPoint or PDF format.

8 Advice

1. Do not wait!!! Start early! Start now!
2. Use/ask Manish whenever you can.
3. Search the web for components, circuit ideas, and sensors (look for robotic sites).
4. Don't reinvent the wheel. Your time is quite limited, so look for concepts and methods that have proven themselves to be reliable.
5. Try to limit the number of sensors and actuators. More sensors and more actuators translate to more states in your state machine.
6. Try to leverage (use already made) mechanical components as much as possible. Check the Purdue University Warehouse and Surplus Store (9th Street Salvage).
7. Lafayette Electronic Supply might be a good local source for parts.
8. SparkFun, Digi-Key, Pololu, and Jameco are good sources for mail order items.
9. There are surplus stores on the net that you can order small motors, sensors, etc. We have some motors in the lab. Ask Manish to check out the motors.
10. There are many ways to sense obstacles as well as locating an object. A few minutes of research/planning in the beginning could save you days of work.

11. Prototype any subsystem you are unsure about. Better to fail early when you have time to recover, than to discover a problem in the final weeks of the semester.
12. Make sure you control/limit the weight of the device as well as provide adequate traction. The worst mistake in previous semesters is that the actuator does not have enough torque or traction to drive the device!
13. Check the sensors that your will be using. Make sure you know how they work and how to interface with them! Ask Manish if you have questions. The manufacturers application notes usually have example circuits for interfacing with the sensors and actuators.
14. Beware of grounding, noise, floating input, impedance mismatch type bugs! If you don't know what these mean, look them up in the notes and/or ask questions!
15. Think about debugging when you build your circuit. Strategic use of connectors, test pins, LEDs, or external displays can save significant debugging time and agony.
16. Don't let your circuity become a rat's nest of wires. Troubleshooting becomes very difficult when you're guessing about which wire does what, or you're unsure whether your connections are still secure.
17. Once you have tested your prototype circuit, you will need to build it on a prototype board and solder the components. THIS TAKES TIME!!!! It is best to make use of the dip sockets so that if a component fails, you can change it with minimum rework.
18. There are outfits on the web that can make a handful of boards for you for under $150 in 3-5 days. We can try to use these services. However, if you submit the design too late, you may not have time to do another revision. Another option is to etch your own circuit board. Lafayette Electronic Supply may have these tool kits. You may want to test them out with a small sensor or connector board.
19. The lab has a Dremel tool for small part modification. We also have a few soldering stations.

9 Suggested Schedule

1. Week of 3/2:
    - There is no formal time in lab for the group project this week, so you will need to meet with your group outside of the lab period.
    - Formalize preliminary design.
    - Identify subsystem responsibility.
2. Week of 3/9:
    - Meet with Manish during lab to discuss your concept/design.
    - Finalize conceptual design and look for resources and parts.
    - Start ordering parts and components (sensors, actuators, special chips, etc.).
    - Generate block diagram that connect each subsystem and identify/define signals, timing and specifications that connect the subsystems.
    - Check what is available in the lab.
3. Week of 3/16:
    - Spring Break
    - Make sure you've ordered major components BEFORE Spring Break! If you come back from Spring Break and cannot immediately begin assembly, you are going to experience significant difficulties in finishing your project.
4. Week of 3/23:
    - Continue ordering parts and components.

- Begin mechanical component construction.
- Begin electronic design and simulation.

5. Week of 3/30:
   - Continue building mechanical system.
   - Continue building electronics.
6. Week of 4/6:
   - Begin integrating subsystems and electronic controls.
   - Test and debug subsystems.
7. Week of 4/13:
   - Begin integration of major systems.
   - Make final design modifications.
   - Test and debug.
   - Begin collecting presentation materials.
8. Week of 4/20:
   - Continue integration.
   - Make last-minute design modifications.
   - Test and debug.
   - Finalize presentation materials.
9. Week of 4/27 (Dead Week):
   - Make final adjustments.
   - Practice presentation.
   - Project demo (Thursday evening).