Embedded Systems International

Project Statement of Work (PD3)

Team Identifier: 10-B

Team Name (optional):

Team Member Names: **Caleb Rowland | Neil Prange | James Joseph | Edmund Lim**

Submit your document as a PDF file in Canvas under the corresponding project assignment.

One of your section's lab TAs must approve of this Statement of Work by adding a comment in the Canvas assignment. The team is responsible for requesting approval promptly after submission.

Refer to the Project Requirements document before completing this Statement of Work (SOW). A statement of work is a focused concise proposal and agreement that describes work to be done. Teams should complete and submit this SOW form, which represents several parts of a statement of work, including a plan for what you are doing and how. The SOW defines the scope of your project and the approach you are taking to deliver on the goals.

Problem Statement

First, has your team reached consensus on the autonomous vehicle (AV) application you will use as the context or story for your project? All projects, regardless of application, will need to meet the same basic requirements and will be recognized for innovative features.

To define your problem, think about one or more users and their needs. Write at least one Point of View (POV) statement for your application. Follow Steps 2 and 3 in the following guide (also in Canvas as a PDF document):
Define and Frame Your Design Challenge (links to IDF page) (URL: https://www.interaction-design.org/literature/article/define-and-frame-your-design-challenge-by-creating-your-point-of-view-and-ask-how-might-we)

Next, think about and write a few sentences that give a high-level summary of the broad mission goals for your AV application. For example:
The purpose of the AV is to provide ... .
The AV will be capable of doing ... .

The mission goals and user needs establish the purpose of the project and why you are working on it. Now you should translate these into a more detailed problem statement that provides a specific, concise, clear and thorough description of the context for the problem, an explanation of user needs that will be addressed, and an outline of your proposed technical approach to solving the problem.

Problem Statement

POV statement:

I am a hotel guest and I need a way to get my food and necessities delivered to my room using some sort of autonomous robot because I don't want to leave my room and because traditional hotel room service is not always available.

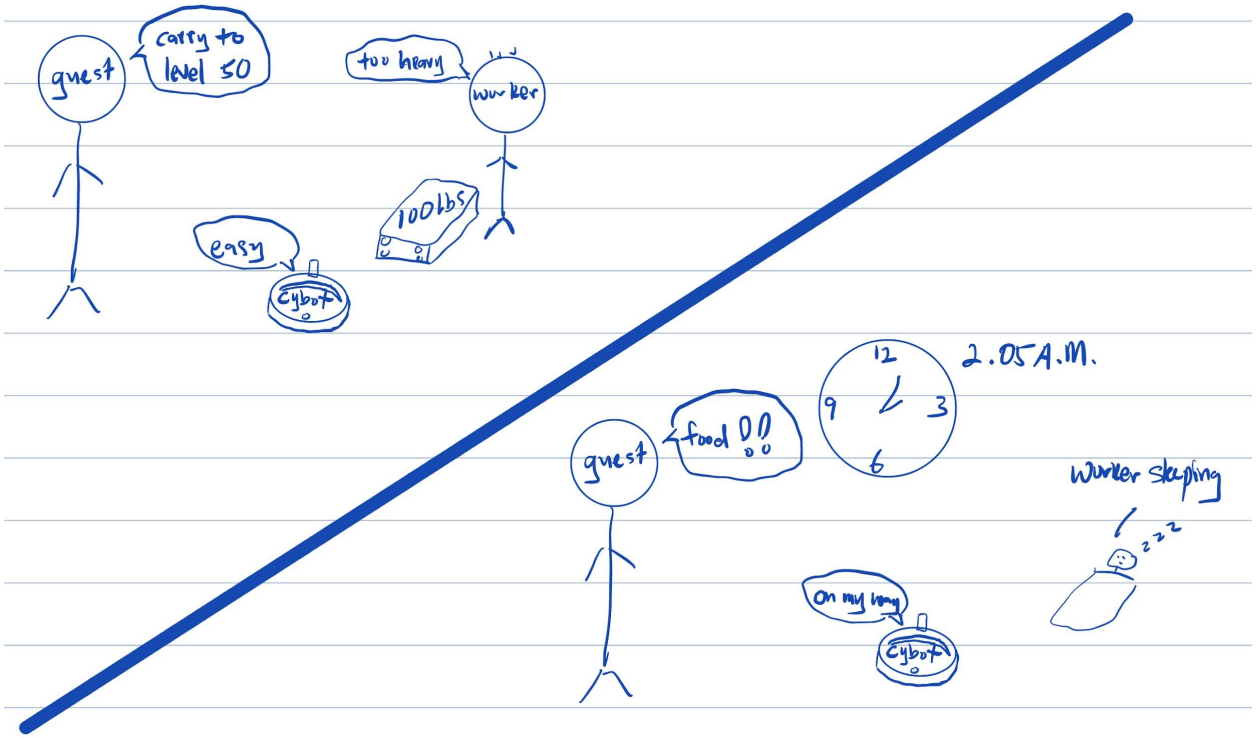
High-level mission goals:

The purpose of the AV is to provide room service assistance to hotel guests.
The AV will be capable of navigating through a series of hallways, and obstacles such as pedestrians and luggage.
The AV must, at all costs, avoid the constantly changing construction zones in the hotel and be able to navigate to the proper room without interference.
If the robot bumps into anything that it was not supposed to, it must apologize to maintain customer satisfaction.

Short description of the problem:
Hotel guests need room service such as food delivery, baggage carry and more during hotel labor's off work time.

For this scenario, the CyBot will be representing a room service robot whose purpose is to deliver food and toiletries to a person's room. This robot will need to avoid obstacles in its path, which will be represented by the PVC pipes on the test field. It also will need to avoid stairs or other drop offs in its path, which will be represented by the removed tile in the test field. Because the user will surely want their products delivered in a timely manner, we will program our robot to be able to navigate the field and reach its destination quickly.

In addition to writing a paragraph about the problem, you are to draw a **problem sketch: a one-page sketch illustrating your solution with a user context (big picture view)**. This should show the scope of your work in relation to one or more user needs. Refer to the sample project sketches.



Design Approach

Next, consider your AV application in relation to the project requirements and the five categories by which it will be evaluated.

1) Functionality in relation to the AV application mission goals and user needs

2) Mapping of functional requirements to platform components and capabilities
3) Elements of the test field
4) Serious incident penalties
5) Feature bonuses

In this section, you will identify and describe how you will design your application for each of these categories.

To complete the tables below, your team may want to use ideation tools, such as Lotus Blossom. Refer to the project ideas guidelines and Lotus Blossom worksheet as needed.

In addition to completing the tables below, you are to draw a **technical system sketch: a one-page sketch depicting a high-level technical system diagram of your proposed solution, such as a block diagram or dataflow diagram**. This should show both hardware and software modules.

The tables below are your initial proposal, and you may update these before your demonstration.

Functionality

Describe each of the basic functionalities required for the project in terms of your AV application. The functionality should be specific to the problem and user(s). Several functional statements are given in the example functional description for the Mars rover application in the Project Requirements document.

Basic Functionality	Mapping to AV Application
Cybot Communication	CyBot communicates with PUTTY ; CyBot communicates with MATLAB
Cybot Movement	Basic movement functionality such as forward by an indicated distance, backward by an indicated distance, turn by an indicated number of degrees.
Object Detection	Object detection will be based on bump, IR,PING sensors.
Object Avoidance	Based on object detection the AV should be able to navigate around any presented objects to reach its final destination untouched.
Boundary Adherence	In order to adhere to the given boundaries such as the edge of the field and the hole in the middle of the field, we will use the IR sensor on the bottom side of the robot.
Arrival at Destination	Cybot will play sounds when arriving at a room door, and it will play a different sound when it reaches its final destination.
User Interface	GUI
Base Station Control	Moving, Scanning, Switching Mode, Calibration, Play Sounds.

Other Application Specific Functionality (may be novel features for bonus points)

- **Detection of reflective tape.**
- **Play sound at a specific scenario**
- **GUI**
- **Multi-thread**

Mapping to Platform

Briefly describe how each of the basic platform components required for the project will be used in your AV application.

Basic Platform Components	Usage in AV Application
Open Interface and iRobot Sensors	Boundary Adherence, Object Detection, Object Avoidance
Interrupts	Send/Receive Commands, Switch Operation Mode, Target Identification
ADC	The ADC is used for the IR sensor while scanning for obstructions.
Input Capture	Changing Mode, Destination Selection
PWM	Servo; Utilized to complete radial scans.
UART/WiFi	Data transfer between Cybot and computer, as well as receive commands and graphing.
Other Platform Components or Modes (may be novel features for bonus points): GUI, Play Sound, Reflective Tape Detection, Multi Thread	

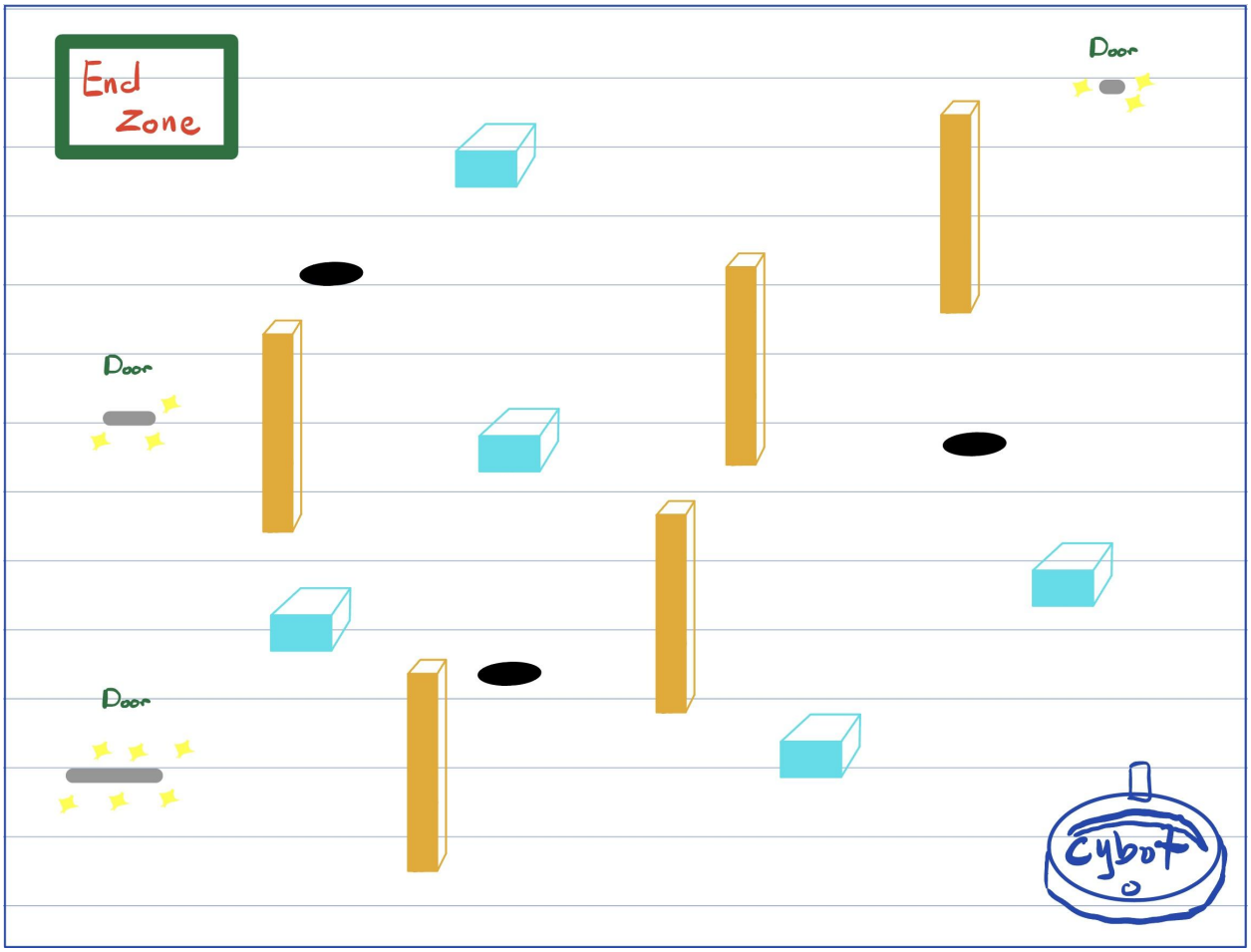
Elements of the Test Field

Briefly describe a test field in the context of the real application (e.g., Martian terrain, city streets, etc.). Then state what each of the basic objects and other elements required for the test field represent in terms of the AV application. Draw and attach a **sketch of a possible simple test field for the lab**.

Test Field Description
Our test field will consist of many different obstacles, and red zones to avoid during operation. As the robot is leaving the starting location it will complete a scan and look for any possible obstructions throughout the halls of the hotel. It will scan for People (Tall Skinny Objects), and it will scan for its designated room door (A tall large object that will be marked with reflective tape at its base) where it is to deliver its service. Along its journey it may bump into luggage (Short Objects) that it could not see with its sensors, in which case it will play a sound indicating that it has detected the object and navigate around. Finally, the field will have a couple of zones where the robot should never go. These will include the stair cases (Holes in the ground), and the loss of signal zone (Out of Bounds), it must safely reach the room that it has been instructed while avoiding all other obstructions, once it has completed this task it will be able to return to its charging station (Destination Zone) where it will wait for any further instruction.

Basic Objects and Other Elements	Mapping to AV Application Test Field
Tall objects (wide or composite)	Room doors where we must deliver to. There will be between 1 and 3 doors located along the edges of the hallway (The hallway will be portrayed using the entire width of the test field, with a variable length based on where the doors are located).
Short objects	Luggage, cleaning service carts, misc. All of these short objects will be scattered throughout the hallway randomly; The robot is allowed to bump into these items as it can not scan them and they are unable to be harmed.
Holes	The hole will be a stairwell that must be avoided. This hole will be randomly located in the hallway among all of the objects. The hole can not be located directly in front of a doorway.
Pillars (thin tall object)	The tall skinny objects will be represented as people walking in the hallway.
Out of bounds	Robot disconnect range, hazardous conditions, and hallway walls.

Destination zone	After the robot has correctly completed deliveries to all required doors, it will then head to its charging station which will be located at a random location along the edge of the field (This will be the final destination zone).
Other Application Specific Elements (may be novel features for bonus points or incidents to avoid) N/A	



Serious Incidents to Avoid and/or Novel Features (Optional)

You may have identified novel features in the tables above. Enter them in the table below and propose possible bonus points if demonstrated successfully. In addition, describe any additional serious incidents that might happen in your test field for your AV application.

Novel Features	Bonus Points
- **Detecting Reflective Tape** - **Play from a selection of sounds for various incidents.** - **GUI** - **Multi-Thread**	

Serious Incidents	Deductions
- **Driving out of bounds.** - **Dropping into the missing tile zone.** - **Bumping into a tall object.** - **Not reaching the end zone in a quick enough time.**	

Sketches

Attach the following sketches to your submission. These were noted above in red.

- **Problem sketch**
- **Technical system sketch**
- **Test field sketch**

Visual communication is helpful for sharing information. There are many ways to represent your information. The problem sketch could be anything from a cartoon (informal) to a UML use case diagram (more formal). The technical system sketch is similar to what has been used/shown in class and lab. The test field sketch probably needs no explanation.

Technical System Sketch