CprE 288 Final Project Proposal:
Group Number: 3
Group Name: Ross's bosses
Group Members: Noah Ross, Joseph Dicklin, Mubassir Serneabat Sudipto, Matthew Rief

Problem Statement:

There is no universal standard for parking ramps and parking lots. Each has its own way of displaying vacancies, which can often be hard to understand, especially in the short time it takes you to drive by. It is not a lack of parking spaces that makes parking difficult; presently, the United States has eight parking spaces for each car in the country. Our parking problems stem from our inefficiency in using available spaces. Our solution is a patrolling robot (**Vroomba**) that updates the parking spots that are free and can sort and display where the spots are. This data can be sent back to a computer that could tell the customer if there are free spots from their phone or car and where they can park.

Application Narrative:

Using a parking ramp has never been so straightforward! An easy and cheap way to measure and live update the capacity of your parking ramp is finally here. The Vroomba parking bot regularly scans and updates the parking map to tell potential customers where and how many spots are available. The Vroomba will communicate with the parking lot owner's computer through a wifi UART connection and display your parking options in an easy-to-read manner.

POV statements:

Parking customers:
"I want to be able to tell quickly how many spots are unfilled and where I can park"

"I want reliable parking and I don't want to fight people for spots or pay for somewhere I can't park"

Parking ramp owners:
"I want to maximize profit and sell the exact amount of spots I have without investing hundreds in sensors and lights per spot"

"I want my customers to be happy and be able to use my ramp efficiently knowing exactly where to park"

Empathy Map:

Did:	Think:
• Gain money from every paid-for parking spot, and lose money from open spots that could be filled • Park for events, park for jobs, parking for businesses (**Source 3**) • Late to meetings or jobs because of inaccurate parking • Most drivers hover for about half an hour during peak hours before they find a parking space, leading to illegal parking in some cases (**Source 2**)	• I don't want to park downtown because it is hard to find a spot • I have a few open slots that could be making money (**Source 1**) • I don't want to pay because I might not find a spot (**Source 3**) • Parking should not be an issue, because "the United States presently has eight parking spaces for each car in the country" (**Source 2**)
Said:	**Feel:**
• Other solutions can be $300 - $500 a space (**Source 1**) • "Parking management challenges are more about the absence of real-time data on vacant spaces" (**Source 2**)	• Parking and driving is not worth the hassle (**Source 3**) • I don't want to pay to park in case they don't have an open spot (**Source 3**) • Most drivers hover for about half an hour during peak hours before they find a parking space, leading to feelings of frustration and anger (**Source 2**)

User Needs:

- Needs to be cheaper and more reliable than other solutions (**Source 1**)
- Needs to be easy to use by everyone, because communicating open spots is the issue (**Source 2**)
- Needs to be live, trustworthy data. Can't take long (**Source 2**)
- Needs to be precise, and be able to tell customers and owners where the available spots are (**Source 2**)

Sources for the POV statements, User Needs and Empathy Map:

Source 1:

D. Roos, “How parking garages track open spaces, and why they often get it wrong,” *HowStuffWorks*, Apr-14-2017. [Online].
https://electronics.howstuffworks.com/everyday-tech/how-parking-garages-track-open-spaces-why-they-often-get-it-wrong.htm
[Accessed: Nov-18-2022].

Source 2:

P. MacCallum, “Parking Management Challenges.”
OperationsCommander, June-22-2021. [Online].
https://ops-com.com/blog/parking-management-challenges/
[Accessed: Nov-22-2022].

Source 3:

Parking.com “Reviews”,
Trustpilot, The reviews all come from different dates
https://www.trustpilot.com/review/parking.com
[Accessed: Nov-22-2022].

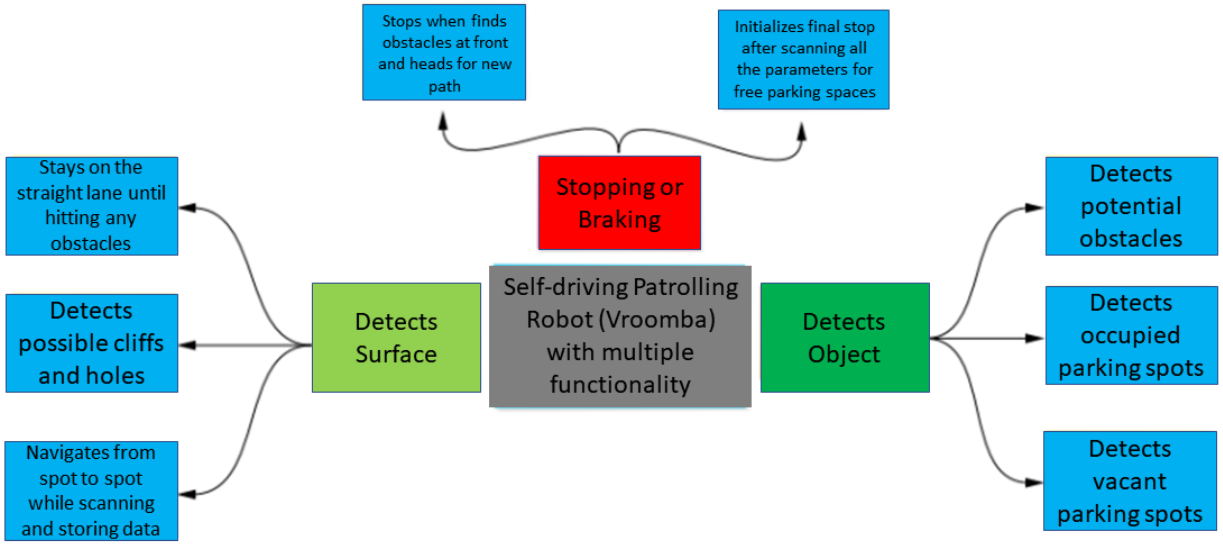
Source 4:

Patrick Sisson, “Cities have a parking problem. More spots is not the solution”
CITYMONITOR, Nov-24-2022. [Online].
https://citymonitor.ai/transport/parking/cities-have-a-parking-problem-more-parking-is-not-the-solution
[Accessed: Dec-4-2022].

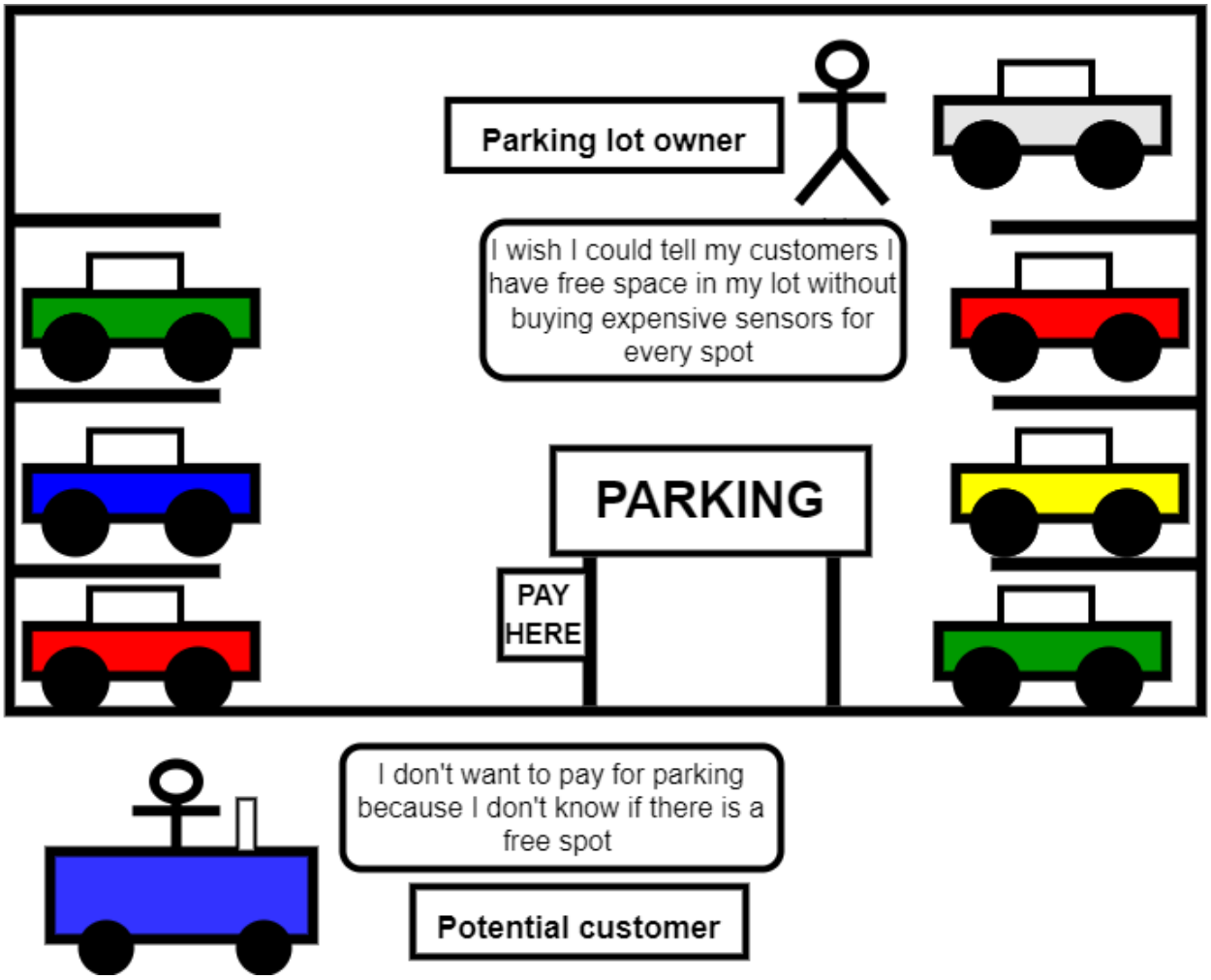
Prototype:

First and foremost, the Roomba should be able to detect cars where we tell it parking spots are. Joseph thought the best way to do this was to detect a car using the Servo, IR, and PING sensors, and Matt came up with the Idea of storing the car's location in an Array. When it detects the edge of the parking ramp using the cliff sensor, the driver will know to take a turn and go down the next row of cars. When it detects a "pothole" (removed tile) Noah mentioned the fact that it will need mark the spot as though it is full and consider it unusable. When the driver calls a parking update function, the Vroomba will share what of the spaces are available and which are not so far. Mubassir came up with the idea that the parking return should be incremental, so whenever it is called, only the spots scanned are shown. (Note: the Vroomba nor the "cars" are to scale. Both will be much larger in real life, and there will be no danger of running the Vroomba over as it will be car-sized)

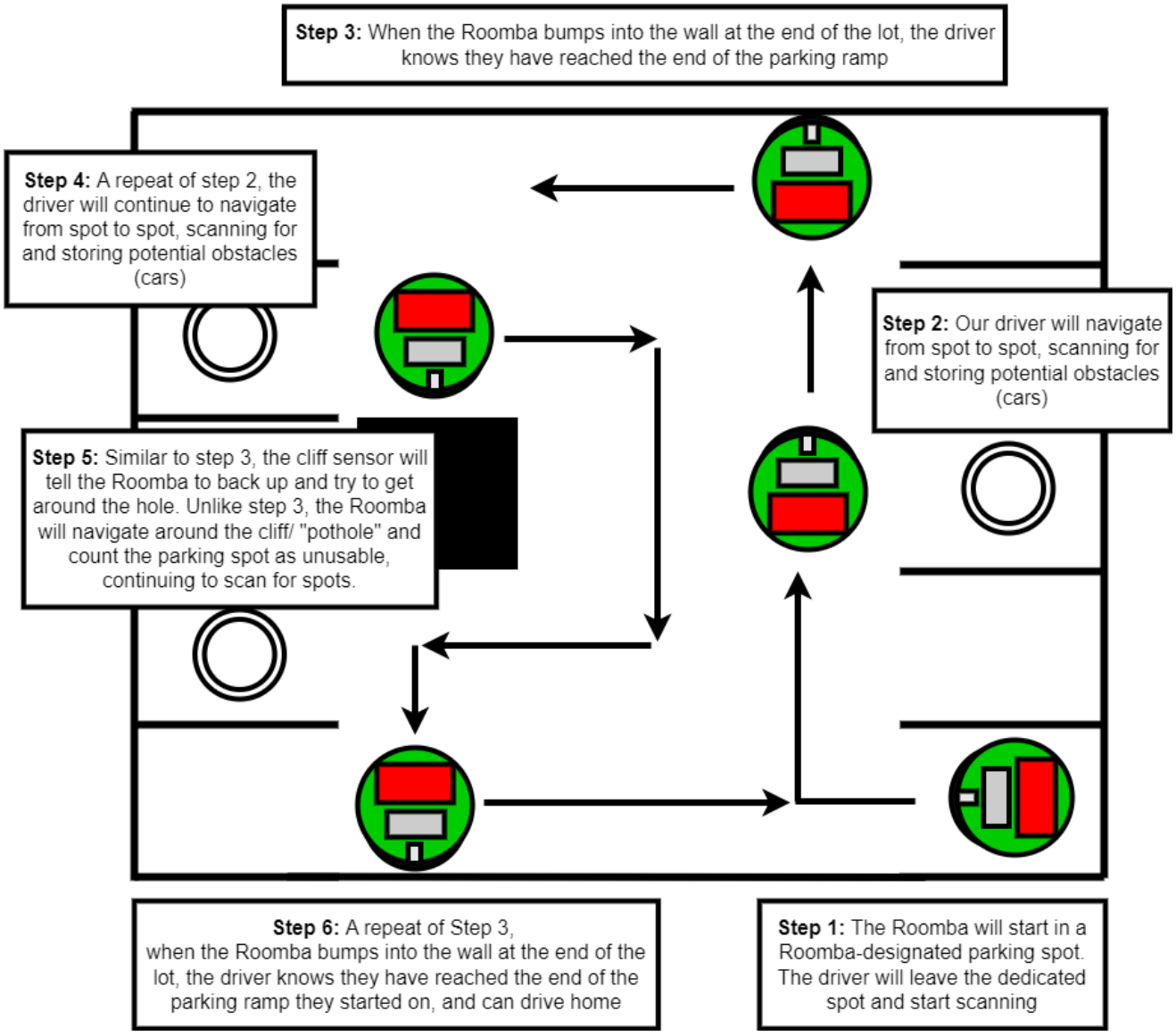
Lotus Blossom Diagram:



Big Picture Narrative (User-Centered sketch):

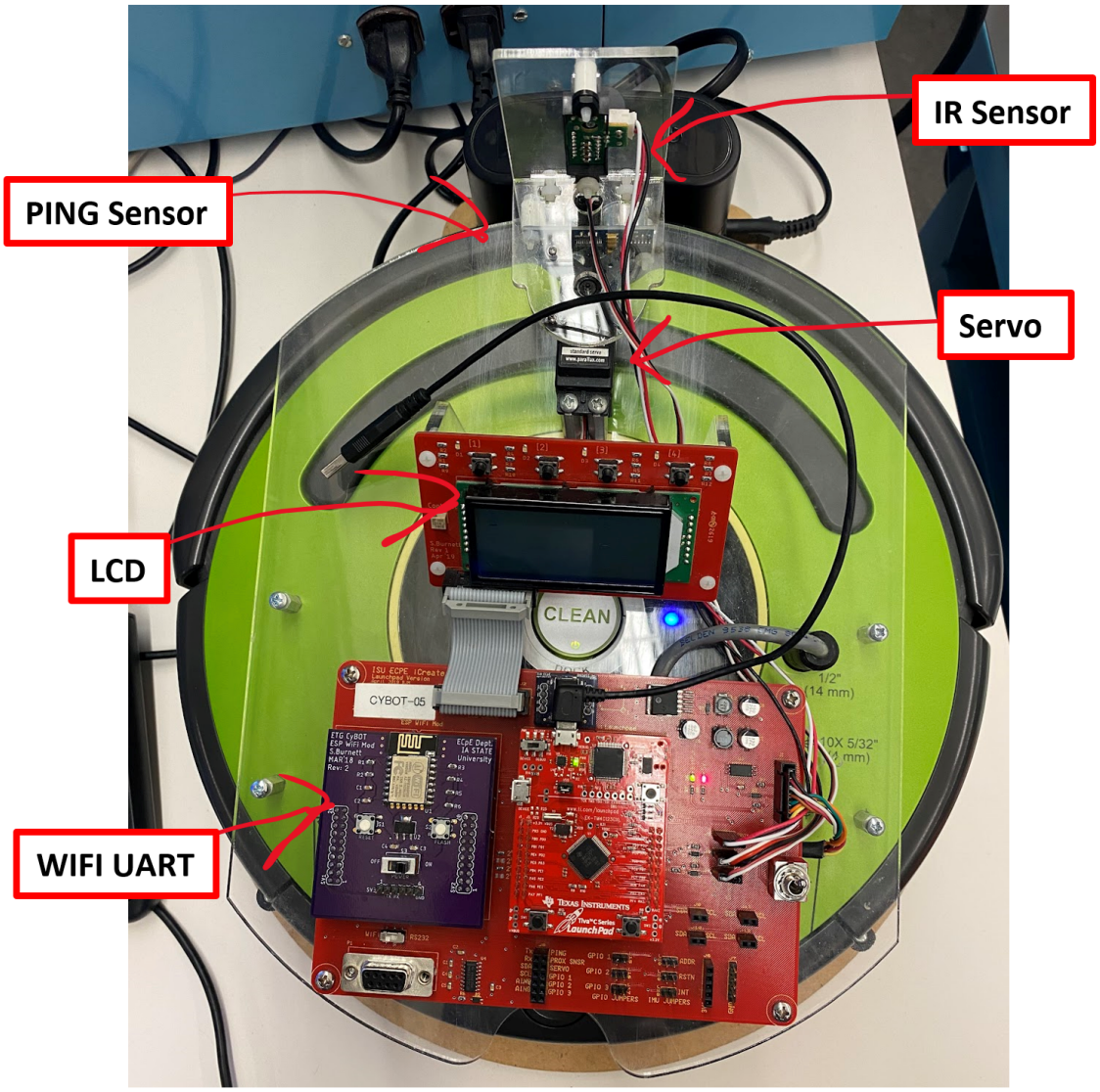


Test Field Sketch:

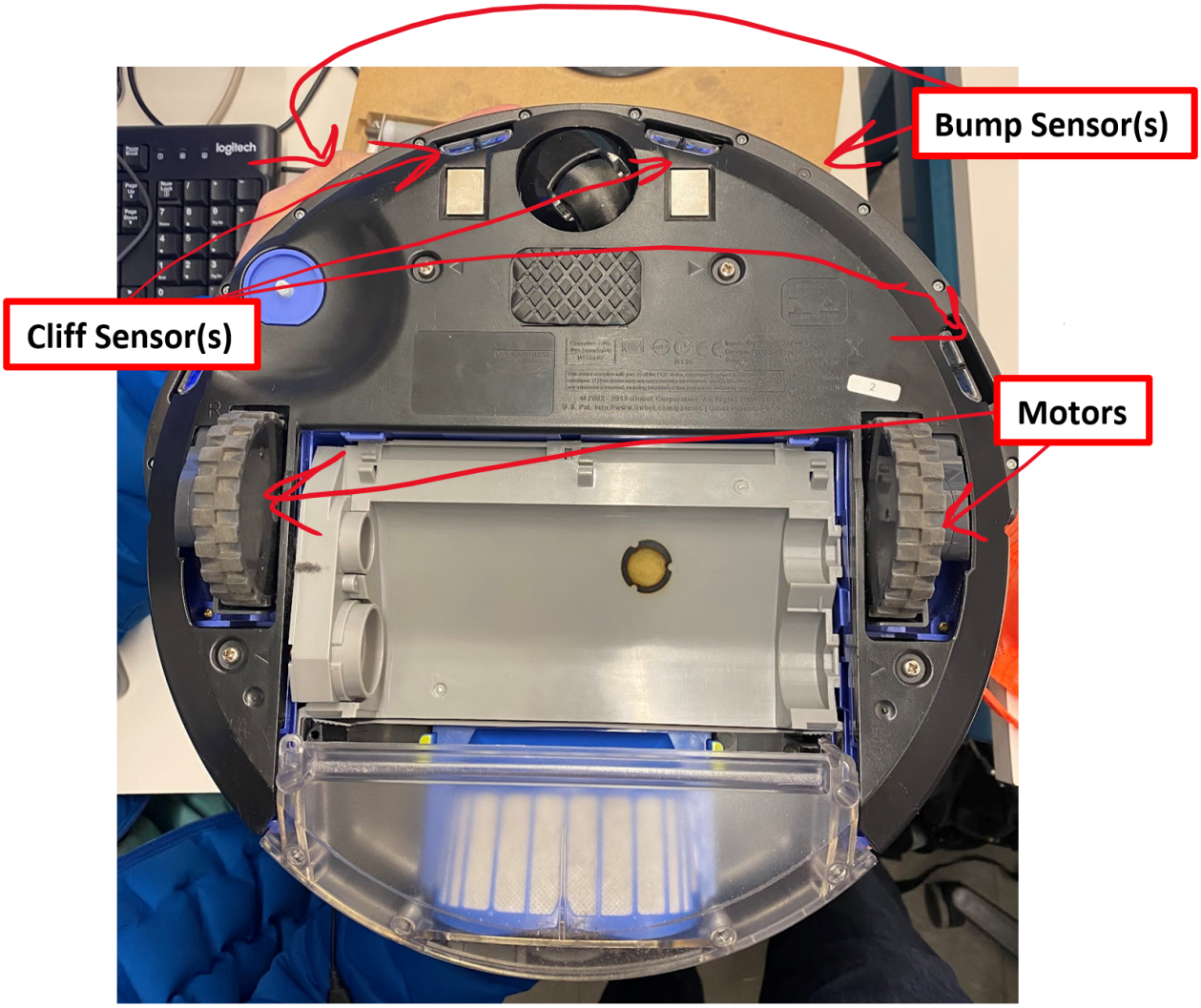


Vroomba Features and their respective uses:

TOP VIEW



BOTTOM VIEW



List of features:

- **TM4C123GH6PM Microcontroller:** This is the brain of the project and allows us to enable and control the other Roomba features. Used in all steps.
- **Motors & wheels:** They allow the robot to move, which is necessary to get from parking space to parking space while scanning for cars. Used in all steps.
- **Servo motor:** Using ADC conversions, sets the servo to a specified degree. Used in steps 2 and 4.
- **IR sensor:** Infrared sensor for object scanning. It will be used with the Ping sensor to detect cars in parking spots. Used in steps 2 and 4.
- **Ping sensor:** Sonar-based sensor for object scanning. It will be used in tandem with the IR sensor to detect cars in parking spots. Used in steps 2 and 4.
- **Bump sensor:** Switch activated by bumping or pressing into something. Will tell the Roomba it is at the end of the ramp by pressing into a short object (wall used in step 3 and 6).
- **Cliff sensor:** Similar to the bump sensor, the cliff sensor is activated when there is a different IR reading for the underside IR sensor. This tells the system it is approaching a cliff/hole. Used in steps 4 **uses interrupts.**
- **UART wifi communication:** Our UI created in matlab sends and receives characters through UART to make the roomba move and scan as the driver commands
- **LCD Screen:** Along the way, our roomba will display a variety of messages on the LCD screen to keep the driver and any observers in the loop on what is happening.

Vroomba Feature Mapping:

Function:	Implementation:	Ground level usage:
Move from parking spot to parking spot	We will use the motors and wheels to navigate the parking lot	Setting motor speed and distance using input characters
Scan and label each spot	We will use the IR and Ping sensors to detect cars and keep a tally and location of available spots	Uses the servo controller to scan a small area with the ping and IR sensors using an input character
Bump into the wall and scan for borders or holes	We will use interrupts to detect whether the bump sensor or cliff sensor is triggered on a small object or hole	When an interrupt is detected, the device will change direction of the motors and then do the next task required

Team Contributions:

Team Member:	Their contribution:
Noah Ross	In charge of the project proposal layout and working out details with the TA's and our professor. Also made the sketches, problem statements, and empathy maps.
Joseph Dicklin	In charge of new code and features for the roomba not featured in labs, like the cliff sensor and playing music. Also provided the scanning file including the ADC, ping, and IR files
Matthew Rief	In charge of the GUI and assembling a way of controlling the robot. Also created the method to communicate between the roomba and driver.
Mubassir Serneabat Sudipto	In charge of the technical aspects of the project proposal, and helped with the completion of certain things of the project including lotus diagram, list of features, and sources of references.