THOMPSON RIVERS UNIVERSITY

ENGR 1200 - Engineering Design II

Lab 7 Project:
Smart Parking Lot System

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Date of Submission: March 23, 2021

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1 Design Problem

1.1 Problem Definition

The number of vehicles Canada has increased 1.8 percent within a year, increasing from 35.1 million in 2018 to 35.7 million in 2019 [1]. With the fast growth of vehicle availability and uses, finding an available parking spot has been more difficult in recent years [2], which we confront almost every day. Many parking lots involve users searching for vacant parking spaces to park their cars. This leads to issues during rush hours and causes people to waste energy and time. It is exasperating for drivers trying endlessly to find a parking spot in a crowded parking area. As a result, a large number of working-hours is wasted due to traffic jams. According to a new survey, the reports illustrate that up to 45 percent of traffic congestion is generated by cars looking for parking spots [3]. One of the reasons that make contributions to this issue is due to the limited records provided at the parking lot [4]. Various measures have been taken in an attempt to solve the problem. Most of the recent parking managements are manually managed and are a little efficient. These ineffective conditions emerged as a result of lack of technical application. Smart Parking concepts have been put into practice in Europe, United States, Japan, and China to avoid driver's time waste and energy to find a parking space in a crowded parking garage [5]. Nevertheless, large investment is required on this type of system to install. The purpose of this report is to present a prototype of an integrated cost-effective system based on open hardware and software components.

1.2 Design Requirements

1.2.1 Functions

Smart parking services are an important component of parking management and have a significant effect on people’s daily lives. By monitoring and processing information from parking lots, a smart parking system allows drivers to receive real-time parking information and reduce parking congestion. The use of technologies in parking services has become the top prevention in the world. Many have been reported across the world on this subject, all of which highlight the importance of upgrading the current parking system and as well as how it is used and managed in order to offer benefits to smart cities [6][7]. The improved smart parking system should: 1. Minimize the amount of time spent looking for a parking space, enabling the driver to save time 2. Developing a model that is as low-cost as possible.

1.2.2 Objectives

The objective of this project is to have a smart parking lot system that displays and shows the number of parking spots available to the user. The system should display the amount of empty parking spots visually and audibly by using any Arduino components, to help tell the user if there are any parking spots available. The system should also detect if an oncoming vehicle is approaching the entrance, which then tells the user in the vehicle if there are any spots available. By using fewer components for the overall project, the system will be easier to create and produce, the overall cost of the system will be reduced and cost-effective.

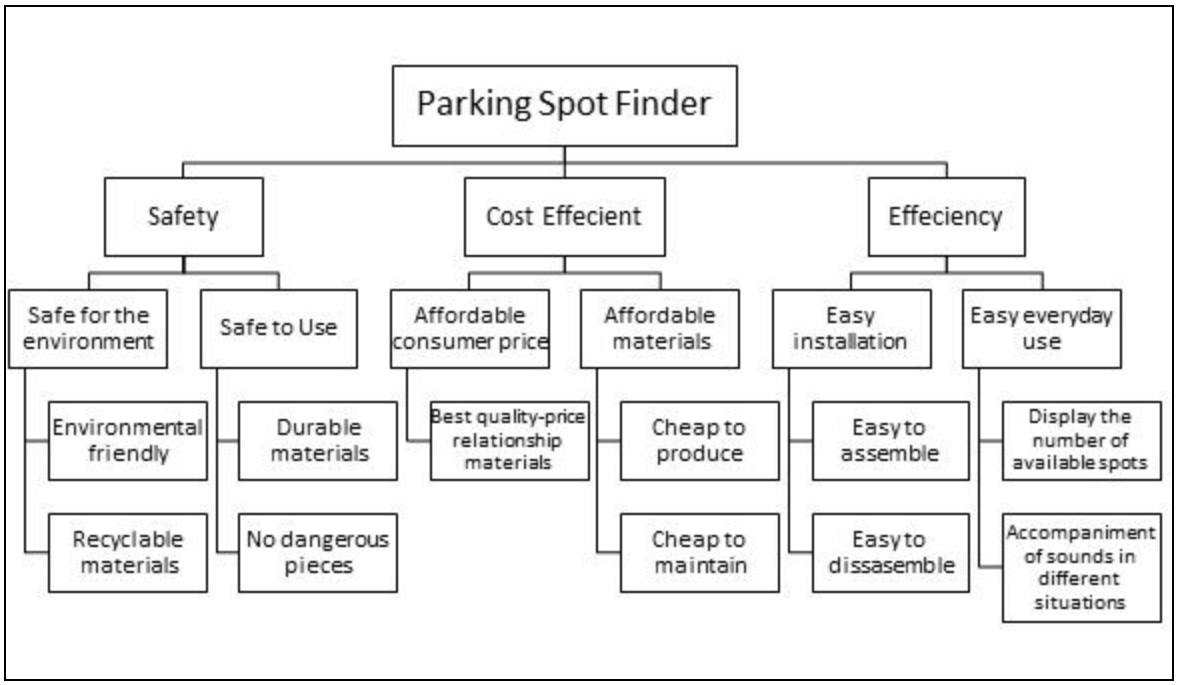


Figure 1.2.2: Objective Tree.

1.2.3 Constraints

The constraints of the project is that the system should be equipped in the parking lot rather than on the car and the system should at least park one or more cars. Also, the system should display the available parking space visually and audibly, and the system should detect cars that are roughly the size of a cell phone. Additionally, the cost of the project should be at a minimum and should not exceed 30 dollars.

2 Solution

2.1 Solution Description

For our final solution, we came up with a design that will let multiple vehicles enter and exit a parking lot. The smart parking lot system will be connected to the main parking lot, where it will have different sensors to detect and notify vehicles that are trying to enter or exit the parking lot. When there are no more parking spots available, the system will tell and notify the driver by displaying a zero on the 1 digit 7-segment display. Also, when the system detects a vehicle approaching either by entering or exiting the parking lot, the system will play certain pitches, depending on what the vehicle is trying to do. With our solution, we did not spend any money when building our design, as we used some scrap cardboard to create the scaled parking lot. In the programming aspect of our solution, there are 3 main sections in the code. The first section is the setup, which all the variables are assigned. The second section is for the calculation of both sensors, which calculates the distance between the sensor and the vehicle and converts the distance into centimeters. The last section is the main determination of when a vehicle is entering or exiting and if there are no spots available.

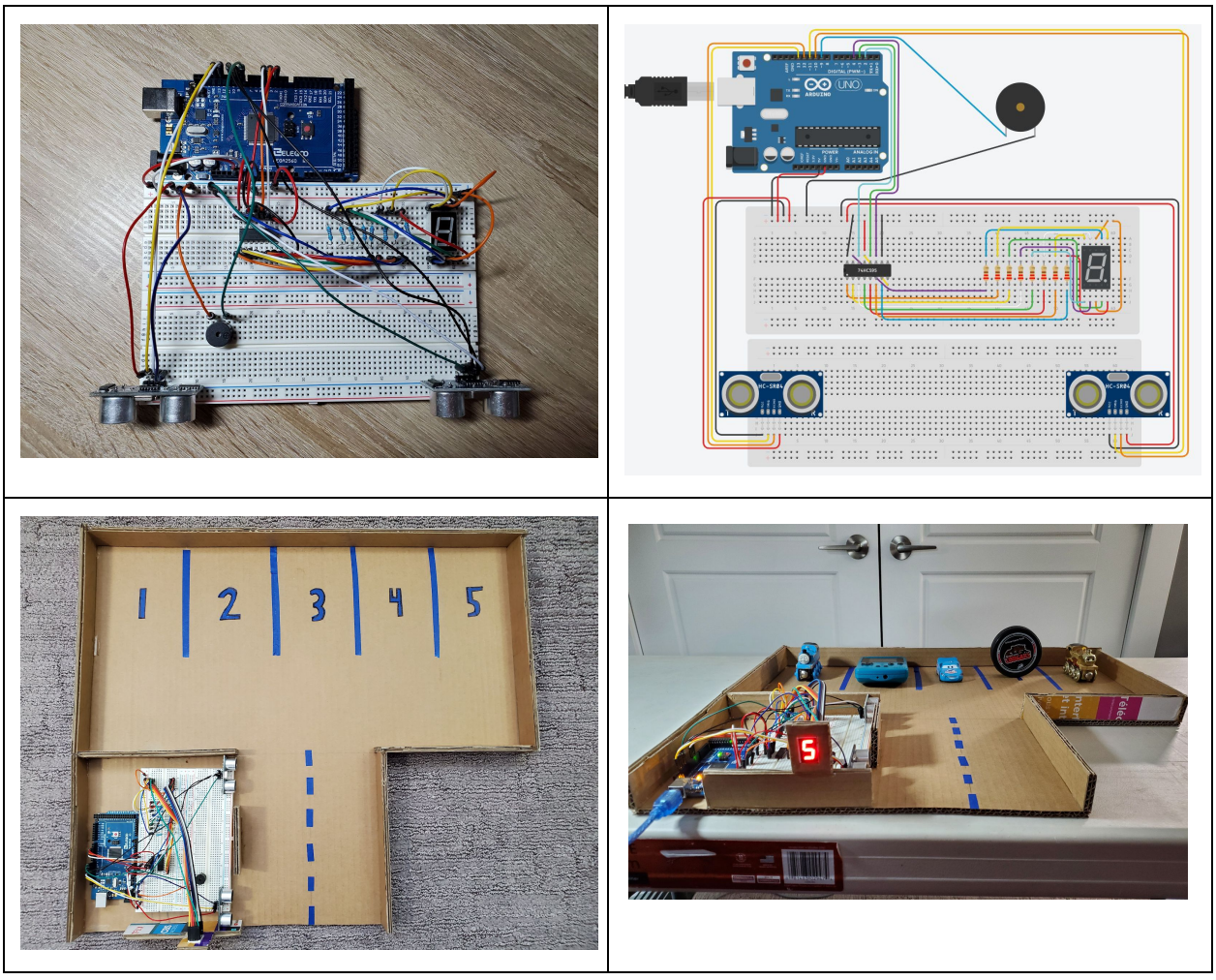
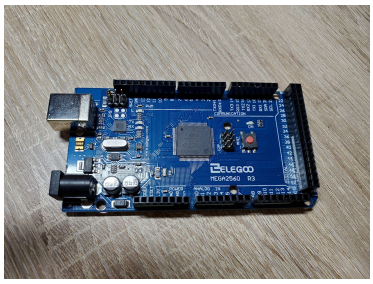
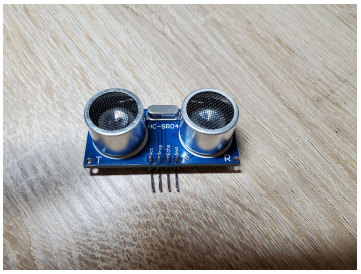
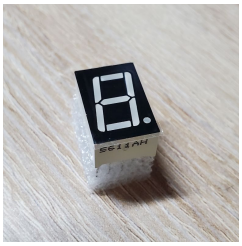


Figure 2.1: Images of the Final Solution.

2.2 Components

For the components, our solution requires certain parts to work properly, but still following the constraints by using fewer parts. This design was built by using components from the most complete starter kit MEGA 2560 Project. The table below displays images of each component and tells the quantity of each component that was used. There is also a brief description of the main function of each component in our design.

Components / Description	
	Arduino MEGA 2560 (x1): Main hub of the system. Allows code to run through the board into all the other components.
	Ultrasonic Sensor (x2): Detects and determines the distance of the cars when they enter and exit the parking lot.
	1 Digit 7-Segment Display (x1): Displays and shows how many parking spots are available in the parking lot.
	Passive Buzzer (x1): Plays a passive sound audibly to the user when they enter or exit the parking lot.

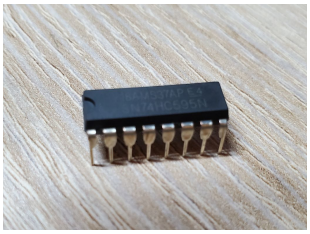
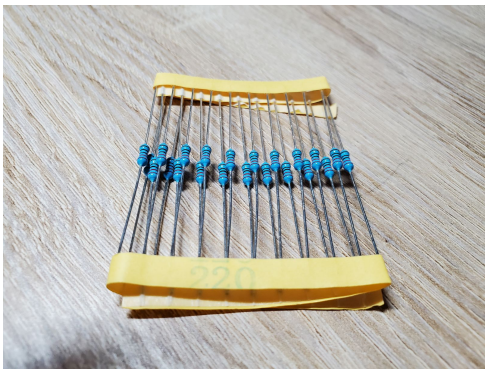
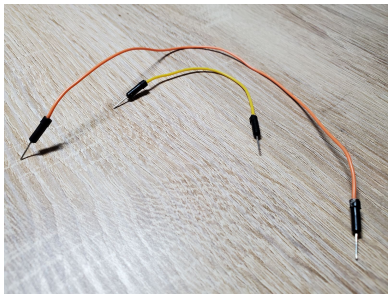
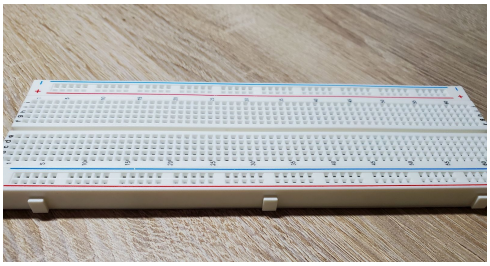
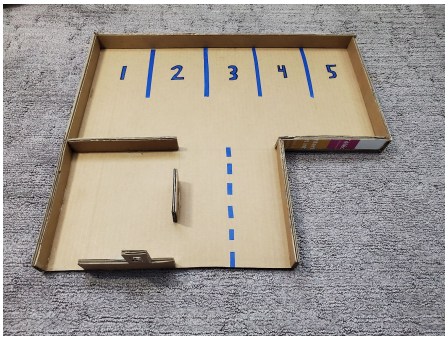
	Shift Register (x1): Helps with the Seven Segment display and saves room on the Arduino Board by using only 3 Arduino I/0 pins.
	220-Ohm Resistor (x8): Used to limit the current going through the 7-segment display. Arduino uses 5-Volts.
	Connecting Wire (x40): Connects each part to the Arduino board and breadboard by using pins.
	Breadboard (x2): The breadboard is used to connect all different components together by using the pins from wires and other components.
	Cardboard Parking Lot (x1): This is the one of the main parts where it will house all the electronics in a section so that it can perform the main task of a smart parking lot system.

Table 2.2: List of Components and Descriptions.

2.3 Features

For the features of our solution, there are many features that intertwine with each other. The ultrasonic sensors used in our solution detects the approaching vehicle from both the entrance and exit. For the entrance, the first ultrasonic sensor reads from a distance between 9 and 17. If the first sensor detects any movement between these distances, it will alert the driver with the passive buzzer and 7-segment display. For the exit, the second ultrasonic sensor reads from a distance between 1 and 7. If the second sensor detects any movement between these distances, it will also alert the driver with the passive buzzer and 7-segment display. For the passive buzzer in our solution, it was used to create different sounds depending on what the vehicle is doing near the system. We used four different sounds to audibly tell the user what's going on with the parking lot. The first sound plays when a vehicle approaches the entrance and the second sound plays when a vehicle approaches the exit. For the last two sounds, they were used to audibly tell the user that there are no parking spots available. The third sound plays when a car approaches the entrance, but there are no more parking spots. The last sound plays when a car approaches the exit, but there are no more parking spots. When this sound plays, the system will tell the user that they freed up the final spot, then play the second sound. The 1 digit 7-segment display used in our solution displays the number of parking spaces available. When a vehicle enters the parking lot, the 7-segment display will go down by one, until the display reaches zero, meaning that there are no more parking spaces available. When a vehicle exits the parking lot, the 7-segment display will go up by one until the display reaches the max number of spots, meaning that the parking lot is empty.

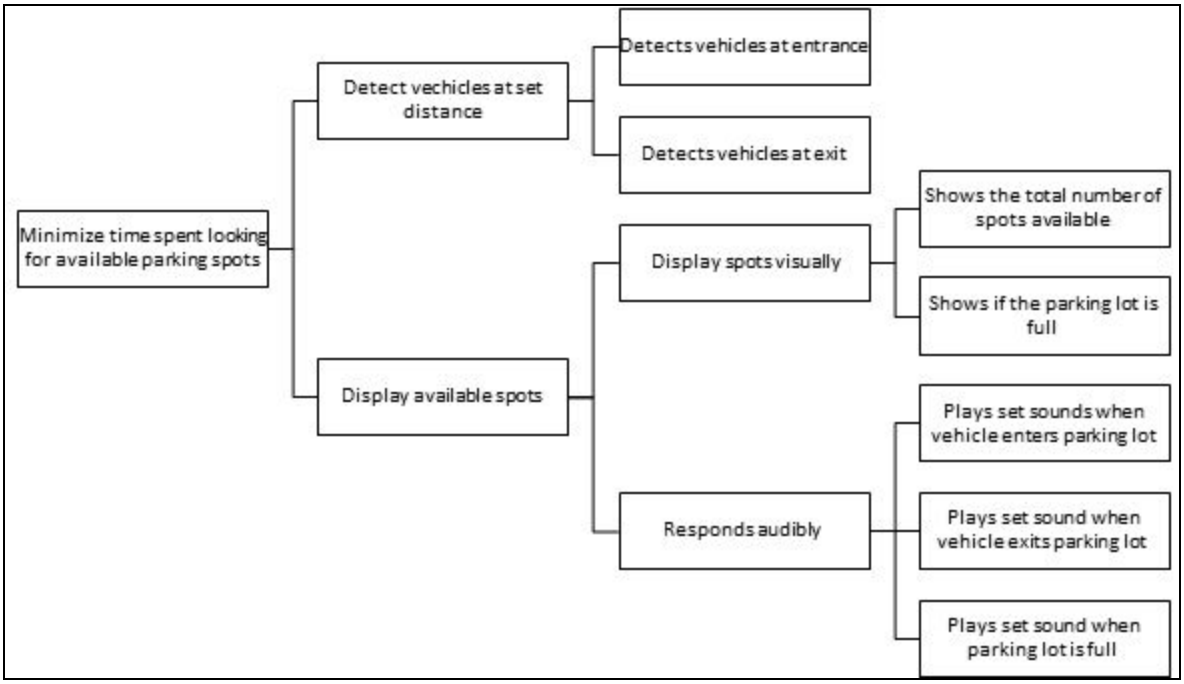


Figure 2.3: Function Tree.

3 Team Work

3.1 Meeting 1

Time: March 6, 2021, 2:00 pm to 3:00 pm

Agenda: A list of topics to be discussed in the meeting

1. Review Project Requirements.
2. Brainstorm and Come up with tasks for Gantt Chart.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	N/A	N/A	Create Gantt Chart
Toma Aitken	N/A	N/A	Create Gantt Chart
Tazrian Zabin	N/A	N/A	Create Gantt Chart
Almat Bolatbekov	N/A	N/A	Create Gantt Chart

Meeting minutes: A list of decision made in the meeting

1. Next meeting all members will work on Gantt Chart.
2. Tazrian didn't attend this meeting, had a valid excuse. Luka will notify her of topics discussed.

3.2 Meeting 2

Time: March 7, 2021, 1:00 pm to 2:00 pm

Agenda: A list of topics to be discussed in the meeting

1. Go through and Revise tasks for Gantt Chart.
2. Create Gantt Chart.
3. Discuss the Report.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	Create Gantt Chart	90%	Design / build solution
Toma Aitken	Create Gantt Chart	90%	Finish Gantt Chart
Tazrian Zabin	Create Gantt Chart	90%	Writing the Report: Problem Definition, Functions.
Almat Bolatbekov	Create Gantt Chart	90%	Objectives and constraints

Meeting minutes: A list of decision made in the meeting

1. Toma will finish making Gantt Chart.
2. Tazrian will start writing the report's problem definition, Functions, components and features.
3. Luka will begin to sketch and build possible solutions.
4. Almat will begin writing the report's objectives and constraints.

3.3 Meeting 3

Time: March 13, 2021, 1:00 pm to 1:30 pm

Agenda: A list of topics to be discussed in the meeting

1. Editing the first part of the report.
2. Show possible arduino connections for solution.
3. Show possible solution code.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	Design / build solution	70%	Build Prototype of Solution
Toma Aitken	Finishing Gantt Chart	100%	Coding
Tazrian Zabin	Writing the Report: Problem Definition, Functions	60%	Writing the Report: Components
Almat Bolatbekov	Objectives and constraints	60%	Make Objective + Function Trees

Meeting minutes: A list of decision made in the meeting

1. Next meeting, discuss the objective + function tree.
2. Toma will begin coding for the final solution.
3. Luka will start building the cardboard prototype.
4. Tazrian + Almat will continue working on the report.

3.4 Meeting 4

Time: March 20, 2021, 1:00 pm to 2:00 pm

Agenda: A list of topics to be discussed in the meeting

1. Compiling and editing the report.
2. Review of prototype and code.
3. Review objective and function trees.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	Build Prototype of Solution	70%	Integrate Arduino + cardboard parking lots together. Writing the Report: Solution Description.
Toma Aitken	Coding	90%	Writing the Report: Features.
Tazrian Zabin	Writing the report: Components.	90%	Converting Sources to IEEE Format.
Almat Bolatbekov	Make Objective + Function Trees	85%	Update the Table of Contents, List of Figures, List of Tables.

Meeting minutes: A list of decision made in the meeting

1. Will meet next day (March 21, 2021), and go over the report and do final editing.
2. Luka will take photos of the prototype after integrating the parking lot with Arduino.

3.5 Meeting 5

Time: March 21, 2021, 1:00 pm to 2:00 pm

Agenda: A list of topics to be discussed in the meeting

1. Go over the report and do final editing.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	Integrate Arduino + cardboard parking lots together. Writing the Report: Solution Description.	90%	Final Editing and Recording the video
Toma Aitken	Writing the Report: Features.	95%	Final Editing and Making pdf of code
Tazrian Zabin	Converting Sources to IEEE Format.	100%	Final Editing
Almat Bolatbekov	Update the Table of Contents, List of Figures, List of Tables.	95%	Final Editing

Meeting minutes: A list of decision made in the meeting

1. Luka will record video of the prototype working and send it to the team.
2. Toma, Tazrian, Almat will do final editing of the report.

3.6 Meeting 6

Time: March 22, 2021, 2:00 pm to 3:00 pm

Agenda: A list of topics to be discussed in the meeting

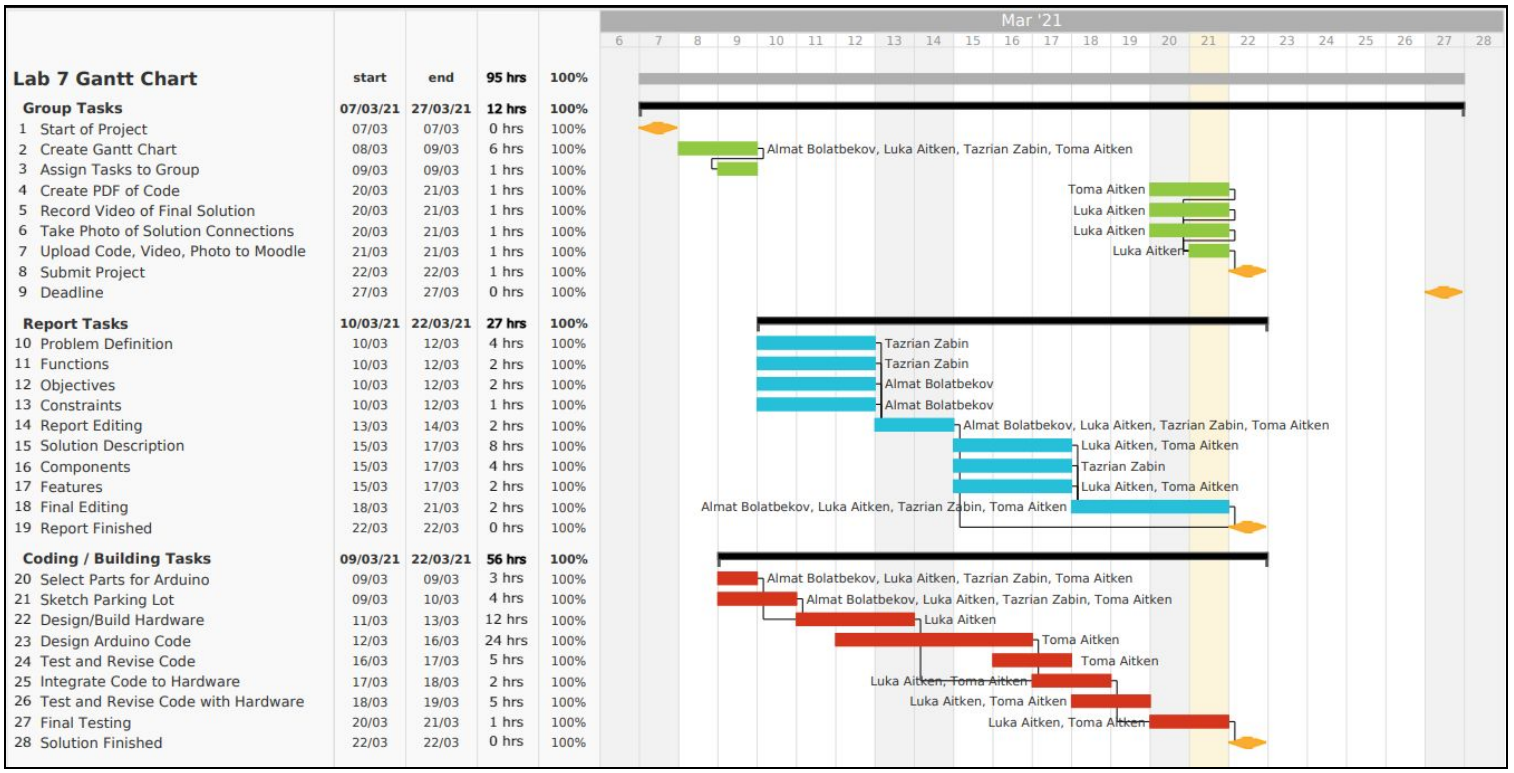
1. Go over the entire report and proofread.
2. Watch a video of the prototype working.

Team Member	Previous Task	Completion State	Next Task
Luka Aitken	Final Editing and Recording the video	100%	Hand in Report, Video and PDF of Code
Toma Aitken	Final Editing and Making pdf of code	95%	N/A
Tazrian Zabin	Final Editing	95%	N/A
Almat Bolatbekov	Final Editing	95%	N/A

Meeting minutes: A list of decision made in the meeting

1. Luka will hand in the report, the video and pdf of code on moodle.
2. Handing the Lab on March 23, 2021, a day later than planned, to give everyone time to process and go over everything.

4 Project Management



Lab 7 Gantt Chart	start	end	95 hrs	100%
Group Tasks	**07/03/21**	**27/03/21**	**12 hrs**	**100%**
1 Start of Project	07/03	07/03	0 hrs	100%
2 Create Gantt Chart	08/03	09/03	6 hrs	100%
3 Assign Tasks to Group	09/03	09/03	1 hrs	100%
4 Create PDF of Code	20/03	21/03	1 hrs	100%
5 Record Video of Final Solution	20/03	21/03	1 hrs	100%
6 Take Photo of Solution Connections	20/03	21/03	1 hrs	100%
7 Upload Code, Video, Photo to Moodle	21/03	21/03	1 hrs	100%
8 Submit Project	22/03	22/03	1 hrs	100%
9 Deadline	27/03	27/03	0 hrs	100%
Report Tasks	**10/03/21**	**22/03/21**	**27 hrs**	**100%**
10 Problem Definition	10/03	12/03	4 hrs	100%
11 Functions	10/03	12/03	2 hrs	100%
12 Objectives	10/03	12/03	2 hrs	100%
13 Constraints	10/03	12/03	1 hrs	100%
14 Report Editing	13/03	14/03	2 hrs	100%
15 Solution Description	15/03	17/03	8 hrs	100%
16 Components	15/03	17/03	4 hrs	100%
17 Features	15/03	17/03	2 hrs	100%
18 Final Editing	18/03	21/03	2 hrs	100%
19 Report Finished	22/03	22/03	0 hrs	100%
Coding / Building Tasks	**09/03/21**	**22/03/21**	**56 hrs**	**100%**
20 Select Parts for Arduino	09/03	09/03	3 hrs	100%
21 Sketch Parking Lot	09/03	10/03	4 hrs	100%
22 Design/Build Hardware	11/03	13/03	12 hrs	100%
23 Design Arduino Code	12/03	16/03	24 hrs	100%
24 Test and Revise Code	16/03	17/03	5 hrs	100%
25 Integrate Code to Hardware	17/03	18/03	2 hrs	100%
26 Test and Revise Code with Hardware	18/03	19/03	5 hrs	100%
27 Final Testing	20/03	21/03	1 hrs	100%
28 Solution Finished	22/03	22/03	0 hrs	100%

Table 4.1: Gantt Chart.

5 References

1. “More vehicles on the road in 2019.” Statistics Canada. https://www150.statcan.gc.ca/n1/daily-quotidien/200910/dq200910d-eng.htm (Accessed March 12, 2021).
2. D. Shoup. “Problems with Parking Requirements in zoning Ordinances.” Eno Transportation Foundation. https://babel.hathitrust.org/cgi/pt?id=mdp.39015021808756&view=1up&seq=11 (Accessed March 12, 2021).
3. P. White, "No Vacancy: Park Slopes Parking Problem and How to Fix It.” Transportation Alternatives. http://www.transalt.org/newsroom/releases/126 (Accessed March 12, 2021).
4. H. Ibrahim, “Car Parking Problem in Urban Areas, Causes and Solutions.” SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3163473 (Accessed March 12, 2021).
5. “Parking Guidance Information (PGI) System.” A.G.K. Limited. https://agkdisplays.com/occupancy-pgi-systems/ (Accessed March 12, 2021).
6. T. Giuffre, M. Siniscalchi, G. Tesoriere, “A Novel Architecture of Parking Management for Smart Cities.” Procedia -Social and behavioural Science. https://www.researchgate.net/publication/257717417_A_Novel_Architecture_of_Parking_Management_for_Smart_Cities (Accessed March 12, 2021).
7. M. Idris, L. Y.Y, T. E.M, N. N.M, “Car Park System: A Review of Smart Parking System and its Technology.” Information Technology Journal. https://www.researchgate.net/publication/26593976_Car_Park_System_A_Review_of_Smart_Parking_System_and_its_Technology (Accessed March 12, 2021).

6 Appendix

Additional Photos of Solution:

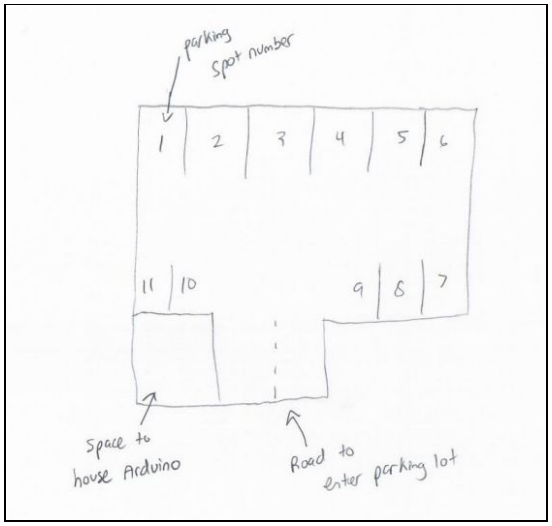


Figure 6.1: Sketch of Prototype.

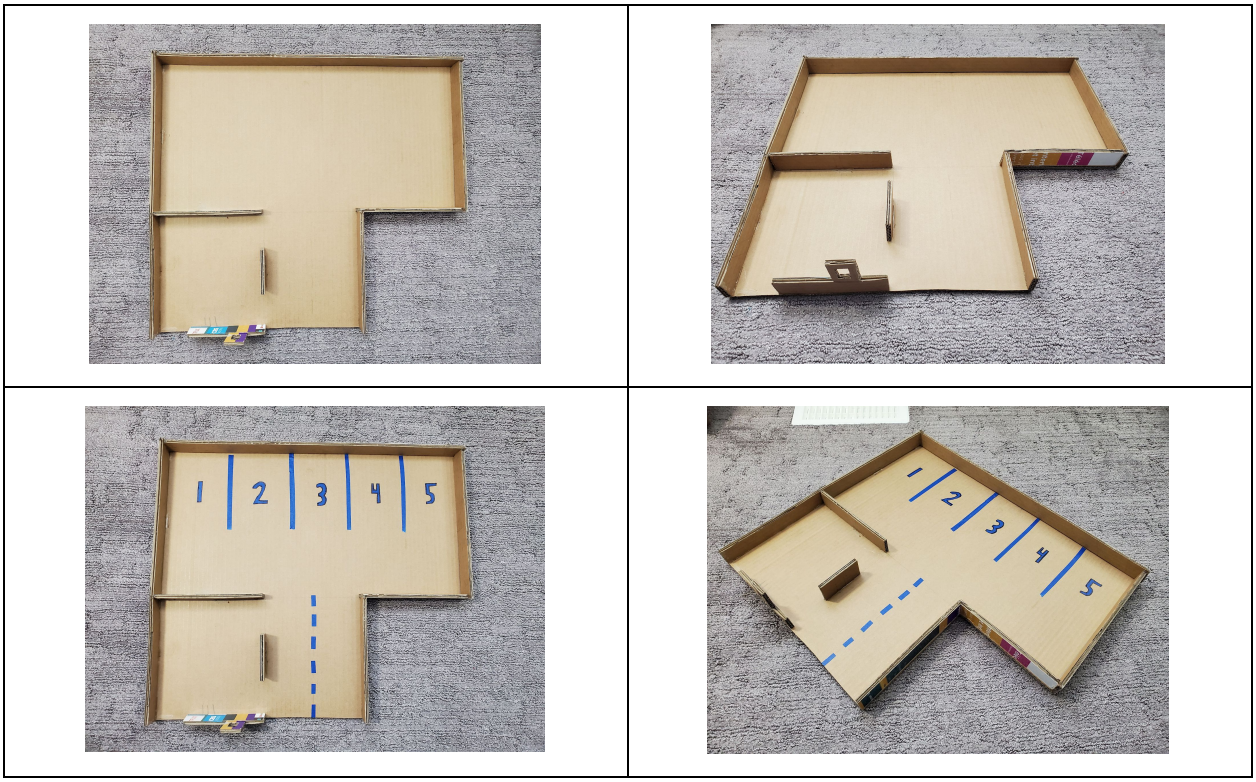


Figure 6.2: Additional Images of Cardboard Parking Lot.