2017

Smart Parking Lot

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Overview

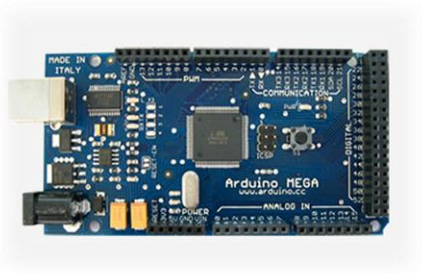
Although there have been several advancements to parking infrastructures and lots, there is still room for growth. Users often circle a parking lot for several minutes before finding an open spot. This can be frustrating when you're trying to catch a game or attend an event on time. To solve this problem, we specifically focused on closed parking lots and decide to create a smart parking lot. The main goal of this project was to make it easier and quicker for users to find open parking spots.

Materials Used

MATERIALS	QUANTITY
Arduino Uno	**2**
Arduino Mega	**1**
LEDs (assorted colors)	**44**
Ultrasonic Sensors	**3**
16x2 LCD display	**2**
4 digit 7 segment display	**1**
Velostat pressure sensor	**4**
Paint (black, white)	**2**
Insulation Foam (base)	**1**
Wires	**~500**

Our choice of materials was influenced by the rather large scale of our project. We started with choosing the base which was a ½" thick insulation foam. Then we decided that we should paint the foam and needed to purchase two cans of paint, one white and one black. Next, we decided on the number of parking spots we were going to include and the appropriate number of LEDs

based on that. To implement the individual parking spaces, we decided to purchase velostat that would act as a pressure sensor. We also added two 16x2 LCD displays that would be placed near the top of the entry and exit gates. This could provide information or statistics about the parking lot or would simply greet the drivers as they entered the lot. In order to display how many spots were open in the parking lot, we also chose to add a 4 digit 7-segment display. We decided to go with a 4 digit instead of a single digit because our parking spots exceed 9 spots (max displayed by a single digit). We also added three ultrasonic sensors for a section of our parking lot that was meant to display another concept about the parking lot. In order to power all these sensors, we needed an Arduino board with more pins and therefore we chose to purchase an Arduino Mega. This, combines with two other Arduino Unos were able to power all the displays and sensors. We were in a group of three and needed to use six external devices and by choosing these sensors, displays and output devices, we were able to meet that requirement as well.



Arduino Mega

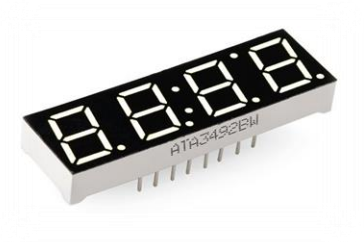
Wires

Velostat Pressure Sensor

Arduino Uno

16x2 LCD Display

Ultrasonic Sensors



4 digit 7 segment display

Pink Insulation Foam

Assorted LEDs

Purpose

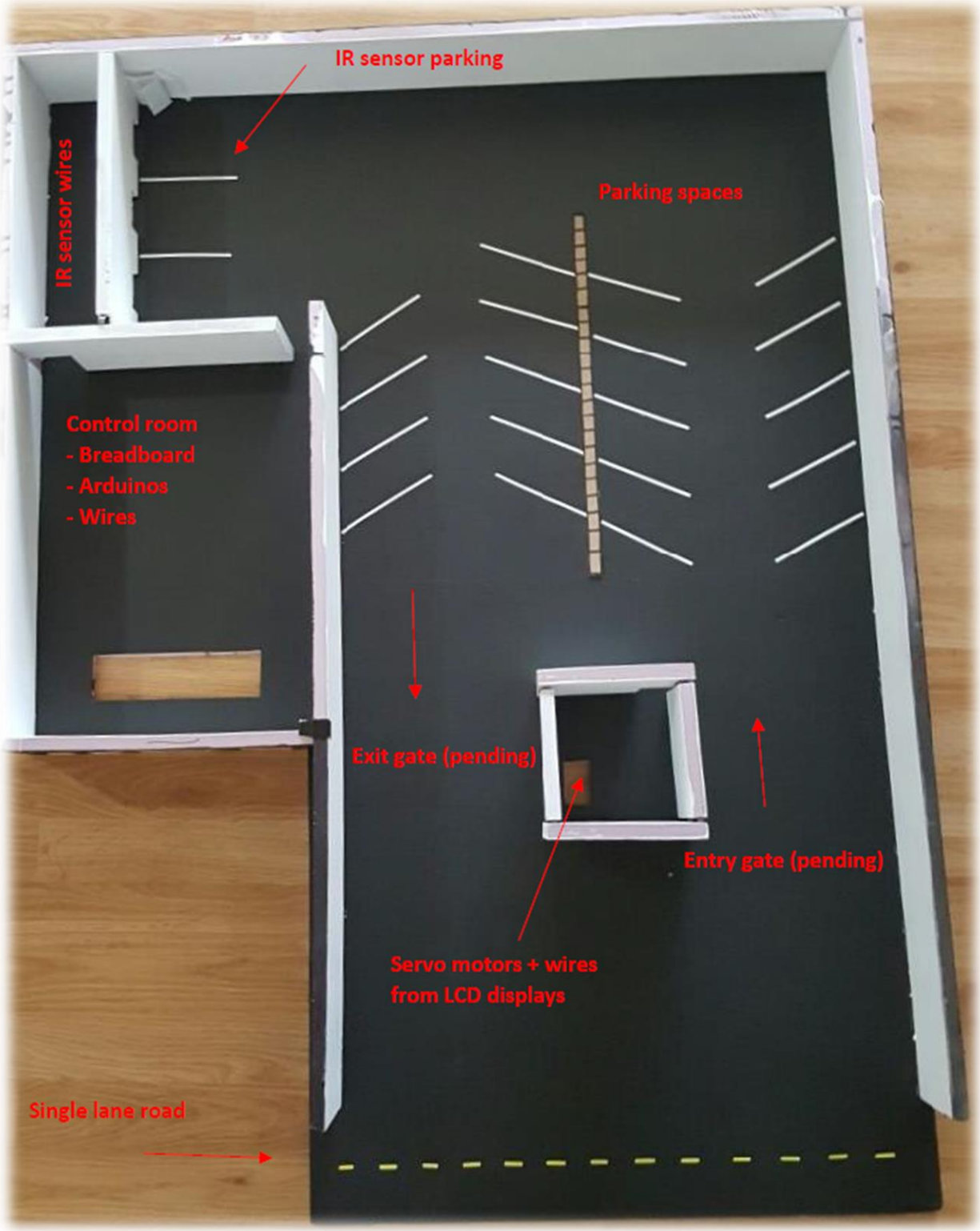
The purpose of this project was to implement a smart parking lot that would be able to guide users to the nearest open parking spot. We chose to do this via a series of flashing LEDs that would show drivers the path to the nearest spot. Too many times, users have no idea where to

park and end up circling parking structures for minutes on end. There are also cars that park between two spots or park too far in which can lead users to thinking that there is a space available when in reality there isn't one. So far, there hasn't been any improvement to the parking infrastructures and we thought that a couple smart concepts should be implemented in the lots that are built from now on. There is also another concept that uses the ultrasonic sensors that was meant to alert the user if they are getting too close to the wall or are parking too far back. This prevents from others getting tricked into thinking that there is a parking spot when in reality there is a parked car that is just too close to the wall or is a small car.

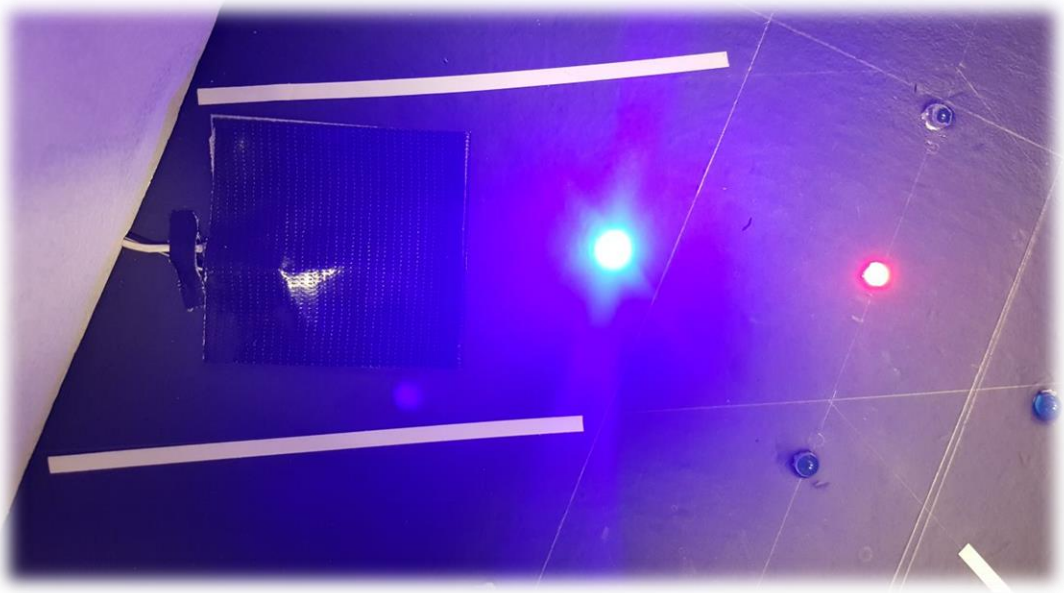
Approach

In an effort to make parking more efficient and quicker for users, we decided to use a series of blinking LEDs that would guide the users to the nearest parking spot. We started by first choosing the base for the project, which was the pink insulation foam. Initially we were unsure as to what material we should be choosing but in the end decided that wood would've been too heavy and harder to cut and therefore went with foam. The consistency of this foam was also firm and this resulted in almost no foam shavings when we cut the pieces. We cut a 2x3 piece for the base of the parking lot and cut separate pieces that were 4 inches that would serve as the walls. Our initial thoughts were to implement an entry and exit gate and because of this we included a single box in by the entrance of the parking lot that would cover the wires and hold the two motors in place. We also included a separate space for the ultrasonic sensors and decided that we would only demonstrate the concept on three parking spaces. Behind the parking spaces, we left a section open that would hold the sensors in place. At last, we also left a decent amount of space for the "control room" or the region that would hold our breadboards and Arduinos.

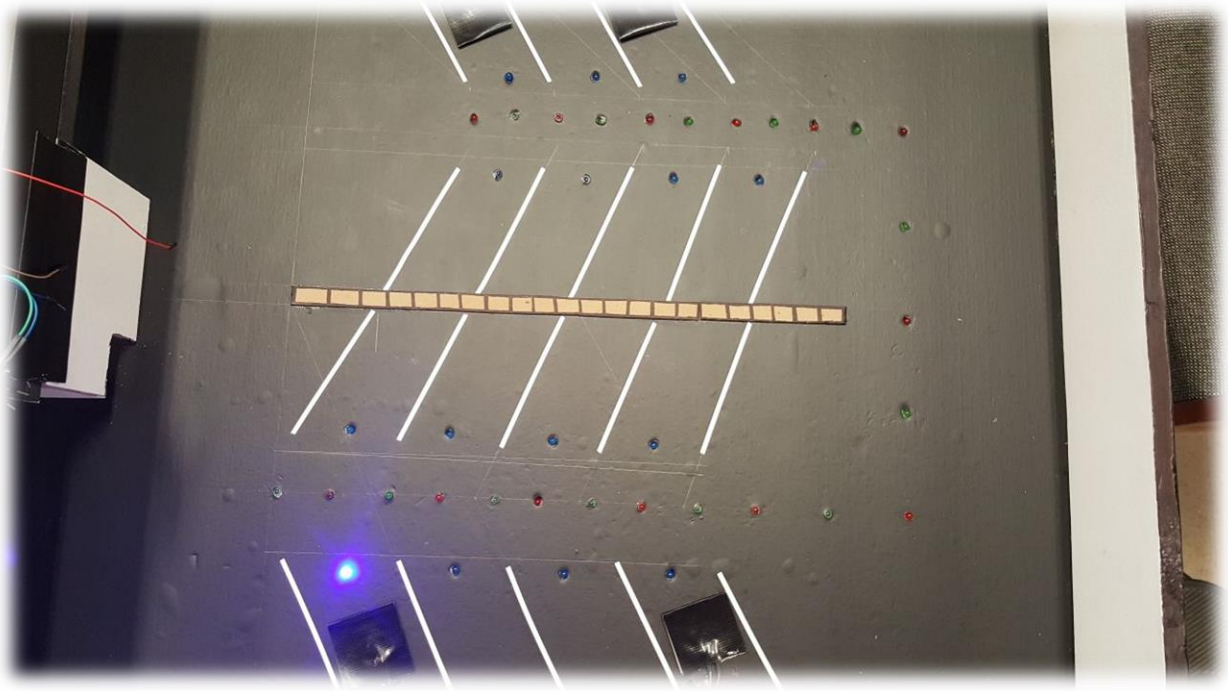
Once the lines were drawn for the parking spaces, this is what the parking lot looked like:



Once the overall structure of the parking lot was complete, we started making the pressure pads for the parking spaces and started to determine how many LEDs we would be using. To make the pressure pads, we use Velostat sheets that were cut into small pieces and then sandwiched them between two pieces of foil and ultimately and outer layer of tape. The Velostat acts as a resistor and is was meant to simply detect some sort of pressure. If there was a car on top of the pressure sensor, the serial monitor would print a higher value which in turn changed whether the parking spot was open or full. In order to use the LEDs to guide the cars to open parking spots, we needed to determine how many we were going to be using. We decided to include an LED in every parking space so that it would light up if it was open. In addition, we decided to include a path that consisted of 25 LEDs that was meant to guide the cars to the nearest open parking space.

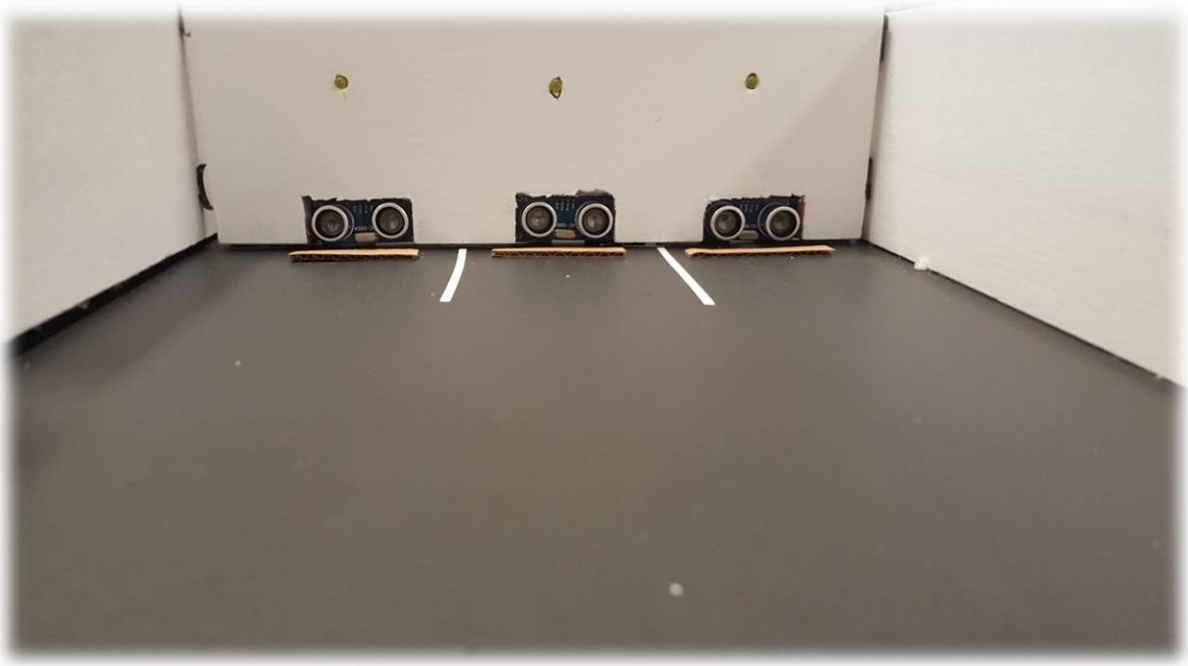


This is what the velostat pressure sensor looked like once it was complete (along with the LED for each parking spot).



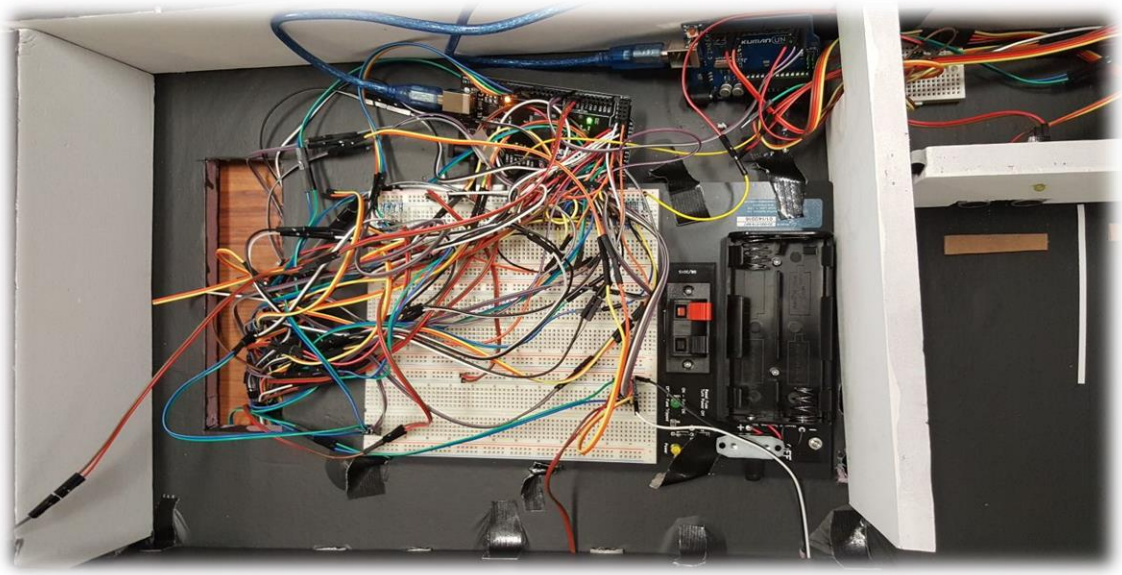
All LEDs in place along with the four pressure pads.

Once the LEDs were in place, we started to connect and test all the LEDs to check if they were working and started connecting them to the Arduino and breadboard. While connecting these LEDs, we ended up using a lot of wires since we had to use a lot of extenders so the wires would reach the breadboard in the control box. Once all the wires were in place at the bottom of the base, we used to tape to cover the entire bottom of the board so everything would hold in place and none of the wire extenders would disconnect. We then started to connect and glue the ultrasonic sensors in place along with the LEDs on top of the walls that would light up when a car is too close to the wall.

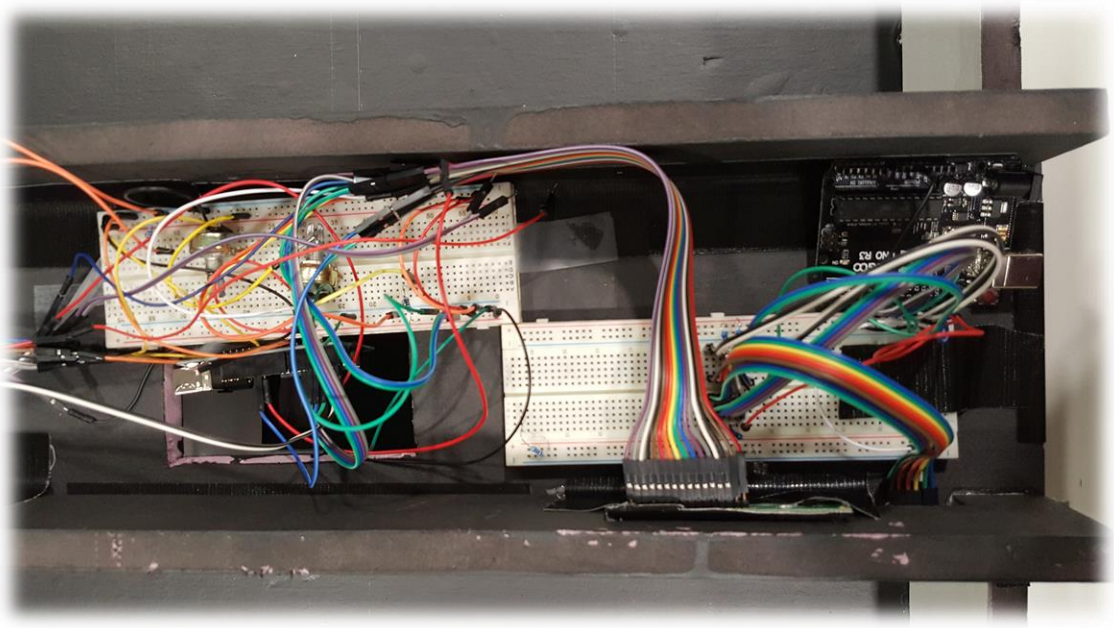


Ultrasonic sensors in place along with the LEDs above them.

Once the ultrasonic sensors were in place and connected, we started to glue the pieces that would hold the LCD displays and started to connect everything together to the Arduinos.



The "control room" after all the wires were connected to the Arduinos and breadboard.



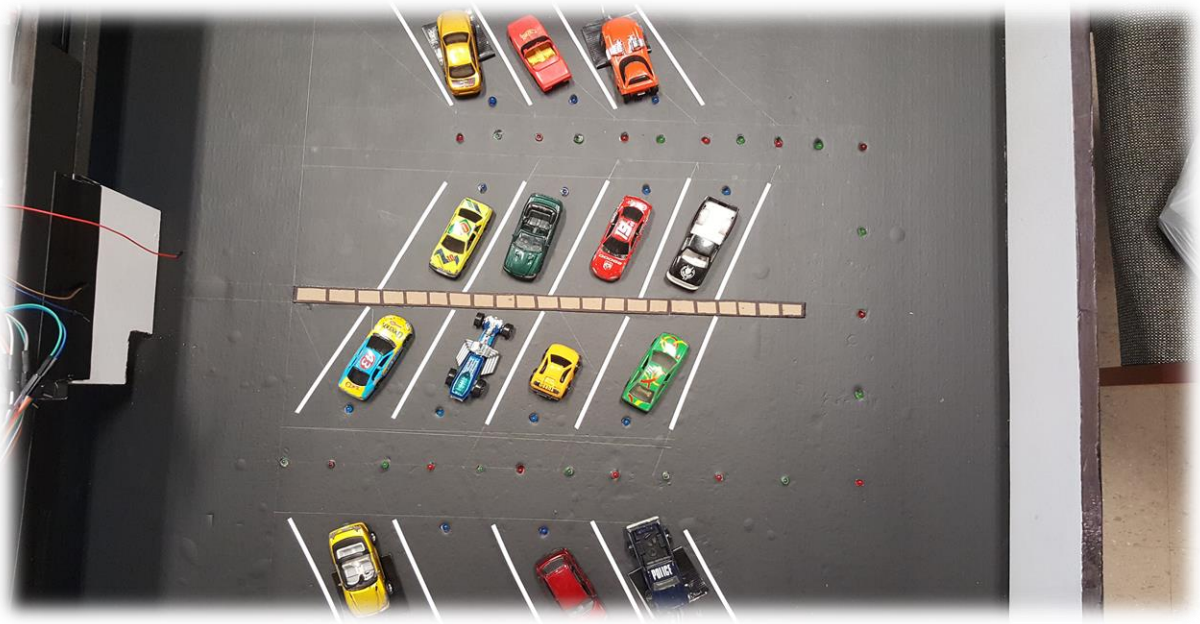
Top view of the section that held the two LCD displays and the breadboards that connected them

LCD display on top of the entry gate along with the 4 digit 7 segment display.

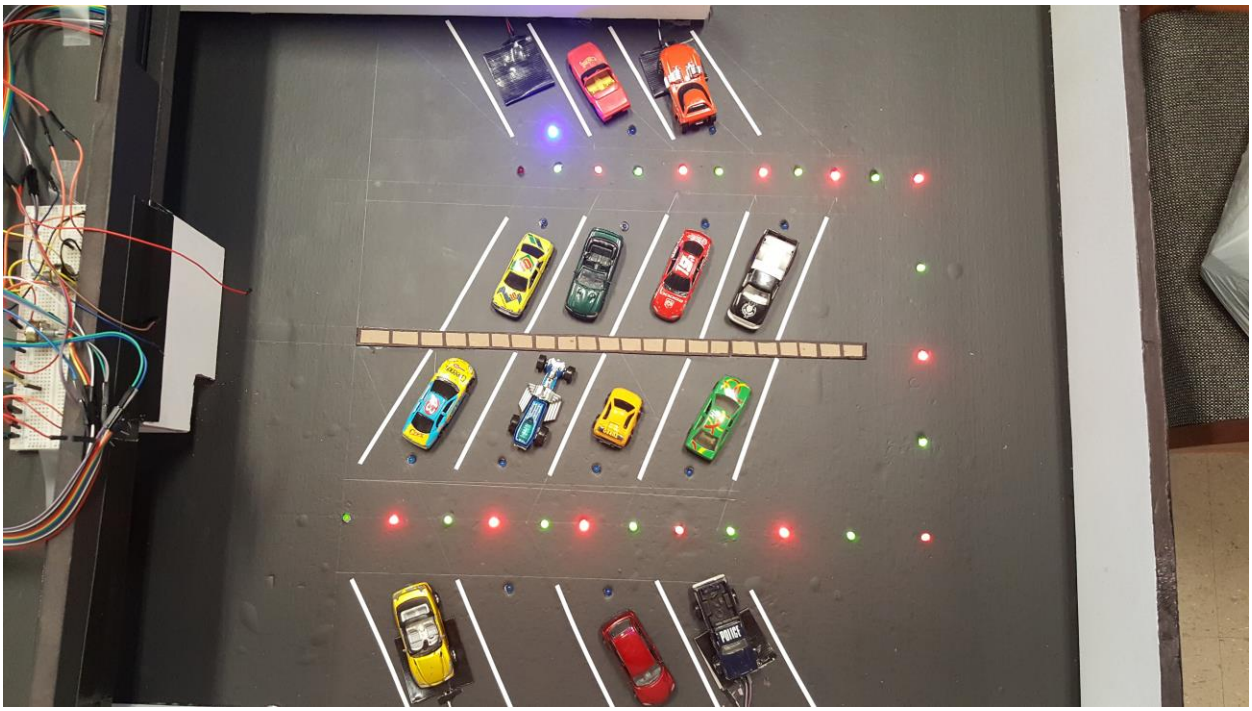
Unsure of the number of parking spots that we were going to include, we ended up making our parking lot much bigger than expected. In the end, the size made it a hassle to carry around and it became harder to work on it since there were wires, Arduinos and breadboards attached to the board. Paired with the sensors and displays, we always had to monitor if there was going to be any rain so our equipment wouldn't suffer water damage while we carried it to and from our car. This was one of the things that taught us that we should've picked smaller dimensions for our project.

Implementation

Once we had implemented all the sensors and displays and got the pressure pads connected, we started to test out the LEDs blinking and the path that it would show while guiding the users. After we got that to work, a good portion of the project was complete. Here are some images when all the components were correctly implemented and functioning.

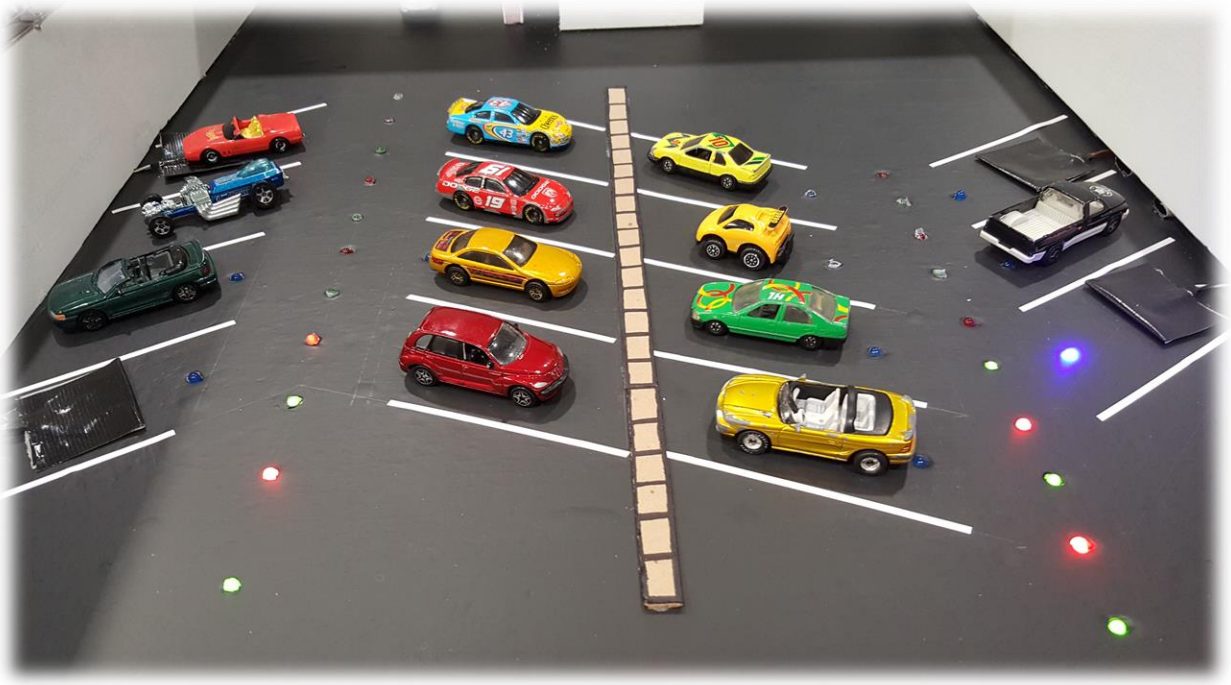


All cars parked on the parking spots – no LEDs are on since there are no open spots.



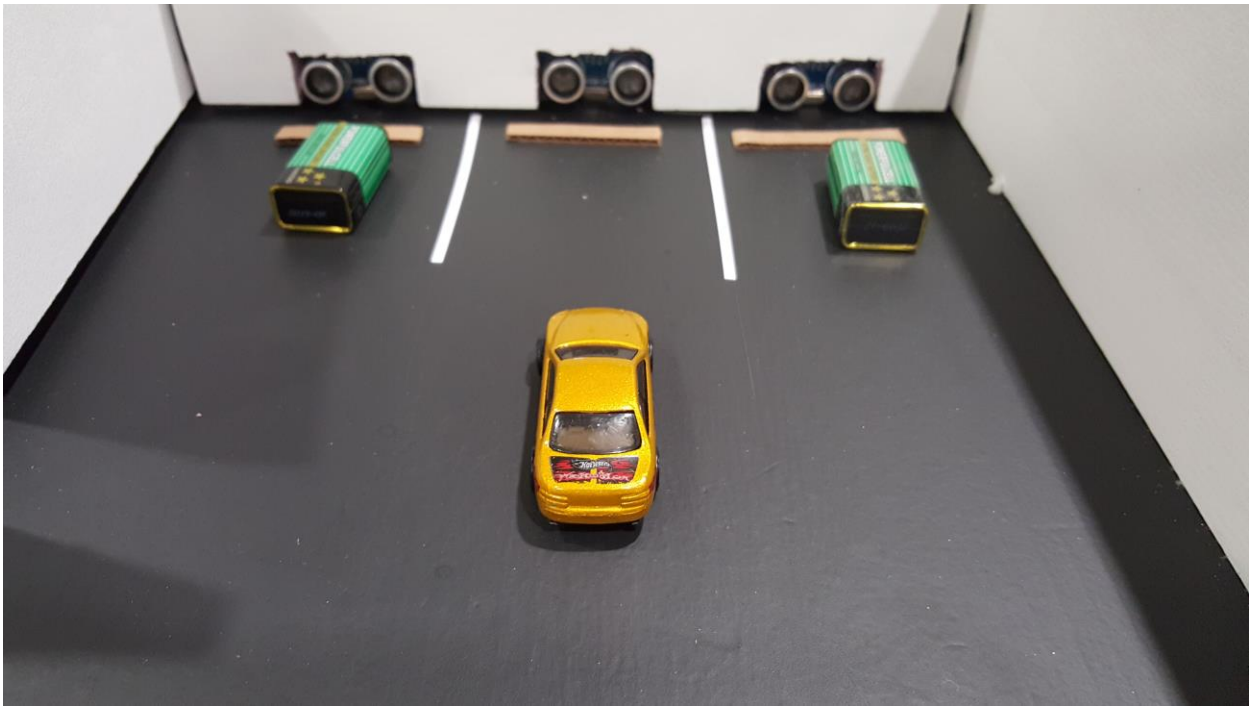
The following shows the first, second and third parking spot being occupied by cars and therefore the series of LEDs lead the next car to the nearest open parking spot which in this case is the fourth spot in the lot (since we only implemented four of the parking spots for our example). The one open spot doesn't count since we didn't place a pressure sensor there. However, in a real-world example, we would have sensors on every parking space. We decided to not include pressure pads on all the parking spots because we had already sealed the bottom of the base with tape and in order to place more sensors we would have to drill through the wires and tape (which we wanted to avoid). We also wanted to implement an entry and exit gate (seen on the left side of the image above). However, we didn't get the motors to work and therefore never got around to implementing them. In addition, the gates were hard to build since there was no material that was sturdy enough and we realized that the entry and exit gates should probably have been made narrower. This issue was caused by not determining dimensions from the beginning and cutting the pieces of the insulation foam prematurely.

Cars entering the parking lot and how they would be guided using the LEDs



An aerial view of the parking spots

We had issues while trying to display the number of spots open and to test this, we tried displaying this information on the LCD display first. As you can see the number of spots says -1 and this is because the when connected with the parking spots / pressure sensors, the analog signal would throw random numbers when spots were filled and -1 when all the spots were available. Due to this, we weren't able to get the 4 digit 7 segment display to work. In addition, while trying to display numbers on the 7-segment display, the code was erroneous and was missing one of the lines while displaying the numbers. The entry and exit gates were also not implemented due to the lack of a servo motor. The motor that we did have wasn't tall enough for the base of the lot and would always hit the bottom instead of providing some clearance from the ground.



Three parking spots that were meant to show the distance concept using ultrasonic sensors.

Issues

When we first came up with the idea to make this parking lot, we had anticipated that a few things might go awry but during the course of this project, there were a lot more issues present. To begin, we didn't really know how to scale the entire parking lot so we had a tough time deciding on the dimensions of the lot. We purchased an insulation foam that was 4 x 8 feet and this was a problem to carry from the beginning. Initially we had planned to build a second level to this parking lot and imagined that we would be able to use the extra foam. However, we weren't able to think of a way of including a ramp that would be efficient and decided on making a single level. In addition, a single level was enough to display our concept. Once we decided on the dimensions, cutting the board itself was a lengthy process since we had to cut it using a box cutter to make clean cuts. Once the board was cut, we decided to paint the board before gluing all the pieces together. At first, we decided to paint the foam using spray paint which was a bad idea. The Touch 'n Tone paint ate at the foam and it didn't work unless we keep the plastic layer on top of the foam. However, this wasn't an option since some of the plastic was already peeling off and we couldn't risk painting the entire board and then the plastic ripping. We considered using black paper over the entire board but in the end decided to go with interior paint since it didn't eat at the foam and had a cleaner finish.

Touch n tone spray pain and the initial results of painting directly on the foam.

Results of painting on top of the plastic layer that initially came with the foam.

We also tried using Acrylic paint but due to the brush, the texture was rough and wasn't idea to use on the entire board.

We ultimately tried interior paint which resulted in the clean finish we were trying to achieve and this is what the results looked like when done:

Behr interior paint after peeling the transparent plastic layer off.

Other issues consisted of the motors not functioning properly due to faulty code and the 7 segment display not able to display numbers due to one of the lines being faulty and the absence of that information being passed to the display. The LCD display that was over the exit gate also wasn't functioning due to the lack of communication as to how many cars were entering and leaving the parking lot.

Lessons Learned

Some of the lessons that we learned from making this parking lot was that it would've been a good idea to determine the dimensions from the beginning since that would help pick the materials and would also assist in making everything to scale. Never use spray paint on foam, even if it's from a distance, it eats up the foam and can ruin the entire project. It was a clever idea to test the paint on extra pieces or else the entire project could've become a disaster. Always test all the displays and sensors that you are using as you are implementing them. We followed this rule throughout the project and this helped us in the end as we didn't have to worry about faulty sensors not working at the last minute. While it might have been cost effective, the pressure pads weren't quite consistent and would often need to be calibrated several times before they were working again. This is another issue that could've been solved by either using ultrasonic sensors or simply buying analog pressure sensors instead of using velostat. We also could have picked a better servo motor that would've been easier to implement with the entry and exit gates. Both the 5-step motor and the servo motors that we tested were inconsistent and weren't behaving properly enough to be implemented in the parking lot.

Expansion – Future Ideas

In addition to showing the concept that uses ultrasonic sensors, we had other ideas that we wanted to implement but didn't have enough time or resources to get there. One of these things would be to get the 7-segment display to work and show how many spots are open or whether the parking lot is full. We could also get the gates to work, combining them with a pass system that will only allow the gate to open if a user presses a button or if there is a car present (another pressure sensor). In a real-world scenario, an app could also be created that would allow people to reserve parking spots.