The Traffic Light System

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Introduction & Explanation

For our culminating project, we were tasked with designing and building a model of an intersection. The requirements included: a working traffic and pedestrian light system with a button that is able to change their timings, a working street lamp that only turns on when it's dark, and a working gate that is controlled by an ultrasonic sensor. Creating a traffic light system allowed us to learn to use different software and it also made us apply the knowledge we already learned in class.

We first started with a virtual model with the simulation programs SketchUp and TinkerCAD. We used SketchUp to design what we wanted our physical model to look like in a virtual environment, and TinkerCAD to set up the circuitry that would make up the internals of the model. We then used the Arduino IDE and an Arduino board so that our program could be run on a real-world circuit built on a breadboard.

How does the traffic lights work at a T-intersection?

The two traffic lights that are parallel to each other are connected and will run in unison, displaying the same color. The perpendicular traffic light will display the opposite of the parallel ones. When the parallel traffic lights are green or yellow, the perpendicular one will be red, and so on. In addition to this, there will also be a small window of 1 second when all the lights are red so as to plan for safe pedestrian traffic.

How does a pedestrian light work?

The pedestrian crosswalk goes from one side of the parallel light to the other. The pedestrian light will be on one side of the street. When the parallel lights are red, then the pedestrian lights will be red. When the parallel lights are yellow or green, then the pedestrian lights will be white.

How does a manual switch change the timing of the traffic lights?

The button on our model will speed up the times that the parallel light stays red and yellow, and will make the timing of the green light stay longer. If the button is pressed when the light is already green, it will change the timings of the next cycle of red, yellow, and green lights.

When will the street lamp be turned on or off?

We have a photoresistor that will determine the brightness surrounding the area. If it becomes too dim in the surrounding area, the street light will turn on.

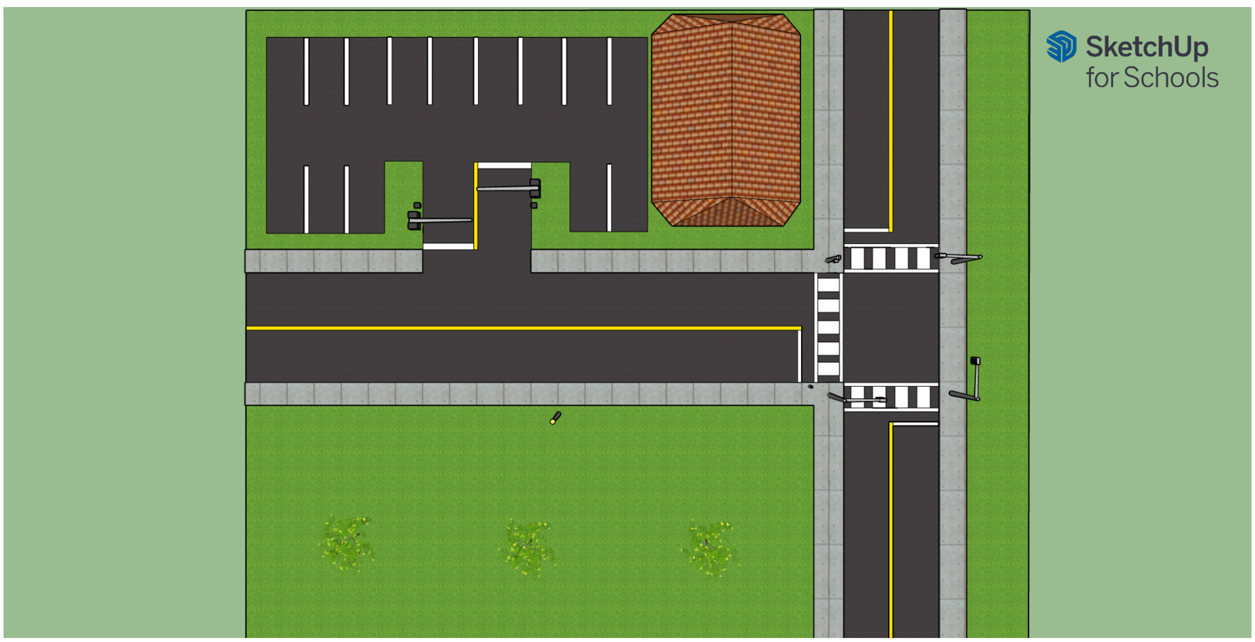
How does ultrasonic sensor work with a gate?

The ultrasonic sensor detects any objects within a specified distance. When it detects an object, it will send a signal through our code to the servo which will then open the gate. Once no objects are detected anymore, the gate will close.

How does the IR sensor work with a gate?

The IR sensor detects inputs from the remote. Depending on what button is pressed on the remote (up or down), the IR sensor will tell the servo to either go up or down.

Final Layout:



Challenge

The first challenge that we faced was that we could not get our physical model of the tinkercad working. There was a problem involving the photoresistor and streetlight where we could not get the streetlight to light up when we wanted it to. We first checked if our code was working by uploading it onto another group's model. It worked so we thought that it may be an issue with the Arduino board as we suddenly weren't able to upload our code onto it. It still did not work and so we pulled out and redid all of our wirings but it changed nothing. The last problem we could think of is that there may be an issue with the breadboard. Our final option was to replace the breadboard. We did the wiring all over again and it finally worked

The second challenge we faced was the complicated code we had to make on the TinkerCAD. We noticed that we couldn't use the delay function for the gate and the timings of the traffic lights since it would stop the whole program instead of pieces of it. While delayed, the program could not run anything else in tandem and so we had to find a way to recreate it. We had to create many methods to replicate the delay function in a way that will only pause that method and not the others. With the collaboration of other groups as well, we managed to successfully recreate it.

Investigation

We first made two separate models of the traffic light on SketchUp. We would later choose the better one and make our physical model based on it

After making our models, we created our own traffic light system on TinkerCad. It is a helpful tool for us to create and test code that we would use on the physical model. This model would include:

- 9 LEDs for the traffic lights
- A photoresistor and white LED for the street lamp
- A pair of LEDs for the pedestrian lights along with a button
- A micro servo for the gate to move
- An ultrasonic sensor to detect objects for the gate
- A remote to control the gate
- An IR sensor to detect outputs from the remote in the tinkerCAD model
    - In the real model, we used it to detect objects

While building the real model, we removed the remote and ultrasonic sensor as we could not get access to those materials. Instead of using the IR sensor to detect outputs from the remote, we used it to detect objects. During the building process, we had to build a replica of the SketchUp model that we chose, which included the platform and all the traffic lights as well. To connect the traffic lights to the breadboard, we also had to solder and wire the components as well.

Another small change we made to the physical model was the extension of the sidewalks to the parking lot. This is so that we could install the gates and IR sensors on a flat surface. We included this change due to the fact that placing the IR sensors in the fake grass could interfere with their functionality.

Evaluation

After finishing this project, we believe that we completed the physical model to the best of our abilities considering the many challenges we faced along the way. Although we think that the end product turned out well, several improvements could definitely have been made, both to our product and the process that got us here.

For next time, we will test equipment beforehand so as not to waste time redoing components. For example, when we were in the process of testing our circuitry, we spent around a week trying to figure out why the LR sensor wasn’t working properly. Had we identified the faulty breadboard earlier, we could have spent our time more efficiently and spent more time on polishing the model. We also could have spread out and designated the tasks clearer to each person, as even when we realized the breadboard was the problem, we still had both people working on it, wasting valuable time. Instead, we should've had one person work on the physical model while the other figured out the issue from the beginning.

Another consideration for future projects is the use of higher-quality materials. For example, if we had thought to use 3D printed components (traffic & pedestrian lights, street lamps, gate, etc.), it would’ve smoothed out the building process by a great deal. Not only would 3D printed components be easier to create, it would also be stronger and not have as many imperfections created throughout the building process. Leading to a cleaner and more polished end product.