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AB8

ECE 110 Final Project Report

1. **Introduction**
   a. **Problem Description**

      The objective of our final project is to have a car follow a light source and avoid collisions.

   b. **Design Concept**

      The car will be able to follow a light source by using photocells and inverting a schmitt trigger in order to create varying pwm signals to control the speed of each wheel. Each motor will need its own photocell in order for the wheels to have different pwm signals to allow the car to turn.

      The car will be able to avoid collisions by using an HC-SRO4 sensor powered by an arduino. If an object is 10 cm or further, the arduino will output 5V. If an object is closer than 10 cm, the arduino will output 0V. This output will be connected to logic pins 1A and 1B of the H bridge. This signal will then be inverted and connected to the respective logic pins 2 so that the car will always either be moving forwards and backwards and never stopped. This will allow the car to continuously reverse and avoid collision until it is 15 cm away from any possible collision.

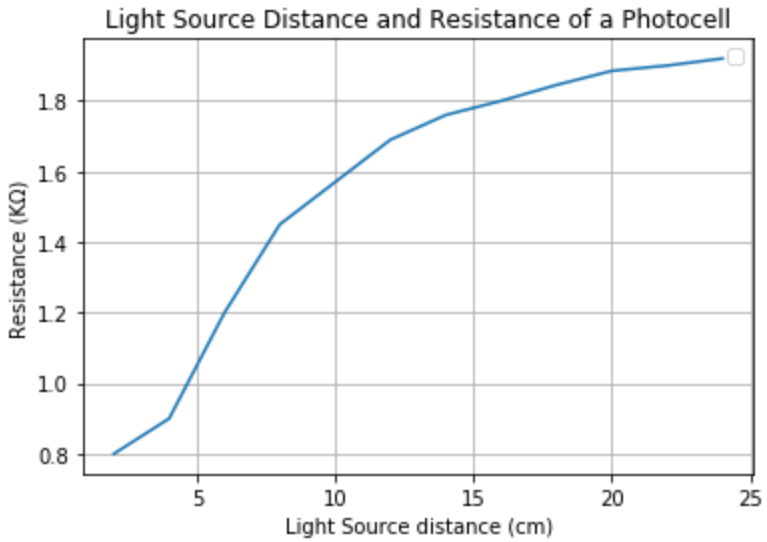
      The combination of the components will result in a car that will follow a light source when there are no nearby possible collisions. When there is an obstacle in front of the HC-SRO4 sensor, the car will be put in reverse until the object is 10 cm away. If the object continuously approaches the car, the car will continually reverse. When the car is in reverse, the car will turn away from the light source.

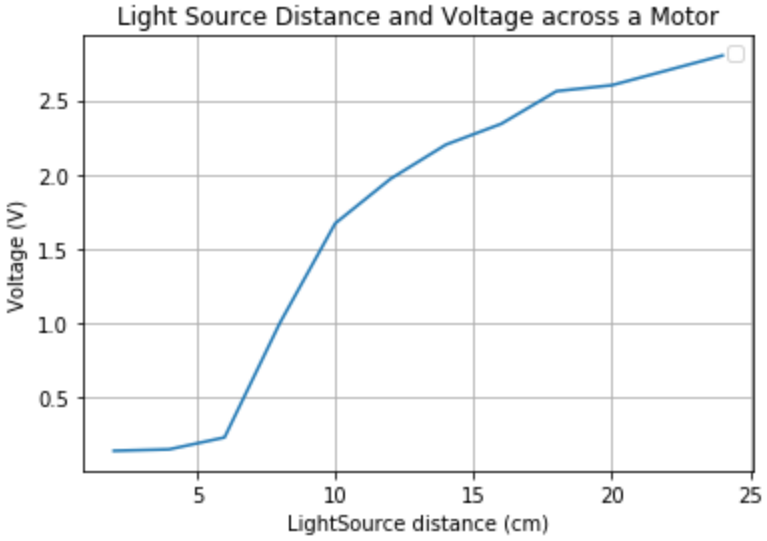
2. **Analysis of Components**
   a. **Characterization of each sensor**

      Photocell

Light source (distance, cm)	Resistance (KΩ)	Voltage (V)
none	2.04	2.95
2	.8	.140
4	.9	.150
6	1.2	.230
8	1.45	1

10	1.57	1.67
12	1.69	1.97
14	1.76	2.2
16	1.8	2.34
18	1.845	2.56
20	1.885	2.6
22	1.9	2.7
24	1.92	2.8

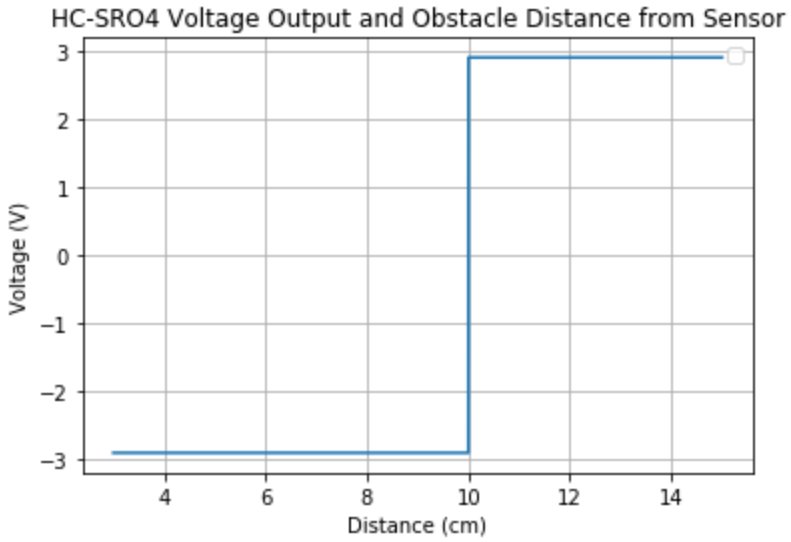




The closer the light source, the more light is captured by the photocell, so there is less resistance when more light is captured. Because the signal is inverted, the motor has a smaller voltage drop when light is nearby. In addition, the results will vary depending on the natural lighting of the room.

HC-SRO4

Distance (cm)	Voltage (V)
3	-2.9
5	-2.9
7	-2.9
9	-2.9
11	2.9
13	2.9
15	2.9



The output switches from negative to positive after the 10 cm marker signifying the motor is in reverse before 10 cm.

b. Design Considerations

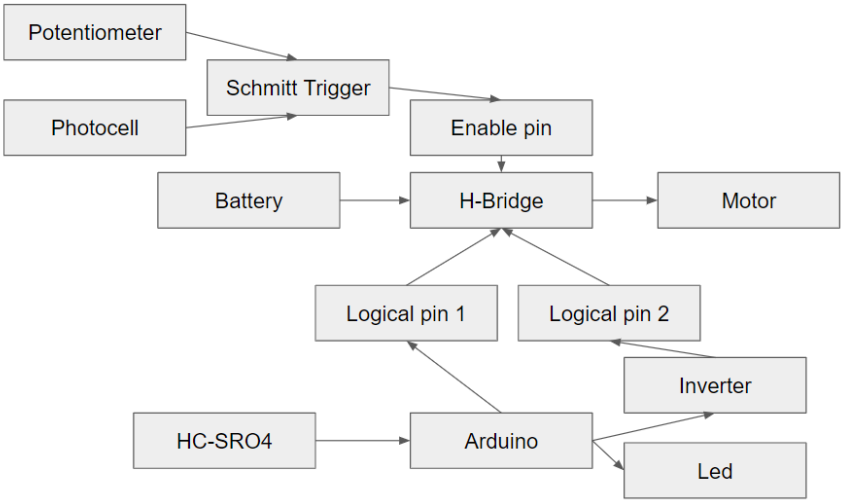
We first tried to place the photocells in series with the motor but this resulted in the motor not running at all. This was due to too much power being distributed across the photocell. To solve this, we had to implement the photocells into

schmitt triggers to create pwm waveforms and feed it into the enable pins of an H-bridge in order to change the speed of each wheel individually.

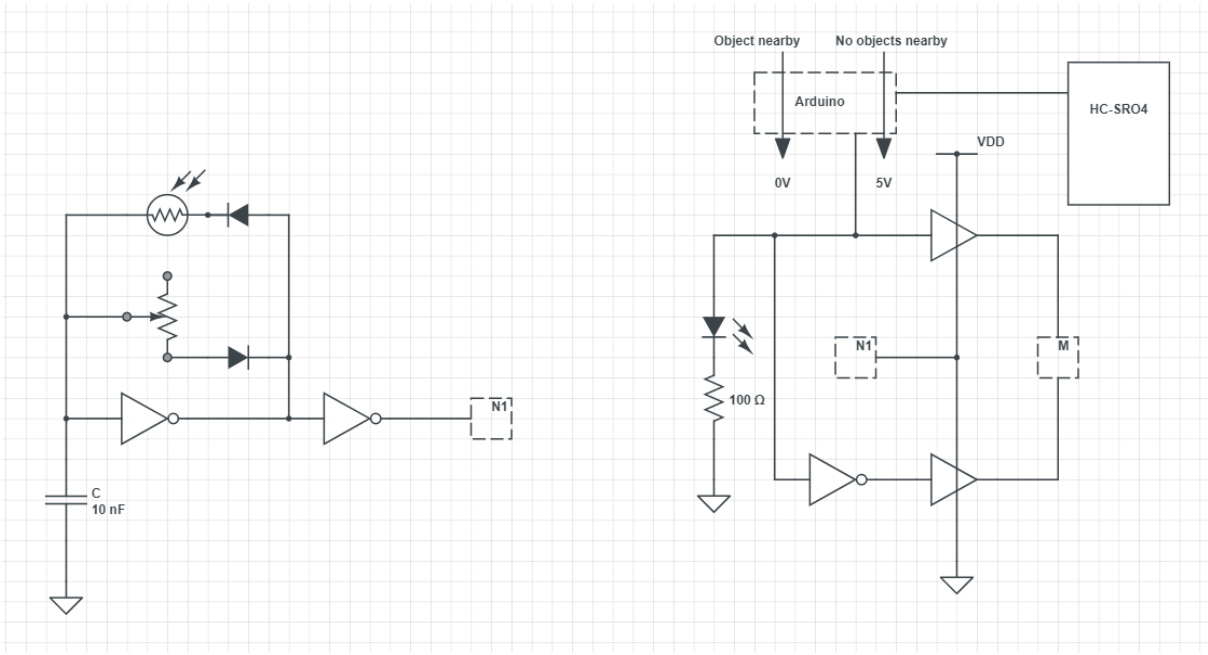
Since the HC-SRO4 sensor is unable to discern the difference between wires and obstacles, the sensor couldn't have any wires in front of it. The HC-SRO4 sensor had to be placed at the front of the vehicle.

3. Design Description

a. Block Diagram



b. Circuit Schematics



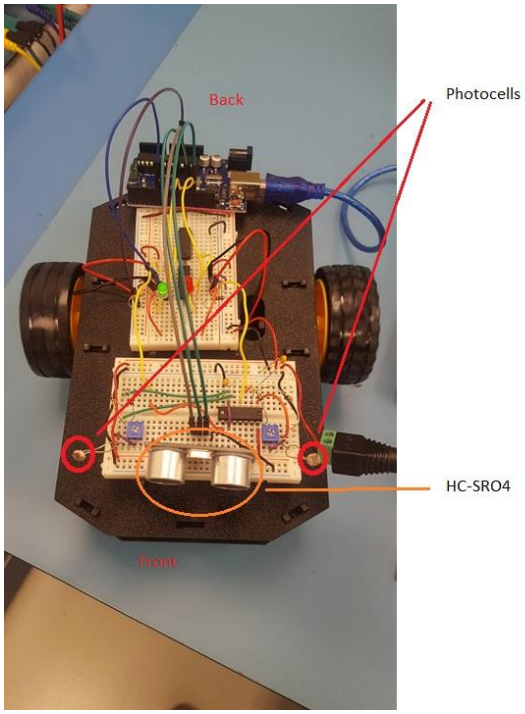
This represents the schematic for one wheel. The two nodes, N1, are the same node. The square with the letter M signifies a motor. The schematic on the right contains the simplified schematic for an H-Bridge found on the Texas Instruments data sheet.

c. Arduino usage

The arduino is used to control the trigger and echo pins of the ultrasonic sensor as well as provide 5V to the H bridge and ultrasonic sensor. The control of the trigger and echo pins could have been replaced with oscillator circuit using the proper capacitor to get 50 Hz input into the trigger pin of the ultrasonic sensor. The echo pin would then be connected to the first motor logical pins instead of back into the arduino. We would have taken this approach if we had more time to create the proper timing of the oscillator circuit.

The 5V also could have also have been created without the arduino by using a LM7805 voltage regulator connected to the battery to decrease the voltage down to 5V to run the H bridge and ultrasonic sensor.

d. Physical/Mechanical construction



The two photocells are placed at the front of the car on either sides in order to detect light pointed at each respective side of the car. Each photocell is connected to their respective motor. In order to change the car speed. If these sensors were not placed at the front, the car wouldn't be able to follow a light source as easily as the sensors would then be further away from the light, which would diminish the effect of the light.

The HC-SRO4 sensor is placed at the front of the car to detect any possible collisions. If placed in the back of the car, the other components of the circuit would obstruct the HC-SRO4 from detecting any objects it may be approaching.

By putting this sensor in the front, it is able to easily detect objects in front of the car.

4. **Conclusion**
    a. **Lessons Learned**

While we had a clear idea of how the car will receive information and react, such as follow a light source and avoid collision, our ideas of how to solve these problems changed throughout the process. We had drawn out our original schematic plans and realized it didn't work. So as our progress progressed, the schematic changed frequently. The reason we had to continually change our schematic is that each component has limitations that we didn't take into account. For example, we thought we could just place a resistor in series with a motor to slow it down. However, we realized that too much power would go through the resistor and thus the schematic wouldn't work and we would need a new plan.

    b. **Self-Assessment**

Overall, the car satisfies the fundamental plan introduced in the introduction. It turns to follow a light source and avoids collision by reversing. While the car does extremely well with an approaching obstacle, it doesn't do well with a stationary obstacle. With an approaching obstacle, the car will continuously back up into the obstacle is removed. However, with a stationary obstacle that isn't removed, the car will continuously reverse until it is out of range, and then drive straight forward until the obstacle is in range again, leaving the car stuck in a forward, backwards movement loop.

Another thing we could have done was make the entire circuit without the arduino. However, we couldn't get the oscillator circuit to work properly with the ultrasonic sensor so we ended up using the arduino to control the trigger and echo pins of the ultrasonic sensor.

5. **Video link:**

https://youtu.be/7QhJfFApBa0