The Phototropic Robot

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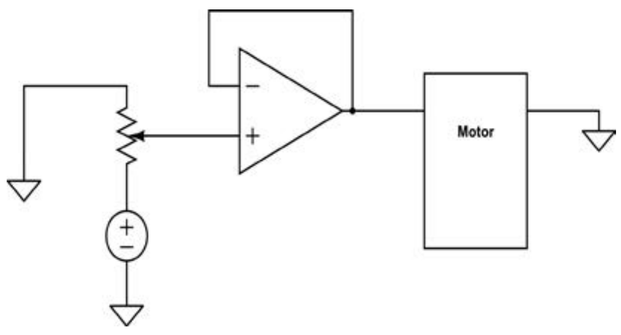
The goal of this project was to create a robot that will follow a black line on the ground. In order to do this, we incorporated photoresistors, feedback circuits, adjustable resistances, and motors. The robot follows a line by turning left when it sees light, and turning right when it doesn't. The robot was able to follow a black line drawn on the ground as long as the line had a radius that was greater than the turning radius of the robot.

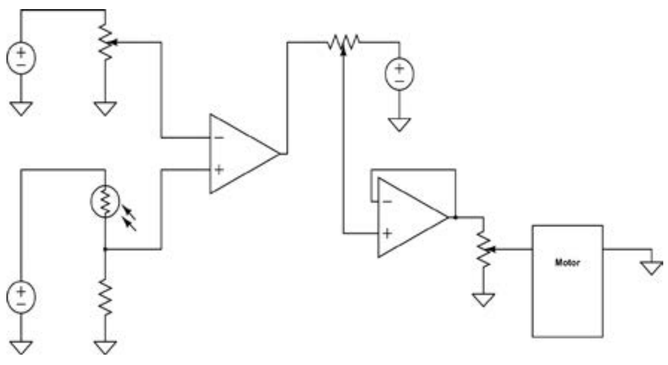
Circuit Schematics

Left Motor



The circuit that drives the left motor is simply a voltage divider, connected through a buffer to the motor. By adjusting the potentiometer, we can cause the wheel to turn at any speed we choose.

Right Motor



Photoresistor

The right motor incorporates feedback from the photoresistor. The photoresistor changes resistance depending upon the amount of light that it recieves. Put in series with a fixed resistance, it creates a voltage divider that changes voltage depending upon whether the photoresistor "sees" dark or light.

Operational Amplifier

The operational amplifier, or op-amp, acts as a comparator. If the plus input is greater than the minus input, the op-amp outputs 9V, and if the minus input is greater than the plus input, the op-amp outputs -9V.

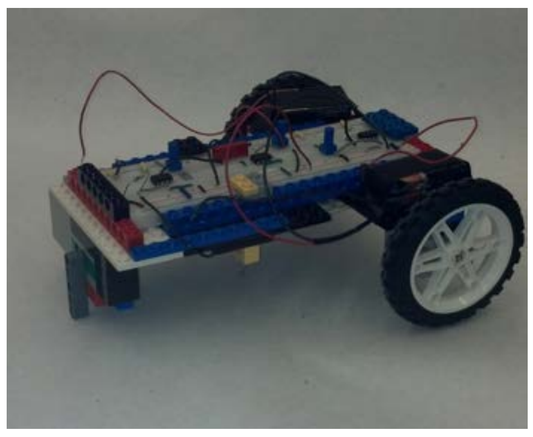
Output Buffering

Although the op-amp only can output 9V or -9V, we want the circuit to create a larger magnitude of positive voltage across the motor than we want for the magnitude of the negative voltage. We want this because we want the net effect to be for the robot to move forward. We created a voltage divider between the output of the op-amp and 9V. This forces the positive output to be 9V, and we can choose any value for the negative output by adjusting the potentiometer.

Voltage Divider and Op-Amp Operation

As inputs to the op-amp, we put the photoresistor subcircuit, and another set voltage divider. By using another voltage divider, we could set the threshold voltage where the op-amp output switches. When the photoresistor sees light, it causes the plus input to be greater than the minus. This causes the wheel to turn forward quickly. When the photoresistor sees dark, the plus input is less than the minus, and this causes the wheel to turn at any value we choose. We chose to make the wheel turn backwards slowly.

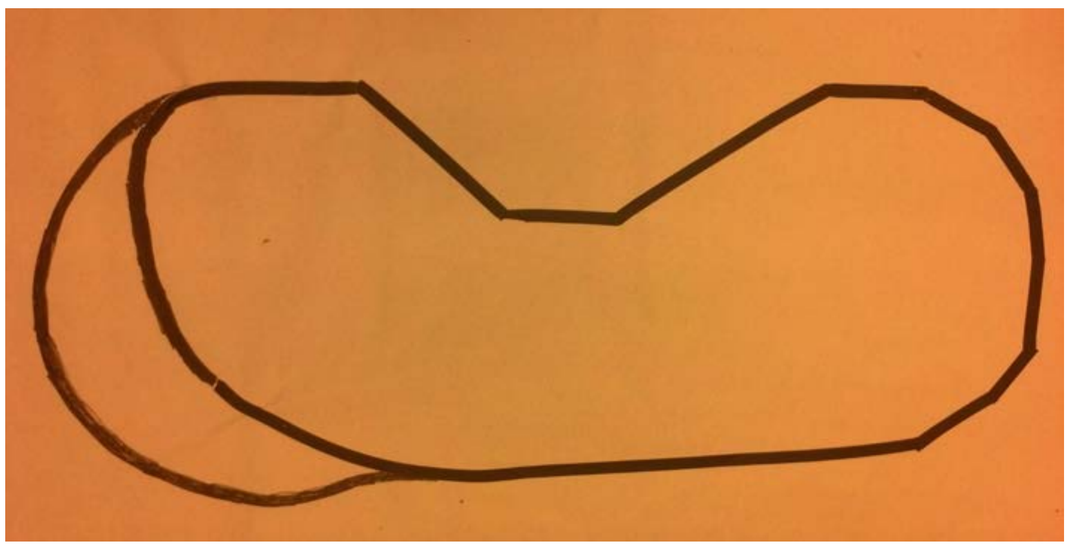
The Robot



Mechanical Design

Our robot was constructed from Legos and our circuit. Due to material shortages we had very few wheels to work with. We took advantage of Legos being nearly firctionless to make a support that would hold up the robot, but also slide easily on the ground so the robot would still be able to turn as one side of the motor spins faster. The construction materials are entierely Lego. The photoresistor is mounted under the center of the robot with a Lego bracket.

The Track



This is the track on which we tested the robot. It was able to follow the line for minutes without making a mistake.

Line-Following Behavior

When over a light surface the output of the right motor will be greater than the left motor causing the robot to turn to the left. When over a dark surface the right motor is spinning backwards and the left motor is spinning forward, this causes a sharp turn to the right. The robot slowly turns to the left searching for a line, when it nds a line it sharply turns back to the right until the photo-resistor is over a light surface. This starts the cycle over again, and the robot diagonally 'climbs' around the line.

Conclusion

Our robot works very well. It can follow most curves; we could improve this ability by increasing its turning radius. To do this the right wheel must spin faster relative to left wheel when the photo-resistor is over a light surface. However, with this change comes a tradeoff in how fast the robot will actually travel along a line. This is because the angle of travel relative to the line it is following becomes much sharper.