B37VB - Edinburgh - Robotics - Group 6 - Final Report

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Introduction

This report will present the development of our light-following robot, focusing on both its software and hardware capabilities. A robotic buggy, wires, resistors and Light Dependent Resistors for light following were supplied. These were used to implement the circuitry needed for the robot to function. And once that was completed frequent and careful characterisation of system elements was undertaken throughout development in order to ensure best performance. The robot buggy itself was already connected up to an Arduino UNO board which had all the required parts for this experiment to run as smoothly as possible.

Theory of Operation

LDR Circuit

LDR stands for Light Dependent Resistor. An LDR circuit in a light-following robot serves as the means for the robot to sense and respond to variations in light intensity in its environment. When the robot senses more light than normal on a certain side its resistance levels change and that changes the robot depending on what its code directs it to do, in our case that would be turning towards the direction of the light. By leveraging the properties of the LDR and incorporating it into the control system, the robot can effectively navigate towards light sources.

PWM Motor Control

PWM stands for Pulse Width Modulation and it's a type of signal in the moving robot that is fundamental to controlling the speed and direction of its motors efficiently. PWM works by rapidly switching a signal on and off at a fixed frequency. The proportion of time the signal is on compared to the total cycle time determines the effective voltage or power applied to the motor, meaning the higher the PWM the faster the motor. In the context of our moving robot, PWM signals were used to control the rotational speed of the motors.

Light-Tracking Algorithm

Each LDR is connected by the circuit to one of the pins on the Arduino Uno board (specifically A1 is connected to the left LDR and A2 is connected to the right LDR).

Upon starting the light tracking algorithm declares integer variables ‘LeftLDR’ and ‘RightLDR’. It then gets the values from A1 and A2 which are the pins receiving the output from the LDRs and assigns these values to the appropriate integer variable.

The difference in magnitude (DoM) between the LDRs is then calculated and the result is compared with a pre-assigned threshold value (which in this case was 100) to decide what the robot does.

If the DoM is higher than the threshold then the value of the left LDR is checked against the value of the right LDR, if the left value is greater than the right value, then the PWM of the left motor is lowered temporarily and then reset so that the robot turns left. If the right LDR value is higher than the left then the PWM value of the right motor is lowered temporarily and then reset so that the robot turns right.

If however, the DoM is lower than the threshold, the algorithm checks if the minimum values being received from the left and right LDRs are higher than a preset threshold (in this case 800), and if they are, the algorithm stops the robot by setting the PWM values of both motors to 0. If they are not higher than this threshold then the PWM values of the robot's motors are set to default values (in this case Left 115, Right 96) and it drives straight forward.

Results

The objectives of this project were to build/program a small autonomous robot to move and follow light accordingly and test its functionality. We found that one of our two motors was naturally faster than the other, thus when it came to attempting to make the robot move in a straight line we had to take into account that one side's initial PWM value would have to be greater than the other. It's also worth noting that when we changed the robots initial PWM values to test it at different speeds, its values did not change consistently, meaning if we increased both values by 20 it would no longer move in a straight line. Although this was an issue that was relatively easily handled.

We also figured out that when the robot's initial PWM values were low there was an external problem when booting up the robot, although the values may have been set correctly to move the robot in a straight line, one of the wheels would start late or not at all until it was manually moved by one of us (more on this in the next section).

The robot had no problems with light following it would turn when we shone a light on one side of the robot (one of the LDR's) and would stop turning when its light levels returned to neutral, resulting in the robot going back to straight forward moving.

Conclusion and Lessons Learned

One lesson we learned was referenced in the “results” section of this report which was that if our PWM values were too low one of our wheels wouldn't start which can be explained through “static resistance”. Every motor has a certain amount of static resistance, which refers to the resistance encountered by a motor internally when not in motion. When the PWM value sent to the motor is too low, the voltage applied to the motor is too low to overcome the static resistance and the wheel may not have enough power to start motion which is exactly what our robot fell accustomed to at low PWM values.

To conclude, a robotic buggy capable of light following was successfully developed over the course of the past 6 weeks. The best possible performance was ensured through careful characterisation of each of the system elements of the buggy, namely the motors and LDRs. The light-tracking algorithm which uses the LDRs to control the motors allows the buggy to reliably follow a shined light. The previously mentioned slower right wheel due to a lack of sufficient power was overcome in terms of driving straight forward. However, it was later noticed (shortly after the final presentation) that the robot turned right slightly slower than it turned left. This could possibly be explained by the static resistance of the motors and the wheels they are powering.

Continuing on from here one possible improvement could be better characterisation of the turning PWM values for the motors to ensure more even turning speed.