ECE-2002 ANALOG ELECTRONIC CIRCUITS

J-COMPONENT PROJECT FINAL REPORT

Prof. SANJAY R

LIGHT FOLLOWING ROBOT USING OpAmps and LDRs

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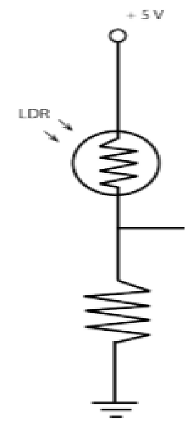
INTRODUCTION

Self-driving cars are no longer just a surrealistic theory. In media you can follow the development of self-driving cars that soon will be put on the road in Sweden for testing purposes by Volvo. Companies like BMW, Mercedes and Tesla have developed self-driving features that are soon to be released on the market with ambition to make fully autonomous vehicles. Google has since 2009 worked with their self-driving car project and are right now testing prototype vehicles on the road .A self-driving car can be defined as a vehicle with features that can make it accelerate, brake or steer with no human input. It requires a great number of different sensors as gyros, radars, GPS, tachymeters etc. and advanced software to make it self-driven. One of the main purposes of a self-driving car is to make the road safer and facilitate daily life for commuting people. Every year approximately 1.2 million people dies in traffic accidents, which 94% are caused by human errors, a figure which could be decreased greatly with use of self-driving technology.For this project a fully autonomous car would be too complicated to build, even in a smaller scale. On the other hand, a smaller amount of sensors could be used for other types of autonomous vehicles, with a mission that is simpler to predict. In working environments not optimal for humans, like in mines, it could be possible to develop a much simpler autonomous vehicle which could for example follow light in a dark tunnel. In an airport, a simpler self-driving vehicle could be used to tow airplane when taxing on the airport following light and colors on the ground to steer its way on the field.

So in this project we will be designing an simple Light following robot using basic components which can later be scaled up to and higher version according to the requirements.

PRINCIPLE



An autonomous robot called light following robot is capable of detecting and following the light source on the traveling path. The light following robot includes two photodiodes, one on the right and other on the left. When the light falls on the right photodiode, the robot will move on the right side. Similarly, the robot will move on the left side when the light falls on the left photodiode. The robot is controlled by a feedback mechanism.

A Light Following Robot is an electro-mechanical device with an added intelligence .It decides the path to follow according to the light that falls on it. In this project we have designed a robot wherein the amount of light falling on it will be detected by a Light Dependent Resistor (LDR) sensor. Whenever light falls on it, its resistance value decreases depending on the intensity of that light. A light dependent resistor, also called LDR, changes its resistive value depending on the incident light intensity. The resistance will decrease with increasing light intensity and vice versa. To be able to calculate the resistance of the sensors, another resistor need to be added. It can be done by either a pull-down or a pull-up resistor. Using a pull-down resistor, the resistor is connected to the ground as illustrated in figure below. A pull-up resistor works in the same way but the resistor is instead connected to its voltage source. This phenomenon, to connect a LDR in series with a resistor gives a circuit called voltage divider.

When the resistance of the light is decreasing the total resistance of the LDR and the pulldown resistor will decrease, in turn the current flow through both the resistances increases which leads to an increase of the voltage across the fixed resistor. Once the output of the voltage divider is known, the resistance of the sensor can be calculated using equation

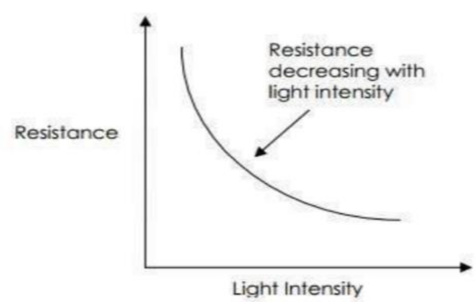


Figure 6: LDR Graph

$$V_{out} = V_{in}\frac{R_2}{R_1 + R_2}$$

where V_{OUT} is the output voltage, V_{IN} is the input voltage, R_2 the resistor and R_1 the photo resistor’s resistance

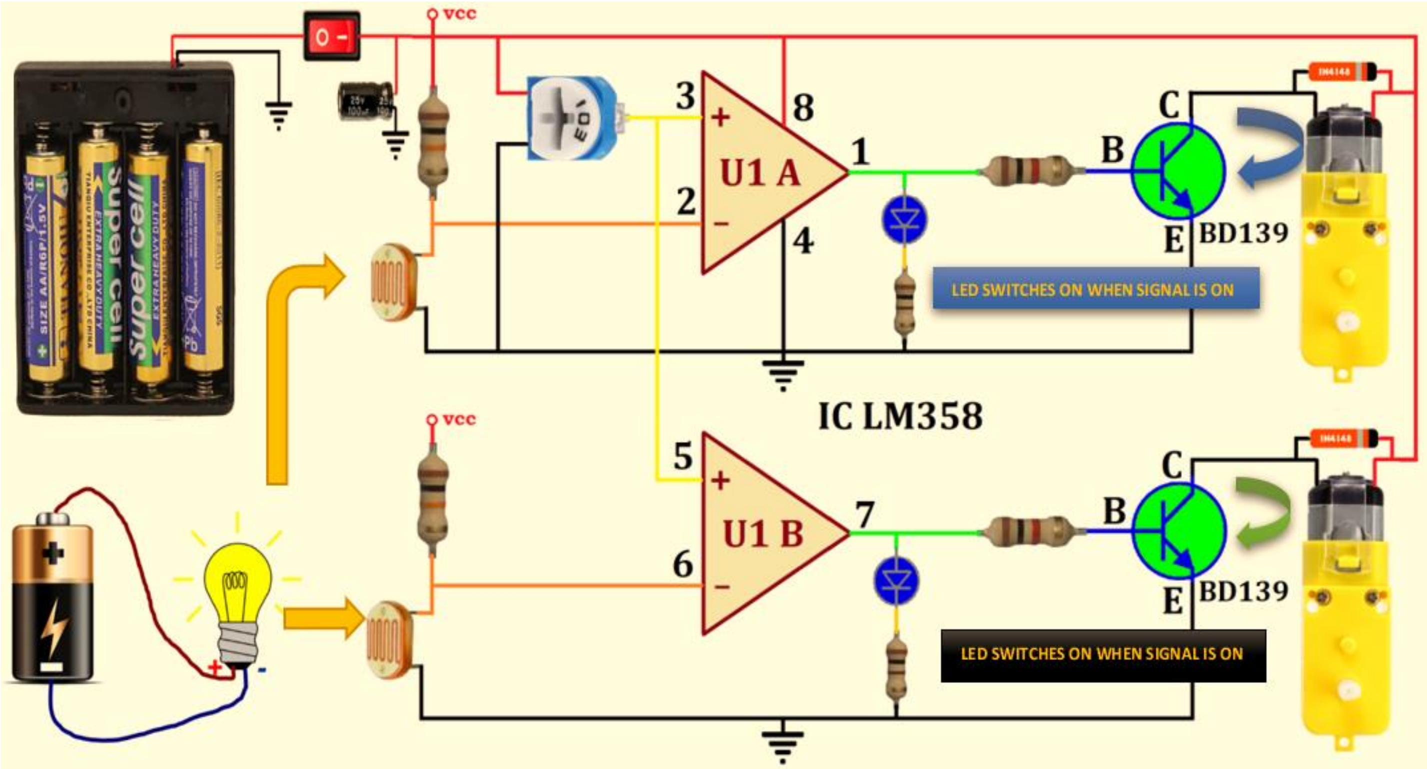
MATERIALS REQUIRED:

S.NO.	COMPONENTS:	USE OF THE COMPONENT:
1.	LIGHT DEPENDENT RESISTOR-LDRs	A light controlled resistor whose resistance decreases with decrease in incident light intensity.
2.	DC VOLTAGE SOURCE	Used to power the complete robot
3.	RESISTORS	It helps in controlling the speed of the motors
4.	OP-AMP TRANSISTOR-LM358	Here used as voltage comparator. It's output is provided to the transistor
5.	DC MOTORS	Used to drive the wheels and helps in movement.
6.	TRANSISTORS -BD139	Used for the switching purpose of driving motors
7.	DIODES-1N4148	To block the effect of back EMF in driving motor
8.	LED -BLUE	Helps to notify the falling of light on the photodiode and indicates which motor is in ON mode
9.	INTERACTIVE POTENTIOMETER	An variable resistor which helps in determining both position and direction of rotation
10.	LIGHT SOURCE	Used as input Light source
11.	CONNECTING WIRES AND GROUND TERMINAL	To make proper connections

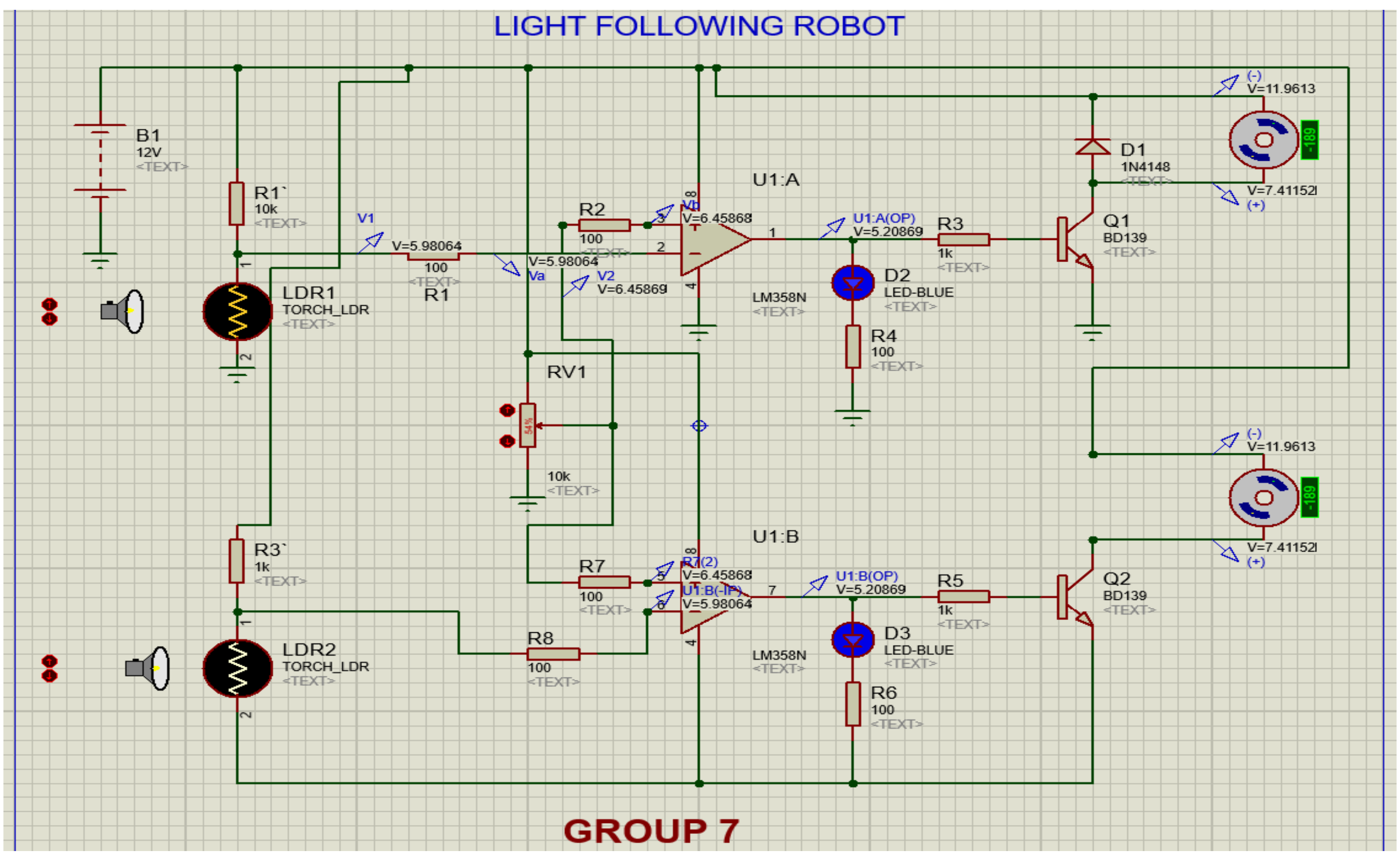
- **We have used PROTEUS 8 PROFESSIONAL for designing of light following robot.**

CIRCUIT DIAGRAMS

- **CIRCUIT WITH HARDWARE COMPONENTS**



- **CIRCUIT SIMULATED IN PROTEUS 8 PROFESSIONAL**

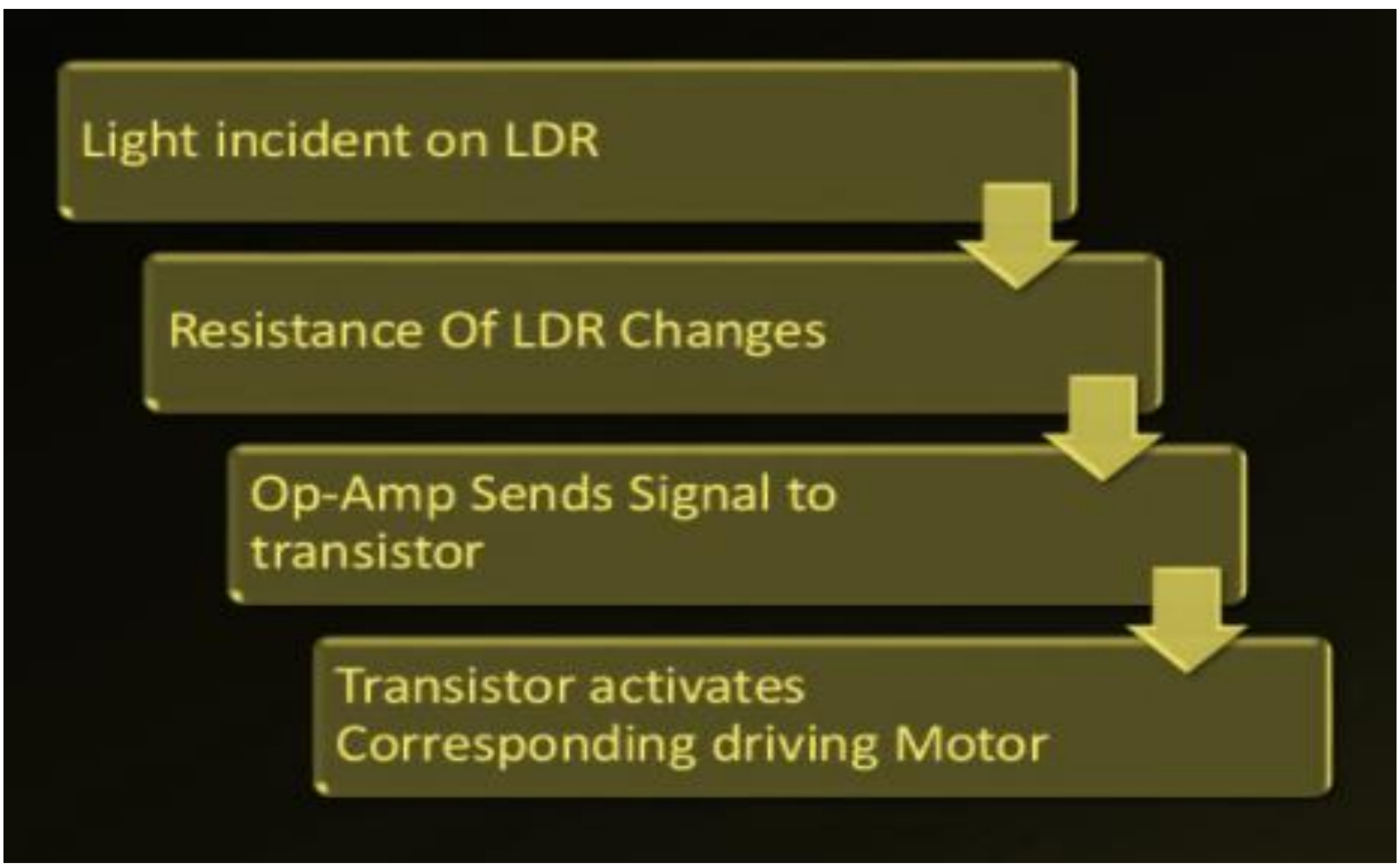


WORKING:

This is an circuit which senses the amount of light falling on the LDRs (LIGHT DEPENDENT RESISTOR) and helps in the functioning of the TWO DC motors attached at the right side of the circuit.This circuit helps in controlling the speed and direction of the robot when this circuit is further attached along with the wheels.

This circuit basically consists of LM358 Operational Amplifier attached to an LDR and along with the BD139 NPN transistor (for motor switching).An LED light along with 4148 diode is also used for the indication that the light of sufficient intensity is falling on the LDR.This configurations are repeated twice for separate operation of each motors.There is also an 10k variable resistor attached in the circuit to control the sensitivity of light falling on the LDRs(MORE SENSITIVITY --THE FASTER THE MOTORS ROTATE).Whenever the light falling on the LDRs is more then the setbands in the OP-AMP then it further sends an signal to the NPN transistor for motor switching.Each LDR controls one of the DC motors—the LDR with more intensity of lights rotates at higher rate and hence determining the direction of the Robot movement

FLOWCHART:



CALCULATIONS:

→ Calculations :-

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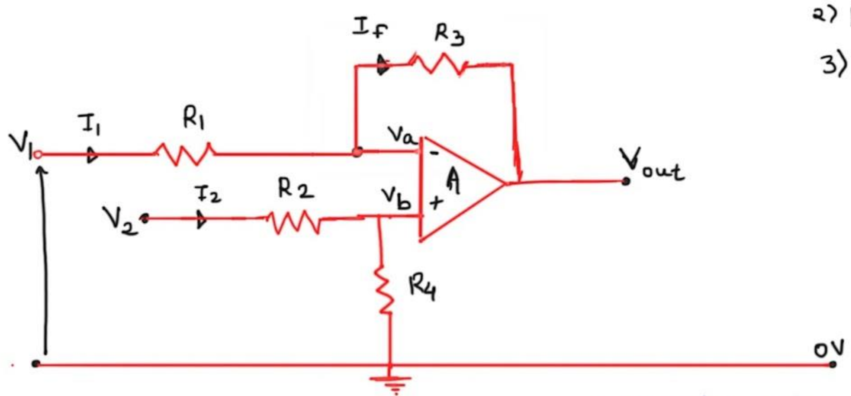
3) Vinyas Shetty.



→ Finding Transfer function,

$I_1 = \frac{V_1 - V_a}{R_1}$, $I_2 = \frac{V_2 - V_b}{R_2}$, $I_f = \frac{V_a - (V_{out})}{R_3}$

Summing point → $V_a = V_b$

and $V_b = V_2 \left[\frac{R_4}{R_2 + R_4}\right]$

If $V_2 = 0$, then → $V_{out(a)} = -V_1 \left[\frac{R_3}{R_1}\right]$

If $V_1 = 0$, then → $V_{out(b)} = V_2 \left[\frac{R_4}{R_2 + R_4}\right] \left[\frac{R_1 + R_3}{R_1}\right]$

→ $V_{out} = V_{out(a)} + V_{out(b)}$

$\therefore V_{out} = -V_1 \left[\frac{R_3}{R_1}\right] + V_2 \left[\frac{R_4}{R_2 + R_4}\right] \left[\frac{R_1 + R_3}{R_1}\right]$

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Now,
According to the circuit diagram, we need to find the transfer function.
Since, in the followed circuit diagram, $R_1 = R_2$.
So, the transfer function will be:-

$$\boxed{V_{out} = \frac{R_3}{R_1}(V_2 - V_1)}$$ - - - - - - - - - Transfer function.

→ Calculations:- $R_3 = 1000\Omega$ $R_2 = 100\,\Omega$ $V_2 = 6.45\,V$ $V_1 = 5.98\,V$ → [∵ from proteus simulation]

$\therefore V_{out} = \frac{10\cancel{00}}{1\cancel{00}} \times (6.45 - 5.98) = 10 \times 0.47 = \underline{\underline{4.7}}$

$V_{out} = 4.7V$ - - - - - - - → [∵ Across motor in simulation]

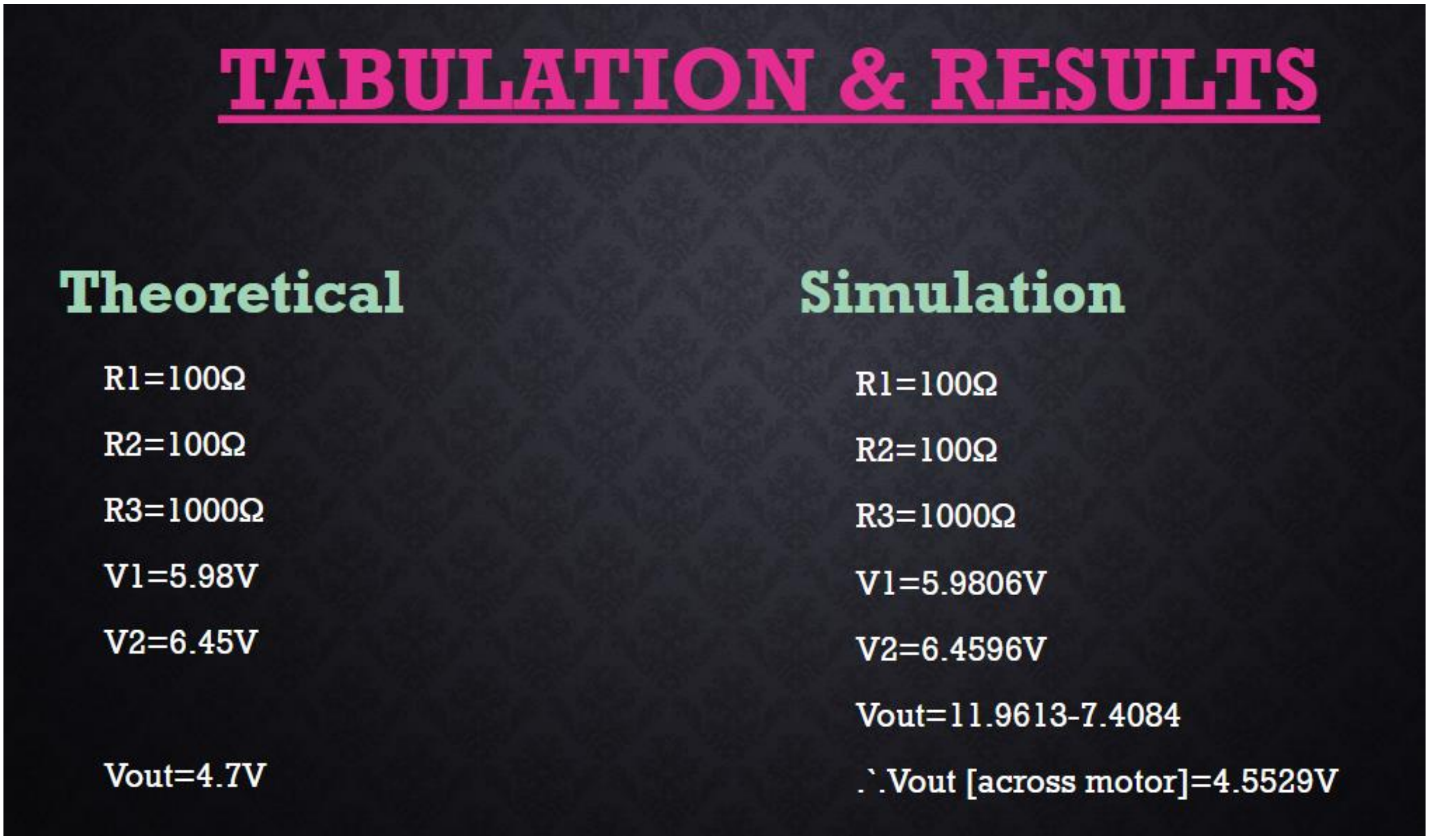
APPLICATIONS

- Automatic Street lights follower.
- Alarm devices in security purpose
- This technology can also be used to measure light intensity for applications that require greater precision.
- A simpler self-driving vehicle could be used to tow airplane when taxing on the airport following light and colors on the ground to steer its way on the field
- Cameras can use this technology to determine the proper exposure time
- Laptop may use in a circuit that varies screen brightness according to ambient lighting conditions

FUTUREWORK AND FUTURE SCOPE OF LIGHT FOLLOWING ROBOT:

The demonstrator and the control system can be improved in a lot of aspects. A construction of a tracking robot using only light is possible, but as described earlier certain limits are required. To construct a complete tracking robot, the demonstrator need to be equipped with more sensors and further developed software to work correctly. Implementing an ultrasonic sensor or infra-red sensor could be a solution to the problem. The demonstrator should also to be equipped with a start and stop system. In addition, it could be interesting to further develop the ability to regulate the speed of the vehicle. The demonstrator could also be developed with an IPS system for indoor use or GPS for outdoor use, depending on its purpose. With help of that system the robot could scan the light intensity of a defined area and position its way back to the brightest spot of the scanned area. It's an idea that could be used for a self-driving mower, charged with for example solar cells. Instead of needing a human input to carry the mower to its charging station, the mower could on its own find the sun and charge itself using solar cells. To use this kind of tracking robot in environments, not optional for humans, such as mines or airports would also require more sensors. For the use in a mine a mapping system and a local navigation system will be needed. To use it on an airport a better safety system is needed, Automatic identification system, which is a system to see others with AIS systems, and a sensing system for a fixed reference in the ground. A reference system in the ground will give the robot positioning help and a lighted line will give exact precision. The concept with red and green color sensing can also be used in shipping lanes for navigation of autonomous ships and boats.

RESULT/INFERENCE:



So we could observe that 12 Volt battery was able to power the circuit and send signals to transistor for motor-switching thorough Op-Amps. We also observed that resistors in the circuit provide enough reluctance from high speed rotation of the DC motors. We also observed that the Voltage output we were getting theoretically and through simulation are approximately the same.

CONCLUSION:

The possibility to control a robot by using only light may not be the most accurate way. It is not impossible to follow a track but it is surrounded by certain limitations. It is achievable if the robot is supposed to follow a certain light as a flashlight or a light trail, but the ability to let the robot freely drive in a normally lit room and seek after the brightest light source is unattainable without adding other sensors to avoid obstacles. Although it is not the best possible way to construct a tracking robot, a conclusion could still be drawn based on the information determined during this project.To sum this up, using light sensing for a tracking robot are an easy and inexpensive method, but should be used as a complement to other sensing devices not as a stand alone method.

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