UNIVERSITY OF NOTTINGHAM

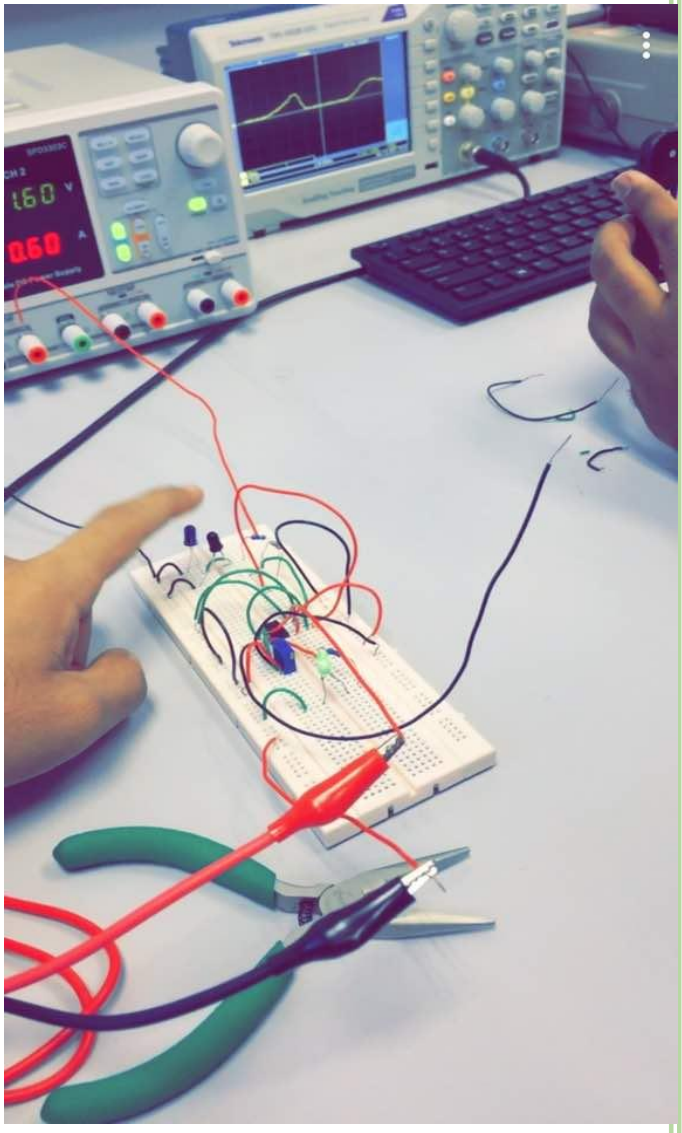
ELECRICAL AND ELECTRONICS

DEPARTMENT.

2017

Introduction to IR Sensors

Applied Mechatronics Construction Project-1031



Vigneshwaren Sunder

20021065

11/29/2017

1.0. INTRODUCTION:

1.1. About the IR Sensor:

An Infrared sensor is an electronic device, that emits in order to sense some aspects of the surrounding. An IR sensor is also capable of sensing the heat and motion of an object. These types of sensors measure only infrared radiation, rather than emitting it that is called passive IR sensors. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiations which are invisible. These invisible radiations can be detected by an infrared sensor. The main objective of this report is to give a broad understanding and knowledge about how IR sensor circuit works and its applications and to provide information about the IR sensors that we used in our project week two. The main task of this project week is to build an IR sensor circuit and test the output in an oscilloscope and observe them.

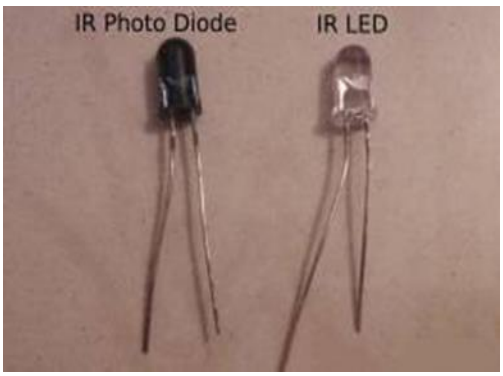


Fig: 1.1 IR SENSORS

1.2. TYPES OF IR SENSORS:

There are 2 types of IR sensors based on its functions.

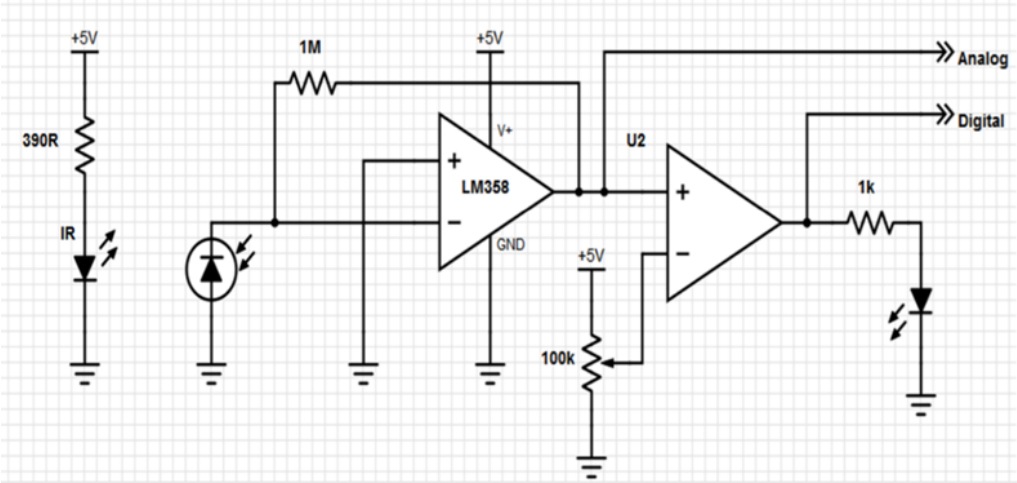
- Thermal Infrared sensor
- Quantum Infrared sensor

They can be also classified into 2 more categories based on their mechanism.

- Active Infrared Sensors
- Passive Infrared Sensors

In our project, we used an active infrared sensor which emits thermal radiations. Let's discuss the working and characteristics of this sensor below.

2.0. IR SENSOR CIRCUIT:



2.1. The circuit comprises of the following components:

- IR emitter and IR receiver
- LM358 operational amplifier
- Variable resistor 100k (potentiometer)
- LED
- Analog and Digital output connected to an oscilloscope.

2.2. Working of IR sensor circuit:

In this circuit, the transmitter part consists of IR emitter which emits infrared radiations continuously which is received by a photodiode. This light is not visible to naked eyes but can be seen by a camera. The photodiode is capable of converting IR light into either current or voltage. When the light emitted by the IR LED is incident on the photodiode after hitting an

object, the resistance of the photodiode falls down from a huge value. One of the inputs of the op–amp is at threshold value set by the potentiometer. When the incident radiation is more on the photodiode, the voltage drop across the series resistor will be high. In the op-amp, both the threshold voltage and the voltage across the series resistor are compared. If the voltage across the photodiode is greater than that of the threshold voltage, the output of the IC Op – Amp is high. As the output of the comparator is connected to an LED, it lightens up. The threshold voltage can be adjusted by adjusting the potentiometer depending on the environmental conditions.

2.3. Why the use of LM358 op-amp?

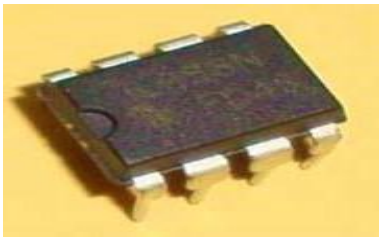


Fig:1.2. LM358 op-amp

In this circuit, we used NPN LM-358 op-amp. It amplifies the low-intensity sensor signal and provides it to the input of the comparator to sense the change in resistance or voltage we used in voltage divider circuit. Thus, we get the variation of the voltage which is sensed by the comparator.

2.4. Use of voltage divider circuit:

A **voltage divider** is a simple circuit which turns a large voltage into a smaller one. Using just two series resistors and an input voltage, we can create an output voltage that is a fraction of the input. Voltage dividers are one of the most fundamental circuits in electronics. A potentiometer is a variable resistor which can be used to create an adjustable voltage divider.

2.5. Use of Comparator in IR sensor:

A comparator is an operational amplifier or a device which compares the 2 input voltages and gives the output as either high or low. In the above circuit, one voltage input is from the photo-diode and the other is generated by using a potentiometer. The second voltage is also called as the reference voltage for that sensor. We can vary the reference voltage by using the potentiometer. The reference voltage should be the mean voltage value of the sensor inputs measured with and without lights. If we connect Inverting Input of Comparator to the potentiometer and Non-Inverting Input to photo-receiver, the only difference observed is that the output will be high when the resistance of the photodiode is high.

2.6. Placement of IR Sensor:

Both the IR LED and Photodiode are placed in parallel, facing both in the same direction. Therefore, when an object is kept in front of the IR pair, the IR light gets reflected by the object and gets received by the photodiode. Make sure that the object should not be black in colour, as black coloured objects absorb IR light and does not reflect. In order to avoid reflection from the surrounding objects other than the object placed in front, the sensors are enclosed properly by plastic tape which is painted black in colour.

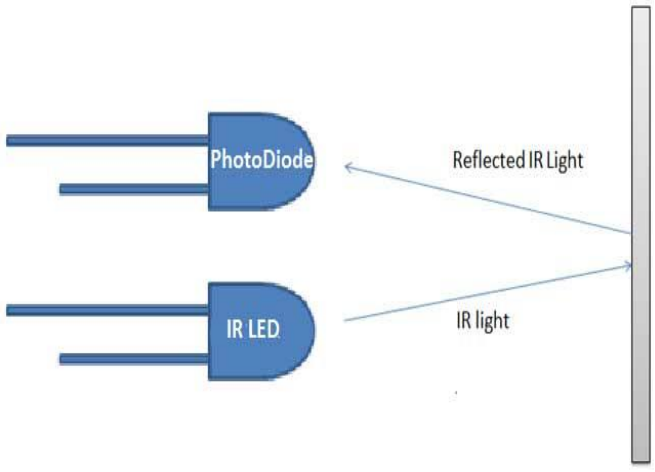


Fig: 1.3. IR Sensor Placement

The Fig. 1.3. shows the exact position of the sensor placed, and how the IR light gets reflected in the presence of an object in front of them.

3.0. RESULTS:

3.1. Analysis of the output using oscilloscope:

The output of the IR sensors can be seen in both analog and digital forms on an oscilloscope. Analog signals are the continuously varying signals within a given range of voltage. Microprocessors and microcontrollers are not capable of reading analog signals directly, hence we converted the analog signals to digital signal in the circuit given above for a better result. In the Fig: 1.4., the sinusoidal waves gives the analog signal output, and the square waves give the digital signal output. We can see that the output is high when the photodiode receives IR radiations.

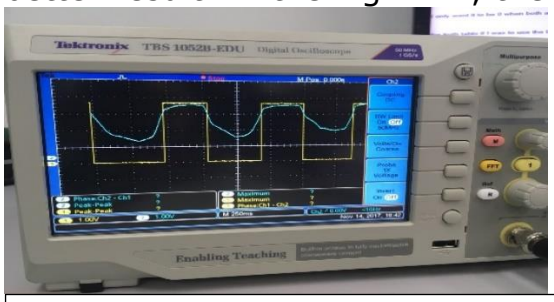
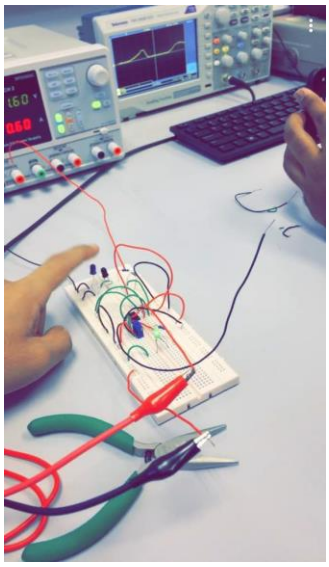


Fig: 1.4. Output on Oscilloscope

3.2. Discussions:



The IR sensor circuit is first constructed on a breadboard. It is then tested, and the outputs are viewed on an oscilloscope. Then the circuit is transferred to a Veroboard and soldered properly, and the board is tested in a similar way. This gives a better understanding on how to build a circuit and troubleshoot them wherever needed. Thus, the ultimate outcome of this project week is to provide knowledge about circuit construction, working of IR sensor and the use of op-amps and voltage divider circuit.

Fig: 1.5. IR sensor circuit on a Breadboard

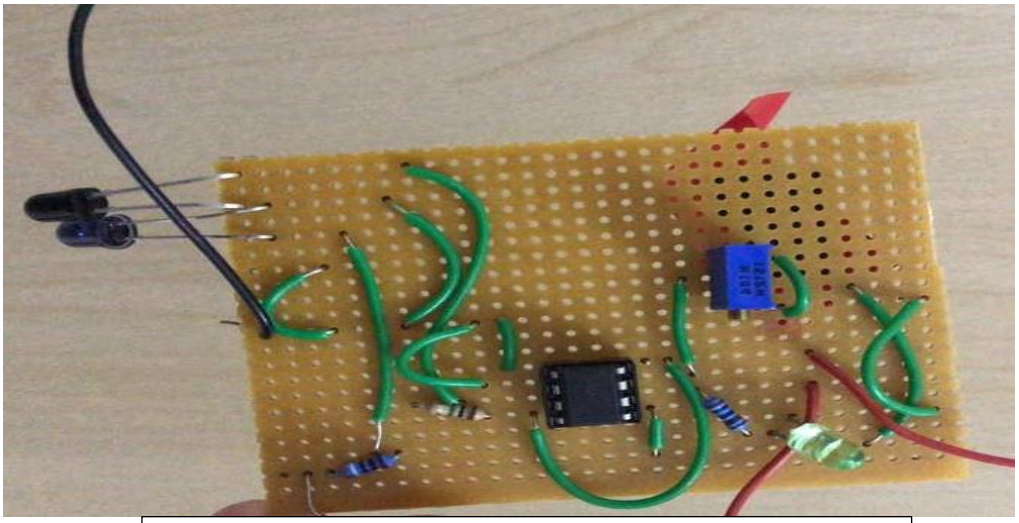


Fig: 1.6. IR Sensor circuit on Veroboard

The Fig: 1.6. shows the actual IR circuit made during the project. The circuit is made on a Veroboard. It can be seen that the IR pair is placed in parallel to each other. A small LED is placed along with the output line. The LED lights up when the photodiode receives the IR radiations. Thus, the ultimate objective of the project is achieved.

3.3. Conclusion:

The ultimate goal of this IR sensor circuit construction is to detect and differentiate between the black and white surface on the floor. There is a wide range of advantages of IR sensors in industries. IR sensors are capable of sensing real-time movements. They are used as motion detectors which operates automatic doors, tracking an object's position and its motion. This project gives a better understanding on how an operational amplifier works and the use of voltage divider circuit in real life.

4.0. REFERENCE:

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ii. Voltage divider Circuit. https://learn.sparkfun.com/tutorials/voltage-dividers
iii. Op-amps. http://www.electronics-tutorials.ws/opamp/op-amp-comparator.html
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5.0 APPENDIX

Detailed explanation about the components used in the circuit is given below.

IR Transmitter

Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

The picture of a typical Infrared LED is shown below.

Fig:1.7. IR Emitter

There are different types of infrared transmitters depending on their wavelengths, output power and response time.

A simple infrared transmitter can be constructed using an infrared LED, a current limiting resistor, and a power supply.

IR transmitters can be found in several applications. Some applications require infrared heat and the best-infrared source is an infrared transmitter. When infrared emitters are used with Quartz, solar cells can be made.

IR Receiver

Infrared receivers are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. The picture of a typical IR receiver or a photodiode is shown below.

Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter-receiver combination, the wavelength of the receiver should match with that of the transmitter.

Fig: 1.8. IR Receiver

LM-358 Op-amp:

The **LM358** is a low power dual operational integrated circuit originally introduced by National Semiconductor company. It is used in detector circuits.

The abbreviation LM358 indicates an 8-pin integrated circuit, comprising two operational amplifiers at low power. The LM358 is designed for general use as amplifiers, high-pass filters, low band pass filters, and analog adders.

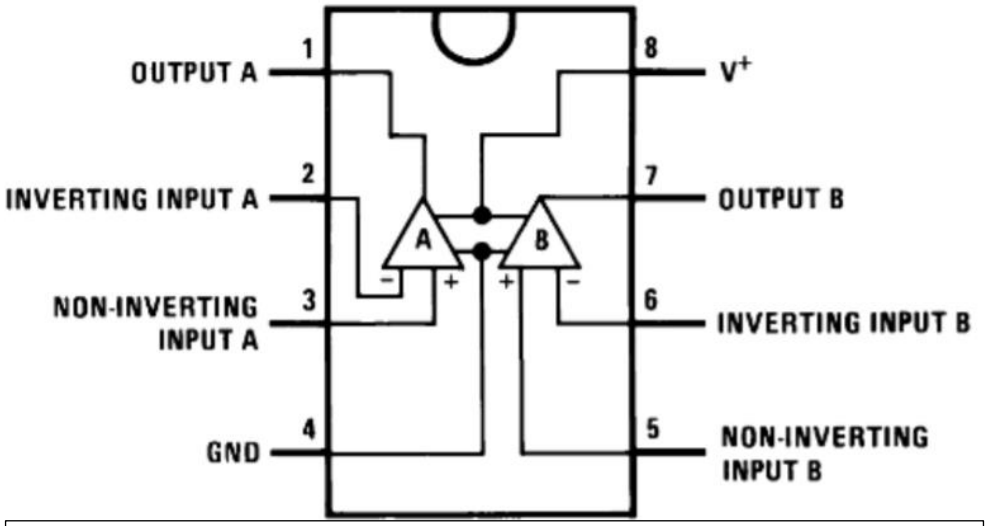

Fig: 1.9. LM358 Dual Operational Amplifier Pinout