



**NEW HORIZON**  
**COLLEGE OF ENGINEERING**

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC  
Accredited by NAAC with 'A' Grade.

## **“Light detector using NAND gate”**

A MINI PROJECTREPORT

*Submitted by*

**Nivedita Salimath (1NH18EC080)**

*In partial fulfillment for the award of the degree of*

BACHELOR OF ENGINEERING

IN

**ELECTRONICS AND COMMUNICATION**

# NEW HORIZON COLLEGE OF ENGINEERING

## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



### CERTIFICATE

Certified that the mini project work entitled “**Light detector using NAND gate**” carried out by **Nivedita Salimath (1NH18EC080)** bonafide students of Electronics and Communication Department , New Horizon College of Engineering, Bangalore.

The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

MiniProjectGuide:  
Ms.Nayana GH  
Senior Assistant Professor  
Department of Electronics and Communication

HOD ECE  
Dr. Sanjeev Sharma  
B.Tech, M.Tech, Ph.D

-----

### **External Viva**

Name of Examiner

- 1.
- 2.

-----

Signature with Date

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**Nivedita Salimath(1NH18EC080)**

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## ABSTRACT

In this project, we have designed a light detector by using NAND Gates.

Light detectors are the circuits that are used to detect the presence of light that is, when a bright light falls on the circuit, for example a flash light, the Light Emitting Diode turns ON.

The circuit is very simple and basic. A photoresistor is the major component used for the detection of light. A photo resistor's light sensing ability is used to detect if the circuit is prone to bright light or darkness. The photo resistor's resistance is altered in the proportion equal to the amount of light that is being exposed to. In case of darkness, there is very high resistance but in case of bright light, the resistance decreases. This is the major principle of the working of the light detector.

If there is a voltage divider circuit along with the fixed resistor, we will be able to exploit the altering resistance and its behavior so that when they are connected to a NAND Gate.

This means that, if one of the inputs is zero then the output is HIGH which means the output will be taken by Vcc(Voltage supply) and the power is applied to the load. If both the inputs are HIGH, then the output of the NAND Gate is LOW which means the output will be drawn to the Ground terminal and the load will not be powered.

## CHAPTER 01

### INTRODUCTION

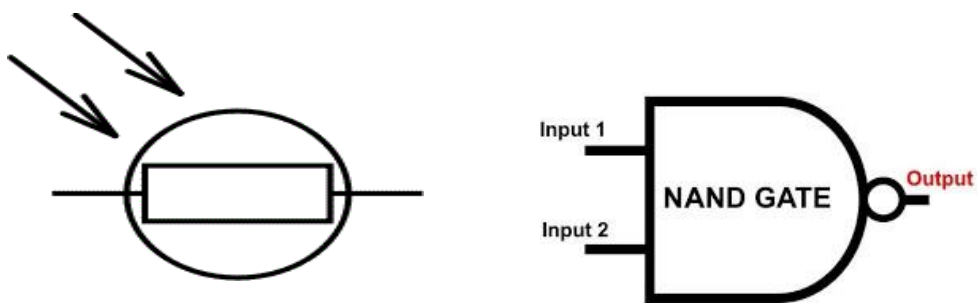
The NAND Gate () is a logic gate that is designed for performing logical and arithmetic operations. NAND Gate can be utilized in applications where it requires mathematical calculations.

Calculators, computers and other digital applications use the NAND Gates.

NAND Gate (IC7400) is being used to design a Light Detector.

A Light detector is a device which detects the intensity or the amount of light that is incident on it. These devices are also called as photoelectric devices because they convert the light energy into electrical energy. These devices can detect lights of different types i.e., visible light, infrared light, etc.

A Light Dependent Resistor (LDR) is being used to design the Light detector. Automobiles, sensors(in dash pad) mainly use light detectors to find out the intensity as well as the angle of sunlight that is passing through windshields to provide the information used to turn on and turn off the headlights and also is used in operating the climate controlling systems.



**Fig1.1: Symbol of Light Dependent Resistor and NAND Gate**

## CHAPTER 02

### LITERATURE SURVEY

Light detection is important matter in areas of urban environment mainly in traffic lights especially in transition to the fully autonomous driving.

There are many literature surveys that have been generated in the very recent stages approaching the various pattern recognition strategies.

Recently, the strength of light in the city can be used to contribute to reduce the crime. In case of darkness, there is improvement in the lightning detectors are used to detect the offenders by the rate of increasing the chances of risk that the offenders will be seen and recognized while committing any sort of crime .

Further, nowadays there is CCTV surveillance that violates the private life of the people which is a major problem in the society.

Anyways in the contrast, light detectors are cheap and easy installation and process flow of the information is smooth.

There are many such papers written on the use of these light detectors in various fields which would be on a high demand for the future applications and for the betterment of the society with a eco-friendly environment.



## GLOBAL POSITIONING SYSTEMS

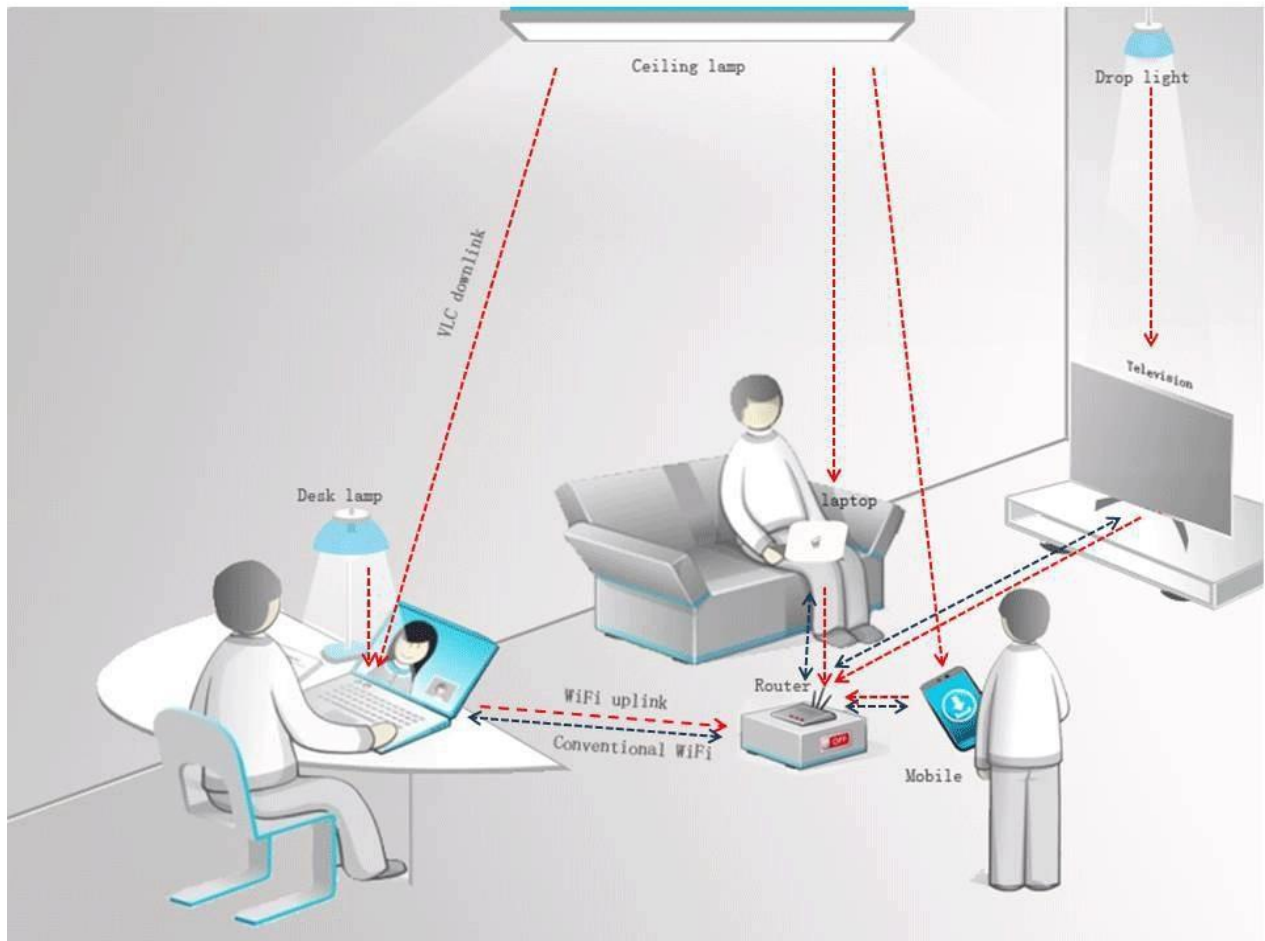


**Fig 2.1: GPS Tracking system using LDR**

Global Positioning Systems as they cannot provide a satisfactory performance in positioning and indoor environment where they utilize wireless signals rather than a GPS signal, has taken a rapid growth in the recent generation.

Whereas, the VLC – Visible Light Communication makes use of the light devices like light emitting diodes(LED) which is deemed to a promising element in heterogeneous wireless signal and networks which might collaborate with the Radio Frequency networks.

This survey on GPS provides a picture of the essential characteristics and principles of working of these light sensors.



**Fig 2.2: Visual Light Communication**

Positioning System is largely in the field of automobiles, aircraft and portable devices as to provide real time navigation and positioning. It makes use of Light detectors which leverages the visible light instead of the Radio Frequency signals.

It uses “green technology” which uses low power and is highly energy efficient. They do not generate any kind of radiowave or electromagnetic interferences.

Therefore, it is very much predictable that to implement this technology on VLC to the upcoming generations.

The lighting of the solid state is now revolutionizing the indoor illumination. Current fluorescent and incandescent lamps are now replaced by LED's and Light sensors at a very rapid pace. Other than the extremely large and energy efficiency, these light sensors are very much advantageous in terms of longer lifespan, improved rendering of color and low heat generation without the use of any kind of harmful chemical substances.

Other benefit of these sensors is that they have the capacity of switching from one light intensity to another light intensity very fastly. This property of it has given rise to the novel communication technology. Here LED's can be used as high speed transfer data.

It also tells us about the physical properties of the VLC channel, MIMO techniques and modulation methodologies. The light sensing applications include gesture recognition , indoor localization , vehicular networking and screen camera recognition.

They have also sketched the challenges that need to be taken care off to design high ranging mobile networking using VLC.

## 2.2 HUMAN ACTIVITY RECOGNITION USING LIGHT DETECTORS

(Oscar D.Lara)

This survey provides opportune and exact information about the behaviors and activities of the humans. This is one of the important and mostly needed task in the pervasive computer technology.

The detection of human activities can be done in two different ways:

External sensors – The devices and elements are fixed and soldered in predetermined point of interest.

Wearable sensors – The devices and elements are fixed to the user itself.

Intelligent housing is one of the best example for external sensing. Cameras at homes can also be put under external sensing. They recognize and detect the gestures and activities of the humans by video sequences which have been the key of focus to this survey.

## CHAPTER 03

### PROPOSED METHODOLOGY

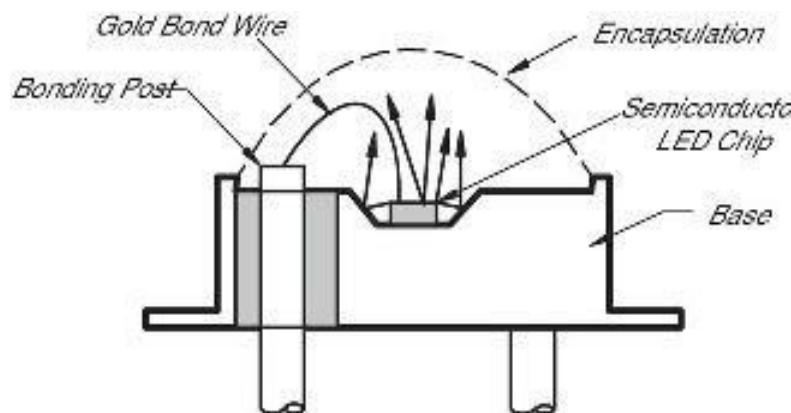
Light detectors or light sensors are divided into mainly two categories that may be based on the required output. They create an output signal that indicates the intensity of the light by exactly measuring the amount of radiant light energy in a narrow range of frequency.

The photoelectric devices or sensors have mainly few components that include lenses, light detector, light source, logic circuits and an output. The light source mainly consists of Light emitting diode (LED) or also called as a laser diode.

#### 3.1 Light source

Almost every device uses Light emitting diodes or the light sensors due to their availability and cheap rates. LED is a semiconductor device that produces light on the passage of current through it. The first visible LED was used as a replacement for the neon lamps and 7-segment displays.

In 1972 Wally Rhines designed the first blue-violet LED using magnesium doped gallium nitride at the Stanford University. White LED lights cannot be emitted by them now due to certain different technologies, we are able to design them as well where conversion from wavelength and mixing of colors and Homo epitaxial Zn-Se.



**Fig3.1: Light Emitting Diode (LED)**

It consists of two states i.e., n state and a p state. On the passage of current through the diode, the electrons get excited and try to jump from one state to the next state where they tend to lose one photon and return back to their original position or state. The photon that they tend to lose is nothing but the light that is being produced by the Light emitting diode.

The color of the light that is being produced by the diode is dependent on the wavelength of the light. One of the best advantages of the LED is that it has the capability to turn on and off very rapidly. Due to this tendency, it can create different pulse of the source. The quantity of light being produced by the diode is dependent on the amount of current that is flowing through the diode.

They are directly proportional wherein, the more the passage of current through the diode, the higher is the range of light that is produced. Too much current may also destroy the diode due to excessive amount of heat that is being produced. Currently, the commonly used diodes are the laser diodes because of their unique properties such as very little beam diameter, wavelength of the light emitted and its long range.

### **Advantages of LED**

- ☐ Less energy consumption compared to the incandescent lights.

- ☐ Improved physical robust property.

- ☐ Smaller size

- ☐ Very fast switching property.

- ☐ They are neither coherent nor highly monochromatic.

### **Disadvantages of LED**

- ☐ Very high initial rates.

❑ They must be given correct voltage else it may lead to damage.

❑ Low heating generation.

## **Applications of LED**

❑ Used in visual networks where light travels directly from source to human eye in order to send the message.

❑ In order to obtain visual response of objects.

❑ Interacting and measuring the process involving zero human vision.

❑ They use narrow band light sensors in order to respond to the incident light rather than the emitted light.

❑ Aviation lighting.

❑ Advertising

❑ Traffic signals

❑ Plant growing light system

❑ Medical devices.

❑ Automotive headlights.

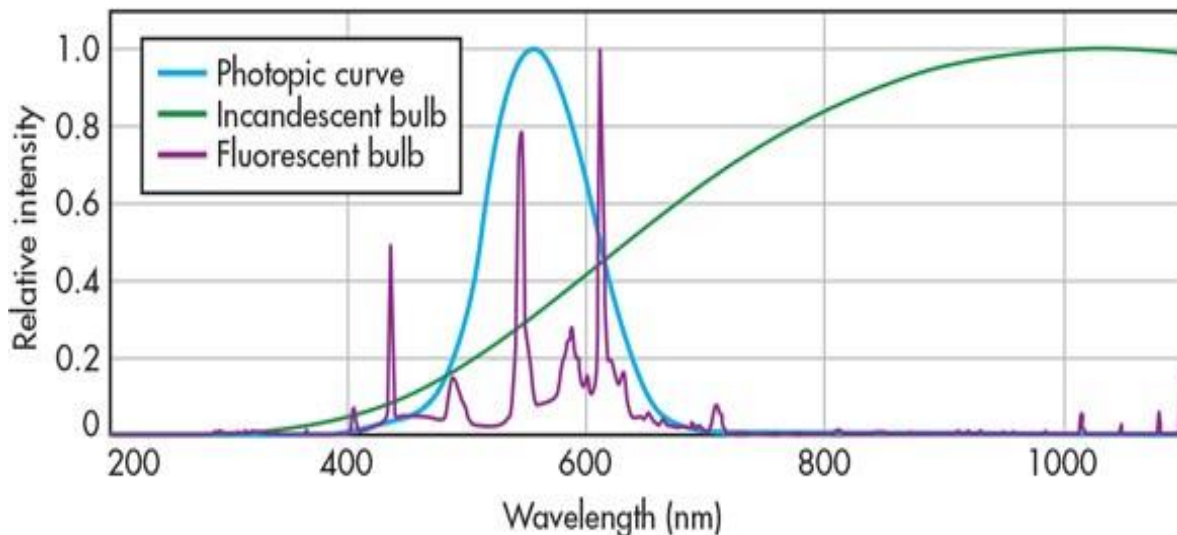
### 3.2 Light detector

Light detector is the most important component that is used to detect the amount of light that is being produced by the source. The light detectors are commonly called as photo transistors or photodiodes.

They are also called as receivers because of their capability of sensing the various pulses of light.

They serve their best application in optical fiber transmission as a receiver end. The transponder that is connected within the optical fiber transmission system converts the light that is sensed by the detectors into the electric pulses.

The response produced by the spectrum of these light detectors determines the sensitivity to various wavelengths on the spectrum. Therefore, in order to increase the amount of sensitivity, matching of the spectrum of the source and that of the detector is required.



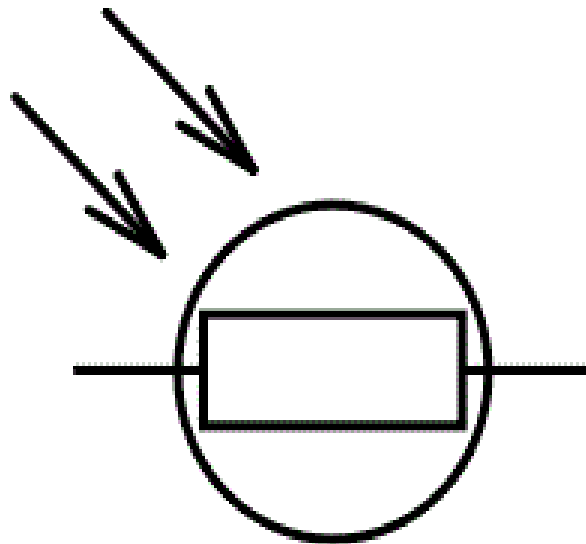
**Fig 3.2: Spectral response of the Light Detector**

### 3.3 Photo resistor

A Light dependent resistor (LDR) also called as a Photo resistor is a variable resistor that is controlled by the light. As the intensity of the incident light increases, the resistance decreases. The photo resistor serves its major application in designing a light detector that exhibits photoconductivity.

It can also be used in Light activated as well as dark activated switches. It is mainly designed using a very high resistance semiconductor. If the light incident on this resistor exceeds certain range of frequency, then the photons that are being absorbed by the semiconductor provide the electrons sufficient amount of energy to jump onto the conduction band.

Therefore, those free electrons lower the resistance and hence conduct electricity. However, the unique photo resistors react substantially to the photons with respect to certain bands of wavelengths.



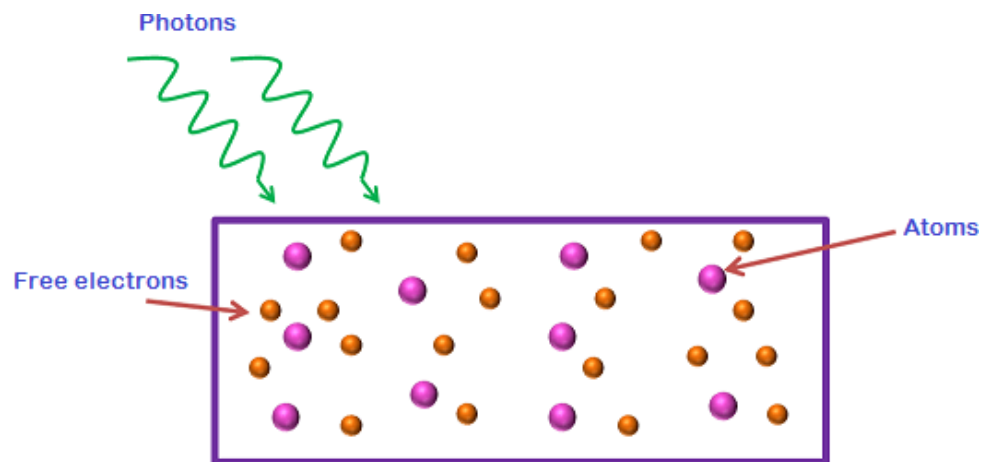
**Fig 3.3: Photo Resistor**



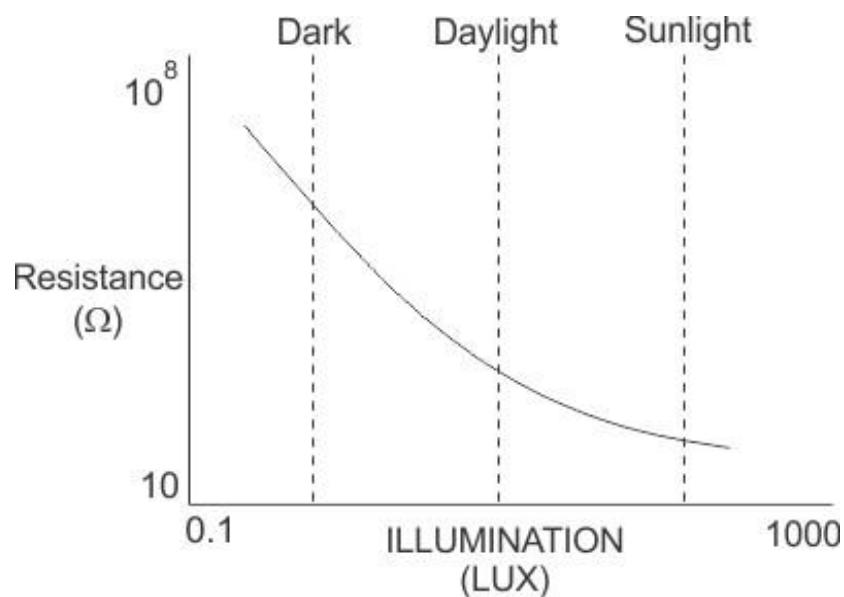
## Principle:

“This resistor basically works using the principle of photoconductivity. When the light is incident on the surface, the conductivity of the material increases and the electrons in the valence shell tend to get excited and jump to the conduction shell. These photons of the incident light possess energy that is greater than that of the band gap of the material.”

If constant 'V' is applied to LDR, then the intensity increases and the current also increases.



[www.physics-and-radio-electronics.com](http://www.physics-and-radio-electronics.com)



**Fig 3.4 and Fig 3.5: Principle and working of photo resistor (LDR)**

## Advantages of photo resistors

- ☐ They are the passive components which vary their resistance values with respect to the response of the light.
- ☐ It has no polarity as it is a passive component.
- ☐ They are the replacement of the variable resistors and depend on the light.
- ☐ Cheap and almost available in all the sizes and shapes.
- ☐ They use small power and low energy.
- ☐ Bi-directional i.e., they can be connected in any of the direction.
- ☐ They represent almost equal resistances in either of the sides of both AC or DC elements.
- ☐ They can also be used in generation of variable resistances.
- ☐ Highly sensitive .

## Disadvantages of Photo resistors

- ❑ They are less sensitive to the light as compared to the photodiodes.
- ❑ They use cadmium supplied which is harmful to human health.
- ❑ If the voltage applied is higher than the maximum voltage then, it may lead to irreversible damage of the photo resistors.
- ❑ It has a slow response time (10ms to 100s).
- ❑ It is bulky and temperature sensitive.
- ❑ Possess non-linear characteristics.

## Applications

They are highly used in manufacture of light sensors.

Used to measure the light intensity.

Manufacture of photography lights and night lights manufacturing.

Used in manufacture of outside sensing and audio compressors due to the latency property.

### 3.4 The NAND Gate

A NAND Gate is a universal logic gate that can be obtained by connecting the output Y of the AND Gate to the input of the NOT Gate.

In Boolean expression, the NAND gate is expressed as  $Y=(A.B)'$  and is read as A AND B negated.

1. If A=0 and B=0, the output Y=1.

2. If A=0 and B=1 and vice versa, the output Y=1.

3. If A=1 and B=1, the output Y=0.

INPUT		OUTPUT
A	B	$Y=(A.B)'$
0	0	1
0	1	1
1	0	1
1	1	0

### 3.5 Design

When a bright light is incident or shines on the designed circuit, maybe a flashlight, the

Light emitting diode turns ON.

It is a very basic circuit.

- **Case 1:**

LDR will be in Darkness hence its resistance will be in  $M\Omega$  Resistance will be in  $M\Omega$

Voltage across LDR,  $V_L = V_{RL} / R_1 + R_2$   $R_1 = 6.8K\Omega$

$R_L = 18.01K\Omega$

$V_L = (9 * 18.01K) / (6.8K + 18.01K)$

$V_L = 6.53V$

$V_L = 6.53V$  which is greater than 4.5V (threshold voltage) Since  $V_L > \text{threshold voltage}$

$\therefore$  Logic is set to high i.e.; Logic 1.

- **Case 2:**

LDR will be in Bright light hence its resistance will be in  $1K\Omega$

$V_L = V_{RL} / R_1 + R_2$

$R_L = 6K\Omega$

$V_L = 4.21V$

$V_L = 4.21V$  which is less than 4.5V (threshold voltage)

$\therefore$  Logic is set to low i.e.; Logic 0.

For 6.8kohm:-

- In darkness, set the logic high as 8v.

Voltage across LDR=8V

$$V_L = V_{RL} / R_1 + R_2$$

$$R_1 = V_{RL} / V_L - R_L$$

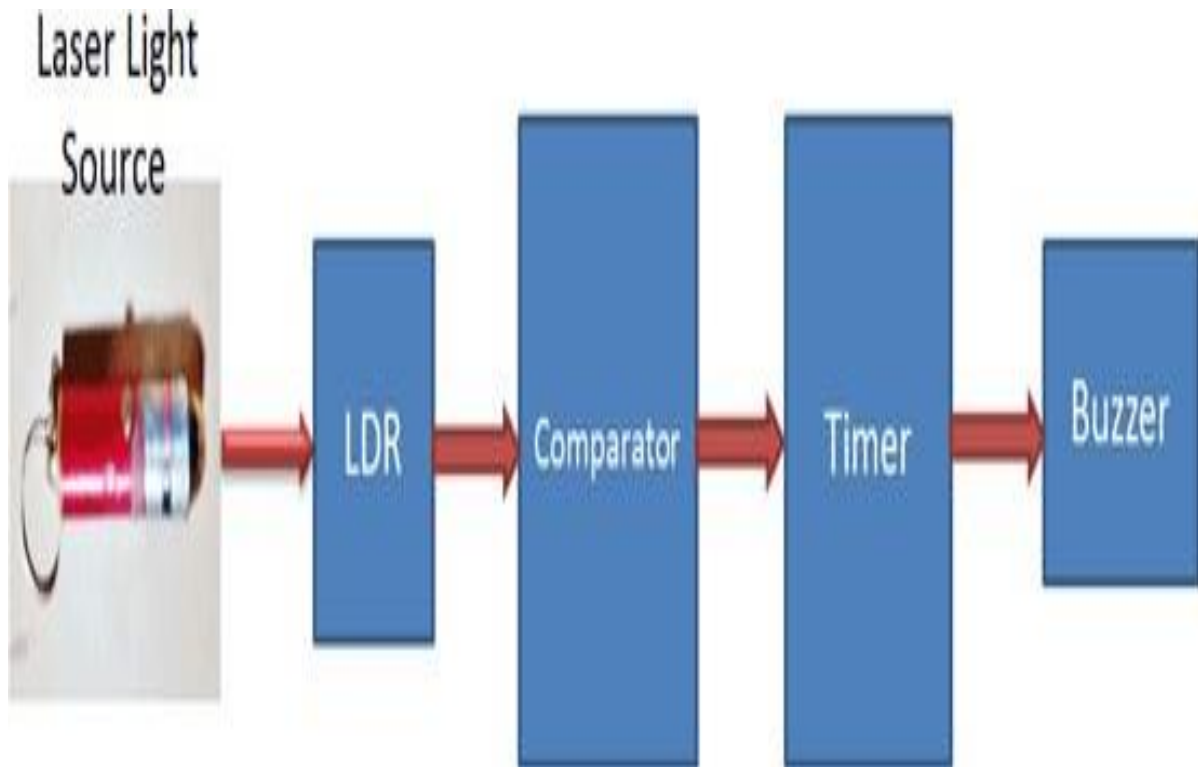
Hence,  $R_L$  will be in same megaohms

In bright sunlight, set the logic low as 1v.

$$V_L = V_{RL} / R_1 + R_2$$

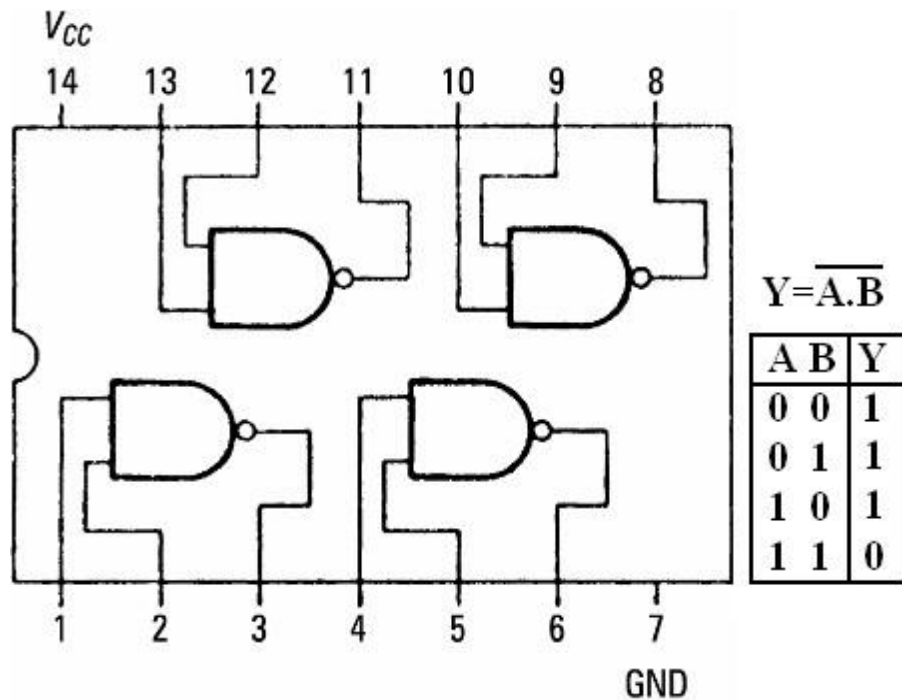
$$R_1 = V_{RL} / V_L - R_L$$

Hence,  $R_L$  will be reduced to same kilo ohms taking average of  $R_1$  we designed as 6.8kohm.



**Fig 3.6: Block diagram of light detector**

### 3.6 IC7400



**Fig 3.7: IC-7400**

The series of 7400 is very popular among all the integrated circuits. Texas instruments in the year 1994 introduced the first element SN5400 TTL(transistor – transistor logic).

They possess special functions. They contain hundreds of elements which include everything from flip flops and the basic logic gates, counters, arithmetic logic units and bus transceivers. It is a 14 pin IC which has two – NAND gate inputs.

Each Gate makes use of two inputs and one output pin where the remaining two pins constitute the ground terminal and the other being the voltage power supply.

These IC's are mostly used in minicomputers. Some examples being Data General Nova series and Hewlett-Packard 21mx series.



## CHAPTER 04

### PROJECT DESCRIPTION

This circuit uses 74AHCT00D IC NAND Gate along with a photo resistor in order to detect light effectively.

The above mentioned NAND Gate is a very high speed C-Mos device that is compatible with a very low power that provides two input quad NAND function.

The photo resistor has a light sensing capacity detects the presence of light.

The resistance of the photo resistor changes in proportion with the quantity of light that is exposed on it. In case of darkness, there is a very high resistance whereas in case of brightness, the resistance drops down dramatically.

The Light Emitting Diode in addition to the photo resistor behaves as an indicator which turns ON during the presence of incident light, for example, a flashlight.

This circuit uses a 5V battery supply that turns the NAND Gate to work which is connected to the pin number 14 and pin number 7 connected to the ground point respectively.

It is designed by using a voltage divider bias circuit that consists of 6.8kilo ohm resistor along with the photo resistor wherein the voltage gets divided in a direct proportion as it is a series combination to the amount of resistance that each component in the circuit offers.

When the photo resistor exposes itself to darkness, the resistance is in order of few mega ohms. If the resistance is high, most of the voltage being supplied to the voltage divider circuit falls over the photo resistor and a very little falling over the 6.6 kilo ohm resistor.

When the inputs of the NAND Gate are connected, they interpret the divider circuit onto logic 1 that is a HIGH logic.

When the voltage fed to the logic is greater than half, it will interpret a HIGH logic and the resistance drops down as a result of which the LED turns ON.

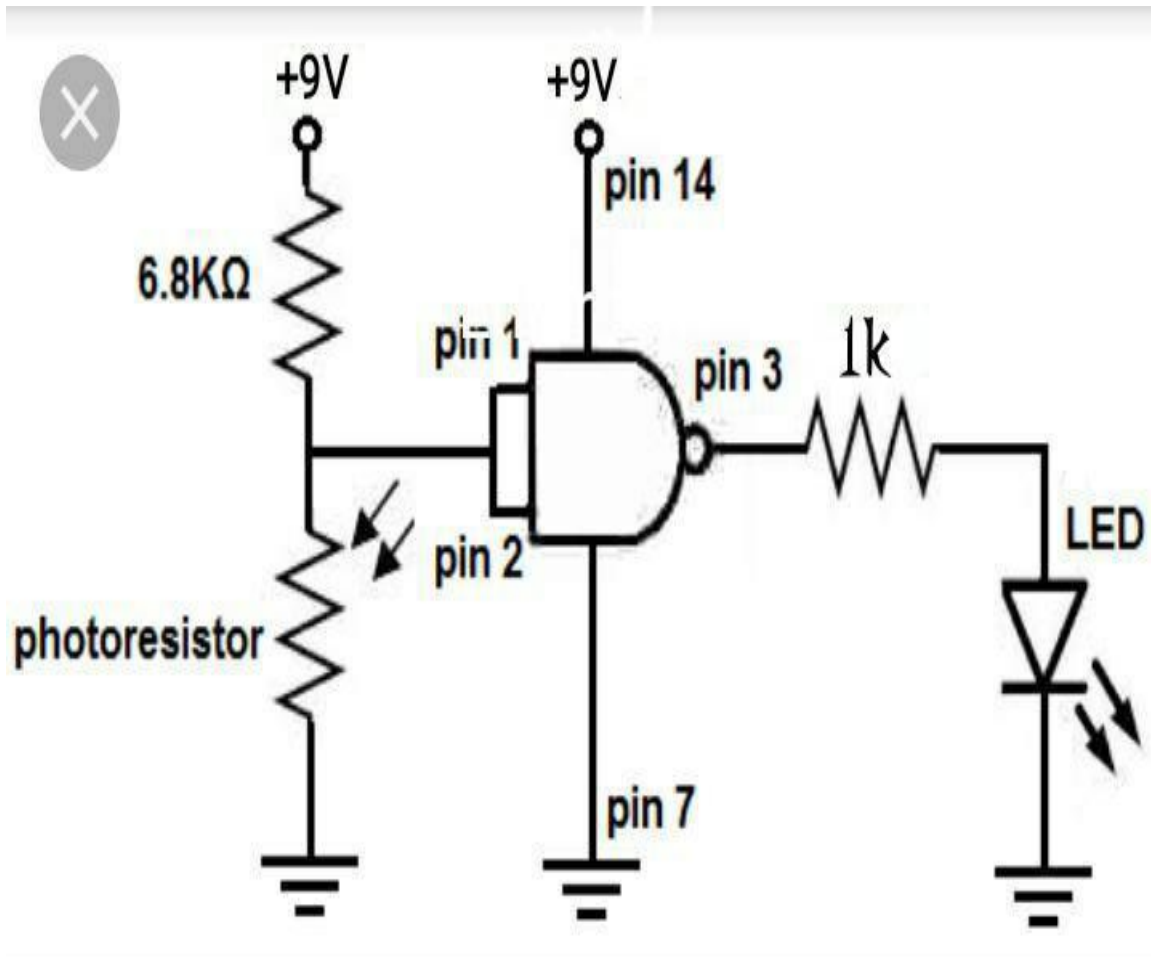
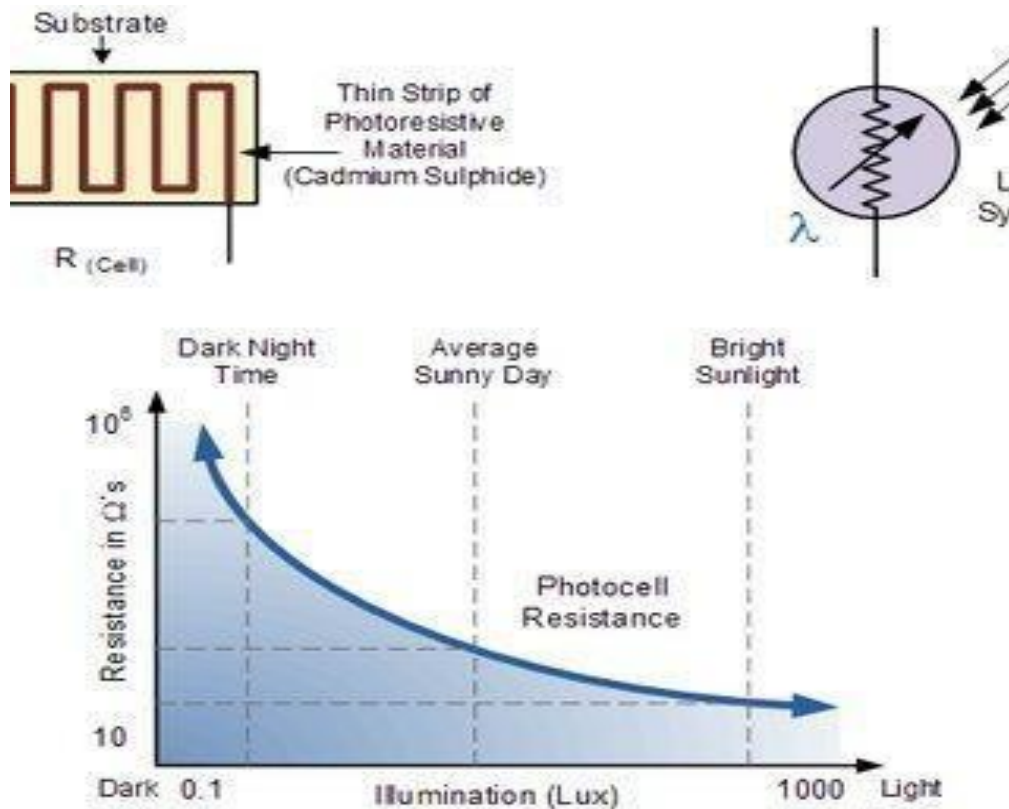


Fig 4.1: Circuit diagram of light detector

## 4.1 Characteristics of the LDR



**Fig 4.2: Characteristic graph of a LDR**

The equation that represents the relation between illumination and resistance is :

$$R = A.e^a$$

Where

R – Resistance

A and a – constants

e- Illumination (lux)

As shown in the above graph, the resistance of the light dependent resistor decreases when the light is incident on it and gradually increases when it is dark.

The resistance is too high when it is dark.

This resistance is known as dark resistance.

## 4.2 APPLICATIONS OF LIGHT DETECTORS

### ❓ Power Conservation of Intensity Controlled Street Lightings

Lighting up of highways uses HID lamps nowadays where the consumption of energy of these HID lamps is high and also there is no mechanism to turn ON and OFF for these lights during sunrise and sunset.

In order to come over this problem, there is an alternative method of using Light Emitting Diodes(LED's).

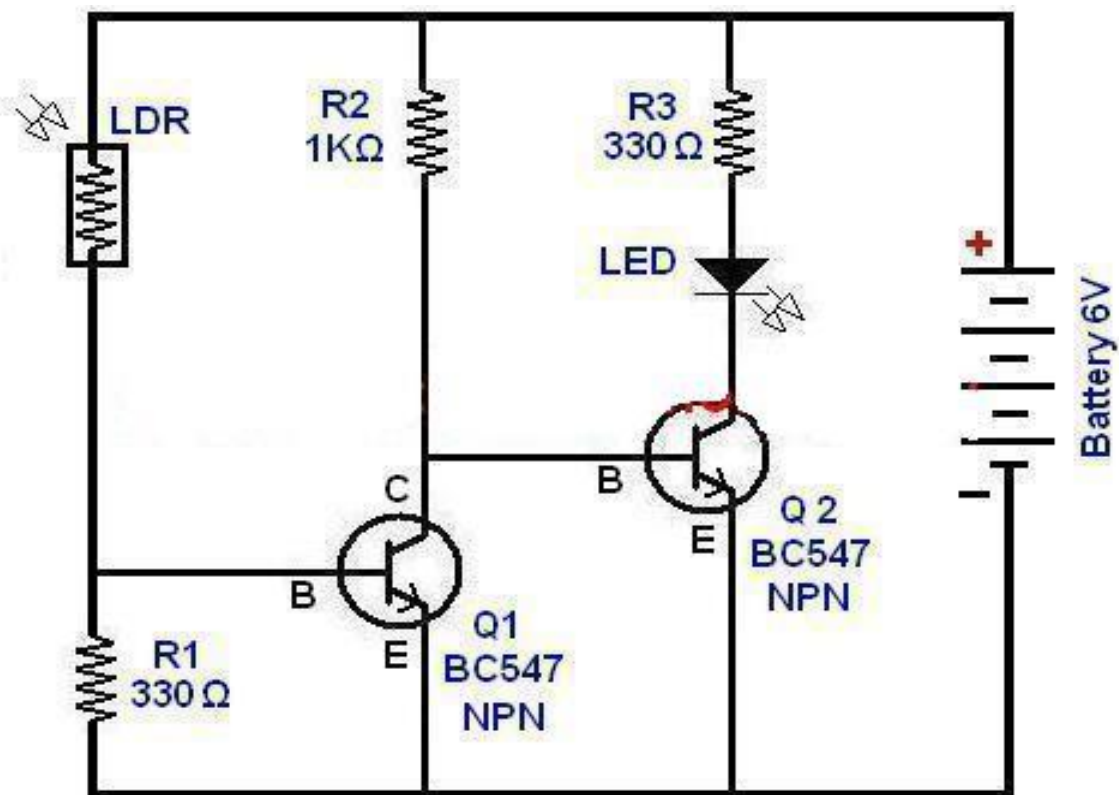
This system is designed to come over the disadvantage of the HID lamps. This system determines the use of LED's as light source and the intensity can be adjusted as per our requirements. These LED lights use less power and their life span is much higher than the HID lamps.

The important property of this idea is that light intensity is controlled based on the necessity at night times and day times which cannot be done with the help of HID lamps.

A LDR is used in the detection of the light and also the resistance of this reduces gradually according to the intensity of light during the daytime that behaves as the input of the controller.

A cluster of LED's are used in manufacture of street lights where the microcontrollers are designed and pre programmed with certain instructions that control the intensity of light which is based on the Modulation of the pulse width. The intensity of light is said to be very high during the dark and the traffic tends to fall during the peak hours whereas the intensity of light during the daylight also decreases gradually.

Hence, the LED lights turn OFF at six in the morning and tend to turn ON at six in the evening automatically and the process will continue every day.



**Automatic Street Light Control System.  
(Sensor using LDR & Transistor BC 547.)  
Very Simple.**

Fig 4.3: Automatic Street Light Control circuit

## ❏ Security System – ELECTRONIC EYE

This Project of the security system that is controlled by electronic eye is based on the photo sensing. It uses 14 stage Ripple carry binary counter for sensing the light's intensity using the LDR.

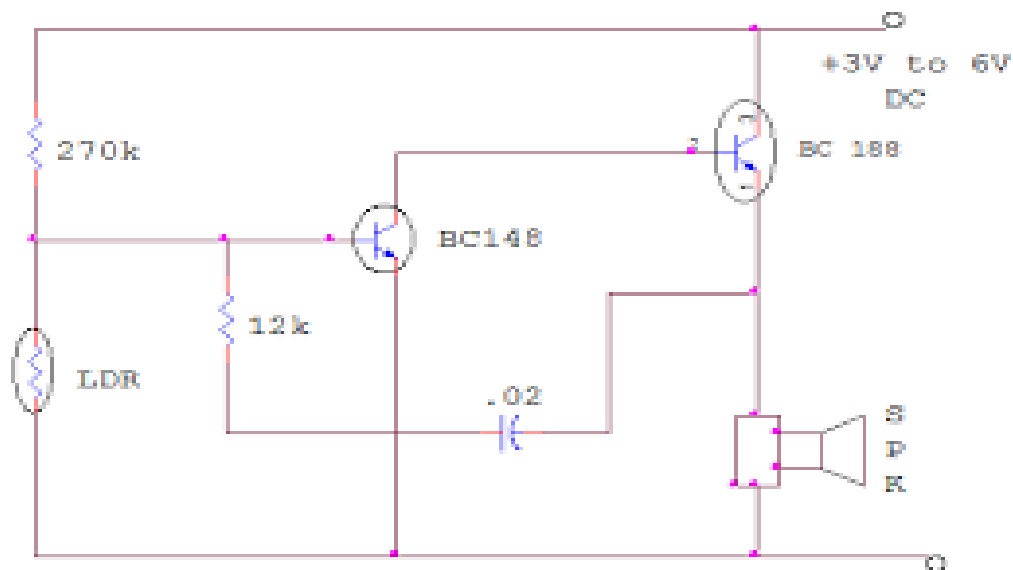
The output includes the buzzer and the relay for a required action.

This project sets best applications in burglar alarms in the shopping malls , jewelry shop and banks.

This system uses LDR that is as the light falls on this sensor, the resistance of this sensor reduces which leads to activate the alarm to provide an alert to the humans.

This also provides a security to the lockers, banks and cash boxes. The circuit designed is kept in the cash boxes or inside the lockers in banks and jewelry shops such that when the burglar opens the locker or the cash box, the torch lights tends to search the necessary valuables. It induces the electronic eye and also commands the ripple counter which triggers alarm and displays a burglary attempt.

In the future, this system could be developed by making use of the GSM along with a microcontroller. It can be interfaced to send a SMS to the customer if there is any burglary.



**Fig 4.4 : Electronic Eye circuit**

## Important Performaning Factors of the Light Detectors

- ☐ A large quantum efficiency is required to transfer many photons possibly into the charge carriers to get a signal of high amplitude. It is the ratio of number of photons produced by the electrons in the light detector to the number og photons incident.
- ☐ A very high readout speed – This is necessary for the timing applications like the Pet in order to get good timing resolutions.
- ☐ It also requires a very good resolution for amplitudes which leads to the combination with the scintillator to convert to a high energy resolution.This can be affected by quantum efficiency, electronic noise and internal gain of the light detectors.
- ☐ They are basically designed for the conversion of the low levels of lights into electronic signals of required amplitudes so as to avoid the deterioration of the signal due to the external disturbance or the noise.

## CHAPTER 05

### RESULT AND DISCUSSION

The light detecting circuit is thus a simple project that is very much favorable and of great use to the beginners who are electronic enthusiasts.

This overview of the project could be integrated to the safety and security of certain devices such burglar alarms that are used to constantly sense or detect even a small beam of light wherein any changes in the amount of intensity of light causes the alarm to beep.

However, they can also be used in motion sensing circuits, televisions, computers and wireless phones to control the brightness of the screens automatically especially in case of high-light or low-light situations respectively.



## CHAPTER 06

### FUTURE SCOPE

The Light detectors also called light sensors besides having greater penetration in the field of automobiles, medicine, sensor manufacturers and industrial arenas also tend to anticipate in the fields of wireless communication and also consumer electronic systems.

These sensors are the ones that sense light, motion, occupancy and temperature. The motion sensors are those which sense the above parameters.

They also find a wide scope because it saves a lot of electricity and also involves in lowering the cost of energy.

It acts as a security because it also senses the motion by chance anyone enters the house and gets a notification immediately over their phones. They also help in preventing from overheating and over cooling as well.

### AUTOMATIC STREET LIGHT CONTROL SYSTEM

The Automatic Street light control system is very simple but very powerful concept that uses transistor which acts as a switch.

Manual works are 100% removed by using this system. It switches ON automatically when the sunlight falls below visible region of the human eye. This is basically done by the light dependent resistors that sense the light according the surrounding intensity of the light.

Energy consumption can be greatly reduced by using this system because the street lights operated manually are not switched off even when the sun is risen but on using this system, there is no manual requirement as it controls everything automatically.

There is no need to find out the ON time and OFF time setting also.

## LIGHT SENSING ROBOTS

These light sensing robots use the light detectors in order to move in the direction of light.

If the light falls on the right side, it moves to the right whereas if the light falls on the left side, it moves towards the left and if the light falls on both the sides then the robots move straight.

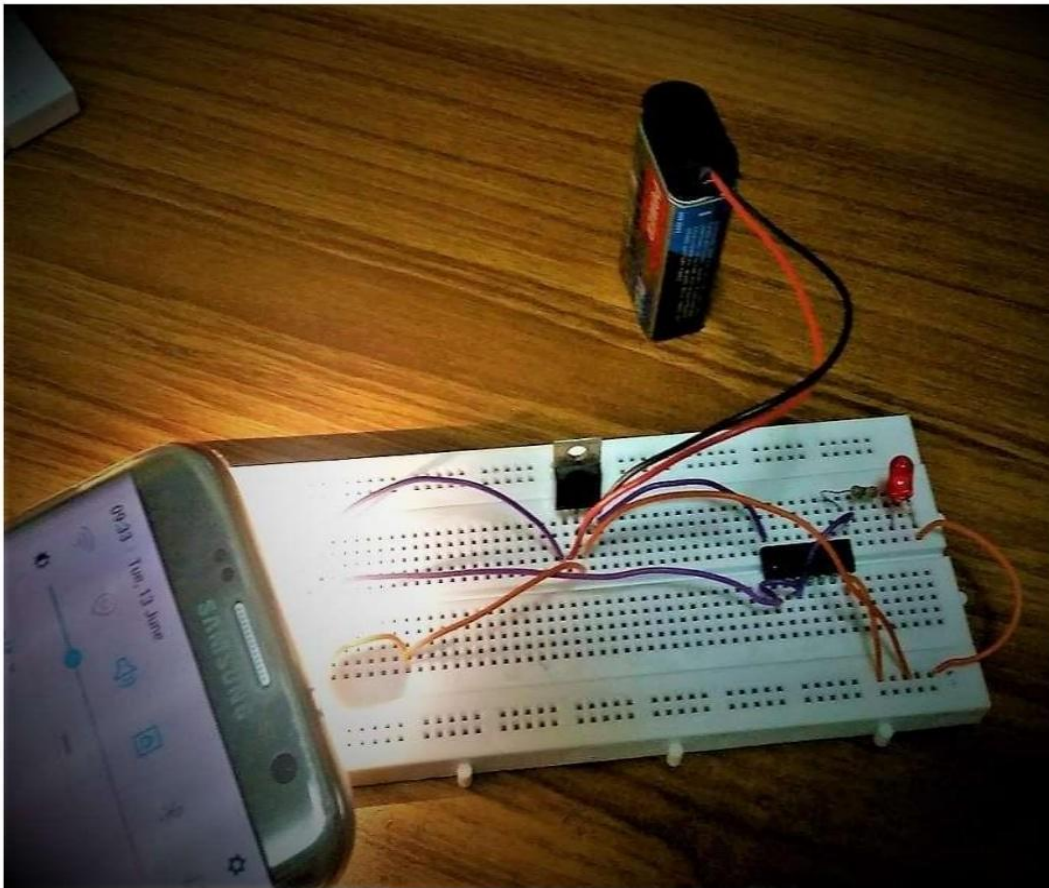
It contains light detectors , power source and a light source along with drivers.

In future, there is a very good scope to build a friendly environment without the consumption of much energy where everything will work under sensors.

However the cost of affording it might be high but it would be worth choosing for.



**Fig 6.1: Light detecting Robot**



**Fig 6.2: View of the project**

## REFERENCES

- [1] Yuan Zhuang, "**Survey on Positioning Systems using LED**", IEEE COMMUNICATION SURVEYS, VOL 20, THIRD QUARTER, 1553-877X, 2018.
- [2] James R. Biard, "**The Life and Times of LED**", Optoelectronics Research Centre, September 15, 2012.
- [3] Diffenderfes, Robert, "**Electronic Devices and Applications**", ISBN 978-1401835149, 2005.
- [4] Fossum, "**A Review of the Pinned Photodiode**", IEEE Journal of Electron Devices,