

The Development of Infrared Sensors and Its Application

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Abstract- Infrared technology is widely used all around the world and not just in industry, but also in every-day life. IR sensors are also used in IR imaging devices, sorting devices, optical power meters, missile guidance, flame monitors, remote sensing, moisture analyzers, infrared astronomy, night vision devices, rail safety and many more. The perk of using IR sensors is that they have low power requirements which makes them suitable for most electronic devices such as telephones, laptops, PDAs. They are capable of detecting motion in the presence or absence of light with almost the same reliability. This paper is based on the advancement and history of infrared sensors and its applications.

Keyword- IR imaging device, IR sensor applications, history of IR technology, types of IR sensors.

I. INTRODUCTION

Almost all audio and video equipment can be controlled via IR sensors nowadays. Due to this widespread use the required components are quite cheap, thus making it ideal for us to use IR control for our own projects and day to day life. An infrared sensor is an electronic device which is used to detect heat and motion of an object [1] [2]. We come in contact with infrared sensors regularly, some we notice and some remain unnoticed. These sensors are used to sense the surrounding environment by radiating or detecting infrared radiation [3]. Due to the current pandemic, we are always being tested by infrared thermometers while entering any kind of shopping malls, offices, hospitals and many others. Infrared thermometers are one of the efficient and cheap thermometers in the local market which is being used in our daily life regularly at present. Infrared sensors have the ability to emit and detect infrared radiation, and because of these abilities it is used in various aspects such as communication, distance or angle measurement, tracking and obstacle detection [3].



Fig 1. Simple Infrared Sensor [2]

II. DIFFERENT TYPES OF IR SENSORS

Depending on the application, IR sensors are sorted into different types.

- Active IR sensor
- Passive IR sensor

Active IR Sensor:

Active infrared sensors are the types of IR sensor that emit infrared radiation which is subsequently received by the receiver. The IR that is emitted by an IR is Light Emitting Diode (LED) and then received by photodiode, phototransistor or photoelectric cells. During the cycle of detection, the radiation is altered, between process of emission and receiving, by object of interest. The change of radiation causes change in received radiation in the receiver. This property is used to generate desired output with help of associated electronic circuits [4].

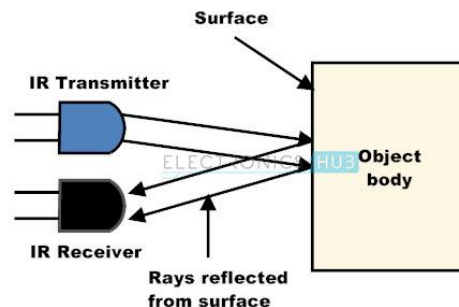


Fig 2. Simple demonstration of Active IR sensor [5]

Passive IR Sensor:

Passive Infrared sensors only detect infrared radiation; these do not have the ability to emit radiation [6]. Passive infrared sensor is also known as a PIR sensor. These sensors detect infrared radiation emitted by any other source. PIR imaging devices and baggage security sensors use the basic fundamentals of passive infrared radiation.

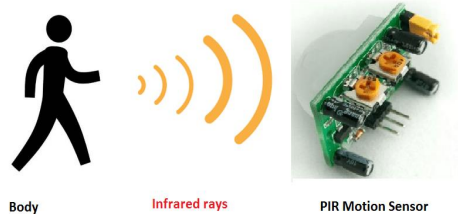


Fig 3. Simple Demonstration of PIR Motion Sensor [7]

III. CIRCUIT ANALYSIS

An infrared sensor circuit is one of the fundamental and mainstream sensor modules in an electronic device. This sensor is comparable to human's visionary detects, which can be used to detect objects and it is one of the common applications in real-time. This circuit consists of the following components:

- Two IC IR transmitter and the receiver pair
- Resistors of the range in kilo-ohms
- Variable resistors
- LED (Light Emitting Diode)

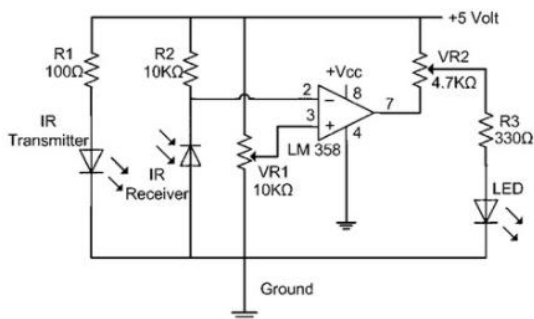


Fig 5. Infrared Sensor Circuit Diagram [8]

This is a simple circuit, in this circuit, you can see that there is a transmitter section that includes an infrared sensor, which transmits continuous infrared beams to be received by an infrared receiver module. The receiver's infrared output terminal varies depending on the infrared beams it receives. Since this variation can't be analyzed as such in circuit, therefore this output can be fed to a comparator

circuit. Here an operational amplifier of LM 339 was used as a comparator circuit [8].

When the infrared receiver does not receive any signal, the potential at the inverting input reaches higher than the non-inverting input of the comparator IC (LM339). Hence, the output of the comparator reaches low, and the LED does not glow. When the infrared receiver module receives any signal, the potential to the inverting input reaches low. Hence the output of the comparator LM 339 goes high and the LED starts to light [8].

Resistor R1 (100 ohms), R2 (10k ohms), and R3 (330 ohms) are used to certify that a minimum of 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs, respectively. Resistor VR2 (5k ohms) is used to adjust the output terminals. Resistor VR1 (10k ohms) is used to set the sensitivity of the circuit Diagram [8].

IV. DEVELOPMENT OF IR TECHNOLOGY

In the 18th century, the great British astronomer Sir William Herschel used a prism and monochromator which used a thermometer as a detector to measure the energy of sunlight and found out that there is a temperature which is beyond red. Sir W. Herschel used to call this radiation, "calorific rays" [8]. This "calorific rays" of Sir W. Herschel is known as the infrared radiation at present.



Fig 4. Sir William Herschel's First Experiment [8]

Lead sulfide was used as the first ever infrared detector [8] [1] [9]. This infrared detector was mainly used in military applications to detect the incoming missile attacks during World War II. This was also used in a variety of other applications in the war by the military [9]. Thermocouples and bolometers were invented and developed in the 19th century [1]. Thermocouple is a thermoelectric temperature

measuring device. Bolometer is a device used to measure the power of a radiant energy. Thermocouples, bolometers and thermometers were used to detect infrared radiation in the early stages [8].

Later in the 19th century, research was going on how to develop the infrared detectors. Firstly, lead then mercury then other materials were used to develop semiconductors for the infrared detectors. In 1959, Lawson and coworkers developed HgCdTe semiconductors which triggered the development of infrared detectors. Using the HgCdTe semiconductor, the development of detector devices was divided into three generations. The first generation was about the linear arrays of photoconductive devices, which is also used in the present. The second generation is about the 2D arrays of photovoltaic devices. And the third generation is about the present stage, which is the staring array of 10^6 elements and its electronically scanning devices [9]. HgCdTe is widely used in the present and is also expected to be used in the future because of its marvelous properties [8]. HgCdTe is mainly used because of its large spectral range and high quantum efficiency.



Fig 6. HgCdTe Infrared Thermal Imaging device [10]

The infrared detectors were mainly used in the military applications, but at present it is also used by the civilians.

V. APPLICATION OF IR SENSOR

Infrared sensors can be found in almost all modern equipment. The following is a list of some sensors of many.

IR goggles:

Night Vision was first introduced by the German military before World War II. The first ever IR night vision was huge and a heavy instrument [12]. Later it was developed into night vision goggles. Every object radiates heat in the form of infrared radiation which is captured by the IR detectors inside the goggles and produces a colored image depending on

the amount of heat radiated by each object [13]. It is popular among the military as it can be used at night for surveillance and missions.



Fig 7. Thermal Imaging IR night vision goggle [14]

Burglar Alarm:

This is one of most widely and commonly used sensor applications. This is another example of a direct incidence method. It works like an item counter, where an active IR sensor is used. The transmitter and receiver both are kept on the sides of the door frame and constant radiation is emitted between transmitter and receiver, whenever an obstacle crosses path, the alarm is set off [15].

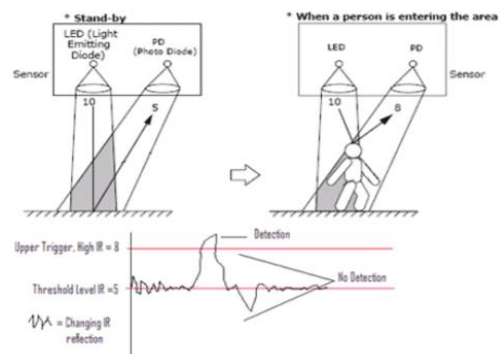


Fig 8. Active Infrared Sensor [16]

IR remote control:

Almost all audio and video equipment can be controlled using an IR sensor nowadays. An IR remote also known as a transmitter uses light (LED) to carry signals from the remote to the device that it controls. It emits pulses of IR light that correspond to specific binary codes and those codes represent commands such as volume up and down. The controlled device also known as the receiver decodes the IR pulses of light into binary code so that its internal microprocessor understands. Once the signal is decoded, the microprocessor implements the commands [17].



Fig 9. IR emitter (LED) [18]

IR thermometer: Infrared thermometers are widely being used in different regions; at present we see this equipment in our daily life [19]. IR thermometers have a specialization that it can measure temperature without coming in contact with the body. The passive IR sensor in the thermometer detects the infrared rays given off by the body and displays its temperature on the screen [20].



Fig 10. Passive IR Thermometer [21]

VI. CONCLUSION

This paper accumulates the history and applications of infrared sensors. Infrared sensors were being used mainly by the military for missions and surveillance. But today, IR sensors are being used in day-to-day life. PIR and active IR sensors are being used in different applications. IR night vision goggles are mainly used by the military, IR thermometer, IR remote control and IR burglar alarm are some of the applications of IR sensors. The development for the advancement of IR sensors is increasing rapidly and with great success.

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