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LOW-COST INTRUSION DETECTION SYSTEM BASED ON OPTO-ELECTRIC SENSOR

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***Abstract*— This paper introduces a hardware design method of an electronic *Intrusion Detection System* based on the *Optoelectric Sensor*, which can be used to achieve the protection of valuables and to detect the intrusion in an protected area. The circuit design is simple, compact, low cost and provides the reliable notice of intrusion. The stability and reliability of this design has been verified by the experiments.**

***Keywords*— Optoelectric Sensor, Intrusion detection.**

I. Introduction

The intrusion detection system is a device designed to detect unauthorized entry into a building or area. As the danger of intrusion or burglary is always there whether it is a residential, commercial or industrial property, to ensure protection against intrusion we need a low-cost, effective and simple anti-intrusion system. However, the existing intrusion detectors are still expensive and complex which makes them unsuitable for residential purposes and the need of protecting the residential areas from intrusion is increasing incessantly. This simple and low-cost design is capable of meeting the needs of residential areas. This design uses a *Photoelectric sensor* which detects the presence of an intruder by transmitting visible beams across an area, where the possibility of intrusion is high, and the intrusion is indicated by initiating an alarm.

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II. Theory

The anti intrusion system is divided into two parts. First, the Opto-electric sensor which consists of a Photo-diode and a Laser. Second, a Processing chip and an Alarm unit. Its work flow chart is given in Figure.1.

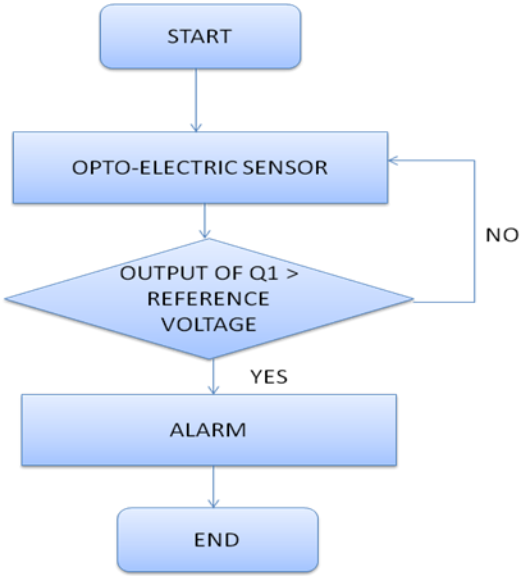

Figure.1.Work Flow Chart

A laser is used as a source of high intensity light which can be easily detected by the Photo-diode. As long as light is falling on photo diode the output voltage of photo diode will be high and any obstruction in this light causes appreciable drop in the output voltage. This drop in voltage can be easily detected and used to infer the entry of a person in the protected area. Any unauthorized entry can then be indicated by means of a siren or an alarm.

III. Design And Analysis

The sensor unit consists of a Photo diode (BPW34) and a transistor (BC548). As the photodiodes are based on

photovoltaic effect, so when the light of appropriate wavelength is made to strike on the photo-diode a potential difference is produced on its terminals. If an external circuit is connected to the photodiode then due to the potential difference developed by the incident light some current will flow through the circuit and in absence of light there will be no current through the circuit hence so the presence of light can be inferred through the knowledge of the current through the circuit. This basic operation does not need any external power supply. For the Intrusion detection having low response time is very important and it can be easily increased by connecting the photodiode in reverse bias. For the use in reverse bias PIN type photodiodes are best suited because they have high resistance to breakdown, hence ensuring reliable operation, and low leakage current. Also, as they are low-capacitance planar diffusion devices they offer very small response time which can be further improved by connecting them in reverse bias. The photodiode BPW34 manufactured by Vishay Intertechnology satisfy all the needs of an Intrusion detection system i.e. low response time, high sensitivity, low leakage current, etc. The range

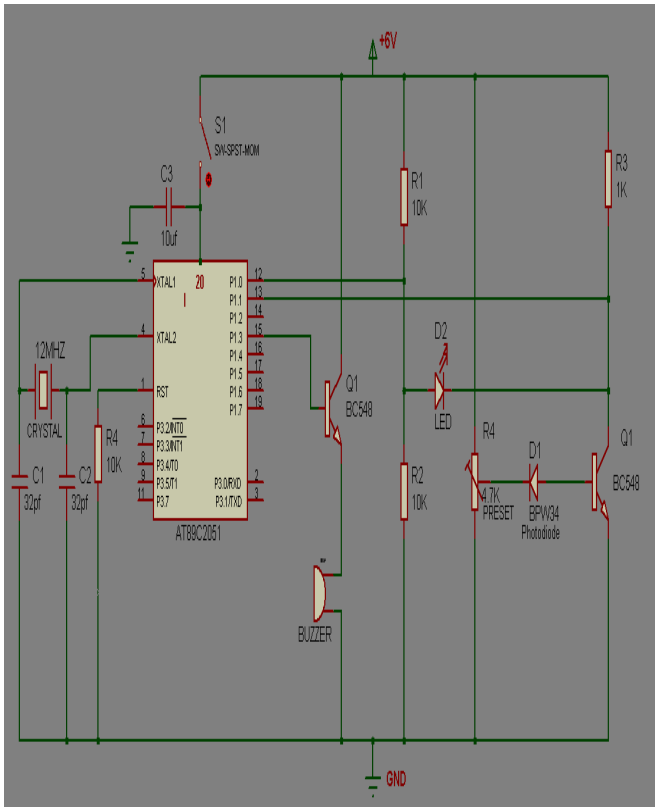

Figure.2. Circuit Diagram of Intrusion Detection System

of its spectral width is from 430nm to 1100nm with peak sensitivity at 900nm. The typical range of visible light is from 400nm to 750nm, which falls well within the spectral range of photodiode, therefore for intrusion detection both the visible light and the infrared light can be used depending on the requirements. The anode of the photodiode is connected to the base of the transistor Q1 (BC548), as shown in Figure.2. If the output of the Photo diode is above 0.7 V, then transistor Q1 goes into saturation region and its collector voltage drops to 0.3 V. In absence of light the output of Photo diode drops considerably causing the diode Q1 to move into cut-off region and collector voltage clings to 6V[1]. The main control unit is composed of the microcontroller AT89C2051 and its peripheral circuit. The peripheral circuit of AT89C2051 consists of C1, C2, C3, R5 and 12MHz crystal oscillator [2]. In the absence of external power supply the open circuit voltage of photodiode is typically 350 mV, the input voltage of photo-diode is set at 1V using a 4.7K preset. In the absence of light photo-diode's output is 0.08V and in presence of light, depending on light intensity, it increases up to 0.76V. The output of the photo diode acts as the input to the transistor BC548 (Q1) which is connected in Common Emitter configuration and biased in saturation region. AT89C2051 has an inbuilt analog comparator whose positive and negative input terminals are accessible from outside through pin no.12 and 13, respectively [3]. The Collector of transistor Q1 is connected to the pin no.13 of the processing chip (AT89C2051). The reference voltage is set to nearly half of power supply using voltage divider resistor circuit comprising R1 and R2, the reference voltage can be changed by changing the value of resistor R2 or R1. This reference voltage is fed to the pin no.12 of the processing chip. The pin no. 15 of the AT89C2051 is used as an output pin and the processing chip is programmed to pull this pin high whenever the output of comparator goes low. The alarm unit module mainly consists of a NPN transistor (Q2) and an alarm. Pin no. 15 is connected to the base of transistor Q2 (BC548) which is biased in saturation region. The alarm is connected to the emitter of the transistor Q2.When the pin no. 15 of AT89C2051 is pulled high the transistor Q2 goes into saturation causing high current flow in the emitter and the alarm is initiated. A red LED is used to indicate the proper alignment of Laser and Photodiode and a switch 'S1' is connected between pin no.20 of AT89C2051 and power supply. The processing unit should be turned ON only when the Laser and Photodiode are aligned, i.e. when LED is glowing, to avoid any false alarm while turning the device on.

IV. Conclusion

Experiments have shown that this design is feasible and stable. In practical applications, this device is best suited for the use in residential buildings and exhibition halls. The alignment of the Laser and Photodiode is very critical in this design as any misalignment may cause a false alarm. The angle of half sensitivity of BWP34 photodiode is ±65 degrees[4], which is sufficient to deal with small misalignment. For better results it can be installed in all those locations where the probability of intrusion is high. Extra features can be added to this design such as connecting two or more transmitter and receiver sections to single processing unit so as to increase the area of the protection zone and the processing unit can be programmed to send an alert message to the owner or to the concerned authority. This design has great development potential and has a stable and reliable performance in long run. The features of this design are light weight, small size, low cost, high sensitivity and timeliness.

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