Design and Implementation of a Dual Infra-Red Receiver Circuit for Intruder Detection

Emmanuel Atta Williams[*], Stephen Marrion Cobbina [**], Stephen Kwaku Okrah[***]

[*&**] Department of Electrical/Electronics Engineering, Takoradi Polytechnic, Ghana
[***] Department of Engineering, Ghana Technology University College, Takoradi, Ghana

Abstract- Security Management and Safeguard of properties have become a necessity in any establishment and requires a measure to deny access to unauthorized personnel from accessing a facility. Some of these measures come at a cost as security is inevitable. The objective of this project was to design and implement an affordable, effective and reliable wireless intruder detection system and to minimize false triggering and enhance detection using Dual Infrared Technology. The idea was to employ distance infrared proximity sensor (SHARP 0A41SK) which generated an interrupted signal when any obstacle is in front of IR sensor. The interrupted signal was fed to an IC (NE 555) timer arrangement to produce a flip-flop audible sound to alert people of intruder presence. The designed and constructed dual infrared intruder detection system subjected to testing produced an accurate security zone that spreads out uniformly to enhance protection for properties, homes and offices. The system could be adapted to monitor other alarm conditions such as fire, heat smoke, flood, etc. The design could be recommended for use of GSM applications as the alarm system that could be programmed to call Police distress line directly and relay a pre-programmed message with the address of the intrusion scene for better response rescue by the police.

Index Terms- Dual, Infra-red, Intruder Detection, Receiver, Security

I. INTRODUCTION

Management of assets and safeguard of properties and human lives have become a fundamental requirement in any establishment such as institutions, hospitals, industries and homes as well. Security management is the identification of assets (including information assets), followed by the development, documentation, and implementation of policies and procedures for protecting these assets. There are two types of security management namely software security and physical security management. Software security is an idea implemented to protect software against malicious attack and other hacker risks so that the software continues to function correctly under such potential risks. Security is necessary to provide integrity, authentication and availability.

Physical Security describes security measures that are designed to deny access to unauthorized personnel (including attackers or even accidental intruders) from physically accessing a building, facility, resource, or stored information; and guidance on how to design structures to resist potentially hostile acts. Physical security can be as simple as a locked door or as elaborate as multiple layers of barriers, armed security guards and guardhouse placement. Physical security is primarily concerned with restricting physical access by unauthorized people (commonly interpreted as intruders) to controlled facilities, although there are other considerations and situations in which physical security measures are valuable (for example, limiting access within a facility and/or to specific assets, and environmental controls to reduce physical incidents such as fires and floods). Security inevitably incurs costs and, in reality, it can never be perfect or complete - in other words, security can reduce but cannot entirely eliminate risks. Physical access controls for protected facilities are generally intended to deter potential intruders (e.g. warning signs and perimeter markings); distinguish authorized from unauthorized people (e.g. using keycards/access badges); delay, frustrate and ideally prevent intrusion attempts (e.g. strong walls, door locks and safes); detect intrusions and monitor/record intruders (e.g. intruder alarms and CCTV systems); and trigger appropriate incident responses (e.g. by security guards and police). Burglar alarms have been around for thousands of years. The most basic alarm used by ancient humans was the dog. It would protect property and guard against people who were attempting to take valuables. Over time, humans used other tricks like chimes to warn them against burglars. The use of burglar bars on doors, burglary proof on windows and fencing of a house are now not a requisite to protect us from burglary. Modern burglar alarms, however, are far more elaborate and use advanced forms of technology [1].

Hardwired systems have circuitries that are interconnected via wires. For installation of these types of systems professional help is needed. They are considered to be the most reliable one, as each and every sensor is physically connected to the control unit. This will reduce the chances of errors in the working of the system.

During the 1980s, improvements to motion sensors merged with other technologies. Motion sensors began to use infrared technology to avoid false positives and also superior electrical components to establish full home protection systems. The Infrared Radiation represents a major field in the electromagnetic spectrum and is the energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. Electromagnetic radiation is energy that is propagated through free space or through a material medium in the form of electromagnetic waves, such as radio waves, visible light, and gamma rays [2]. The term also refers to the emission and transmission of such radiant energy. With increasing growth rate of population in the society, daily crime rate in the homes and offices have also increased

immensely. Home and office security in this modern technological world is an electronic detection device system.
In today's modernized alarm systems, the detection system employs a single unit sensor or dual technology which comprises two type of sensing unit. These can stop the unlawful entry and intruder activity before it takes place, and gives an alert of an intruder attack [3]. Therefore, there is the need to design and implement an affordable and effective Infrared Receiver Circuit for intrusion using Dual Sensors.

II. PROBLEM STATEMENTS

Rapid growth in the world population with in commensurate employment opportunities and pressures of a more complex society, the incidences of human intrusion and burglaries and crime in private and public places are on the increase. Heightened security concerns at homes, banks, shopping malls, schools, offices, etc. have led to continued search for different and improved security gadgets which are expensive. These security gadgets have their sensors for intruder detection at separate locations which makes it expensive [4]. Also both sensors must detect an intruder before an alarm will trigger. This implies that when a sensor unit is faulty the system cannot detect any intrusion. There is there for the need to design and construct an affordable and effective Infrared Receiver Circuit for intrusion using Dual Sensors.

III. METHODOLOGY

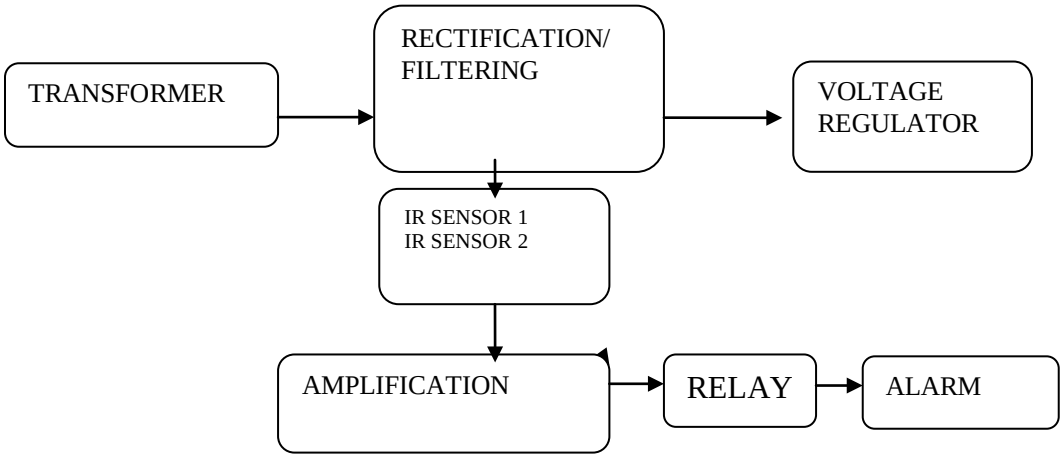

Figure 1. Block diagram of Dual Infrared Receiver Circuit

The block diagram above represented the major components used and the sequential flow of signal from detection of intruder to the sounding of an alarm. This system was designed to alert the user when an intruder entered the home or office. If there was any obstacle in front of IR sensor, it generated an interrupt signal. This interrupted signal was amplified to switch a relay for the buzzer to sound an alarm. IR transmitter emitted infrared radiation which have to be detected by IR receiver.[15] When an intruder or obstacle broke the line of sight, the transmitted IR rays were reflected back to the IR receiver. The breaking of the line of sight (interrupted signal) would trigger a loud audible sound to alert people of intruder presence [5].

The method used for the design and implementation of the dual infrared detection system was categorized under the following stages: Component Assembling, Soldering Station Preparation and Packaging.

IV. RESULTS AND DISCUSSIONS

During the design and implementation stages, tests were carried out and the following observations were made:

The full wave rectifier produced an output of 24Vdc which served the input of the 7812 voltage regulator which generated an output of 12Vdc.The half wave rectification produced a 12Vdc output which was fed to a 7805 voltage regulator and produced an output of 5Vdc.

The Infrared Emitter produced radiated rays which upon intruder detection produced an output signal by Infrared Receiver. The output signal of the receiver was very weak to drive the buzzer and needed to be amplified. The signal was amplified by a transistor to operate the output device which is the buzzer.

The designed and implemented dual infrared receiver system worked by sending out a beam of light, of which when the beam of rays broken by human across the path of the infrared sensor activated the alarm and the buzzer was sounded. The system was tested at an entrance point of an area and an alarm was triggered when an intruder passes within its range of coverage to notify or alert the people within its inhabitant or security personnel. The alarm produced or generated by the output device (buzzer) was audibly enough to alert property owners of intruder presence for unauthorized or unlawful entry into premises (office or home). The designed and implemented Dual Infrared Intruder Detection system subjected to testing ensures an accurate security zone suitable for enhancing protection for properties, homes, offices and safeguarding

humans and offers the advantage of low cost and low power consumption in its operation.

Intensity of Radiation

It was realized that the energy from the point source of radiation which is defined as coverage zone for protection can be calculated using the formula

$$E = \frac{AM}{4\pi R^2}$$

…….. (1)

Where Incidence E is the flux per unit area at the detector, has units of W/m^2

Emittance M is the flux per unit area of the source, has units of W/m^2

Surface Area A is the area from the point source, has units of m^2

Distance R is the distance between the target and Receiver, has units of m

From Stefan-Boltzmann law [6] , M = □□ ↑⁴ ..... (2)

where

ε is the Emissivity of surface

σ is the Stefan-Boltzmann constant

T is the Temperature measured in Kelvin

From equations (1) and (2) , the intensity of radiation was calculated using the following measured parameters:

Area (A) = $0.04m^2$

Emissivity of surface (ε) = 0.94

Temperature (T) = 309K

Stefan-Boltzmann constant (σ) = 5.67*10exp -8 $w/m^2K^{\wedge}-4$

Emittance, M = □□ ↑⁴

= $485.89\ w/m^2$

From the formula $E = \frac{AM}{4\pi R^2}$, the values of intensity calculated against their respective distances were tabulated below [7]

Table 1: The relationship of Intensity against Distance

Parameter	Unit	1	2	3	4	5
Area (A)	m^2	0.04	0.04	0.04	0.04	0.04
Emittance (M)	w/m^2	485.89	485.89	485.89	485.89	485.89
Distance(R)	m	0.05	0.1	0.15	0.2	0.25
Intensity (E)	w/m^2	618.65	154.66	68.74	38.66	24.75

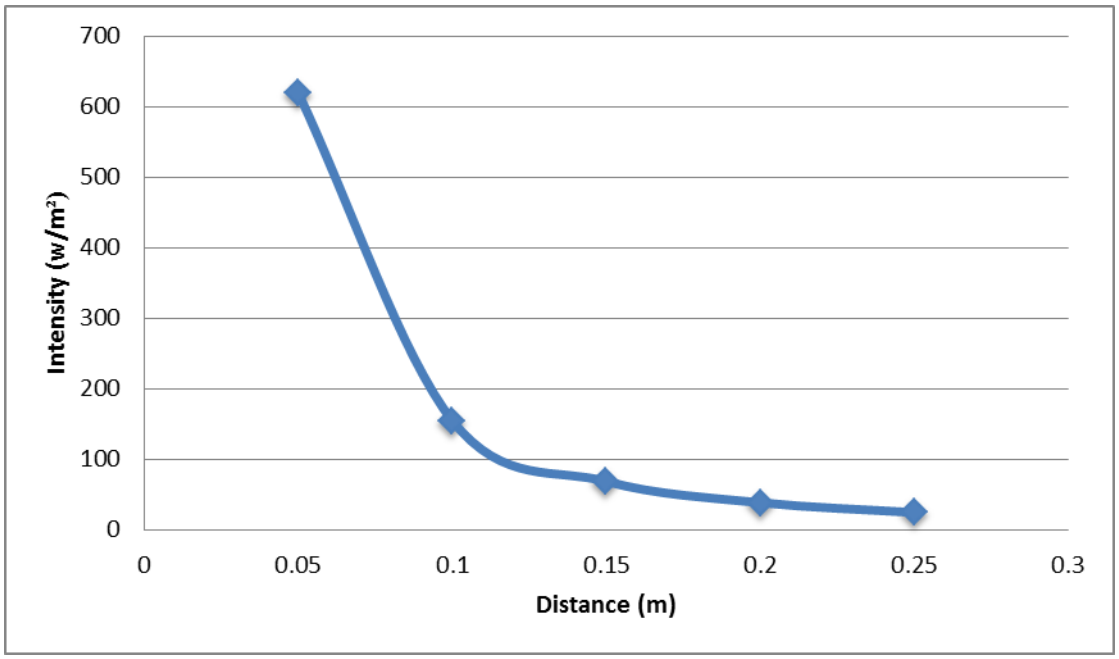

Figure 1: A graph of Intensity against Distance

The analysis made on the design of Dual Infrared Intruder Detection System revealed that the strength of the output signal to trigger the alarming circuit depended on the measure of the distance of the intruder detected by the proximity sensors. If the object is close, the reflected rays will be stronger than if the object is further away. The value of intensity radiated depends on the value of the distance measured between the target and the detector. Therefore, the closer the object the high the Intensity. This principle can be used for several automated systems such as robotics, industrial safety device to detect gas leakages, automated patient monitoring at hospitals, a measure of fail-safe functions for equipments in a factory and for traffic signaling.

V. CONCLUSION

Conclusively, a dual infrared intruder detection system has been designed and implemented. The use of Dual Infrared as monostatic unit radiated beam of lights that spreads across a wider area defined as zone of protection. This phenomenon of dual infrared made it suitable for accurate security protection against human intrusion for homes, offices, banks and properties. The designed project was affordable, effective and reliable wireless intruder detection system. The system is a measure for safe guarding valuable properties and humans against intruder attacks and minimizes false triggering or false detection. The audible sound generated by this research gives the alertness to owners or occupants of properties and neighbours around of intruder attack and can call police for assistance.

ACKNOWLEDGEMENT

We do acknowledge Nana Yaw Yankson and Vincent Olympio, former students of Ghana Technology University, Takoradi, Ghana for their immense contributions toward this article.

REFERENCES

[1] Jason Chavis. (2015, May 08).What Is the History of the Burglar Alarm?[Online]. Available: http://www.ehow.com/facts_5038281_history-burglar-alarm.html

[2] Cool Cosmos (2013). what is infrared? [Online]. Available: ttp://coolcosmos.ipac.caltech.edu/cosmic_classroom/ir_tutorial/what_is_ir.ht ml

[3] A wireless Home Security System, Honeywell Security & Data Collection Newhouse Industrial Estate, Lanarkshire ML1 5SB Scotland, 2009, pp 1-3.

[4] Riccardo Focardi and Fabio Martinelli, "A Uniform Approach for the Definition of Security Properties," in Lecture Notes in Computer Science, Volume 1708, 1999, pp 794-813.

[5] Kh. Asaduzzaman, M. Nazrul Islam, M. Shahjamal and MahbubulHoq, (2010).Infrared Security Alarming System.[Online].Available:http://medwelljournals.com/abstract/?doi=ajit.2010.243.247

[6] Characteristics and use of Infrared Detectors, Solid State Division Hamamatsu Photonics K K, Japan, Cat No KIRD900IE03,2004, pp 3.

[7] Tuneable Rate and Low Jitter. (1998, January 20). Infrared Propagation and Detection[Online].

[8] Available:http://fas.org/man/dod-101/navy/docs/es310/IR_prop/IR_prop.htm

AUTHORS

First Author- Emmanuel Atta Williams, Department of Electrical/Electronics Engineering, Takoradi Polytechnic, Ghana. E-mail : attawilliams@yahoo.com/attawilliams@gmail.com
Second Author- Stephen Marrion Cobbina, Department of Electrical/Electronics Engineering, Takoradi Polytechnic, Ghana. E- mail: ekumtobia@ yahoo.co.uk
Third Author- Stephen Kwaku Okrah , Department of Engineering, Ghana Technology University College, Takoradi , Ghana., E-mail : okrah0612009@yahoo.com

E-mail Address of Corresponding Author:
*attawilliams@yahoo.com/attawilliams@gmail.com