"I admit that I have read this report and in my opinion this report is sufficient in the manner of scope and quality, in Partial Fulfillment of Requirements for Bachelor of Electronic Engineering with Honours (Industrial Electronic)"

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Date : 11/5/2006

HOME ALARM SYSTEM USING METAL DETECTOR

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This Thesis Is Submitted In Partial Fulfillment of Requirements for the Bachelor Degree of Electronic Engineering with Honours (Industrial Electronic)

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May 2006

"I certify that this thesis is entirely my own work except where acknowledgements are given."

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ABSTRACT

The purpose of the Home Alarm System Using Metal Detector project is to demonstrate the use of a metal detector to detect any metal devices used by an intruder right before he has a chance to open the door or window. This will solve the problem with conventional sensors or detectors where the alarm only activates once the intruder has broken an entrance. To realize this project, extensive research and studies have been done on metal detector technology, PIC microcontroller and its programming language and also alarm circuit. A Beat-Frequency Oscillator (BFO) type metal detector has been chosen for this project because by far, the circuit produces the characteristics and metal detection range that is required. To assure that the metal detector circuit functions accurately, certain calibration and tuning has also been done on the circuit. Meanwhile the usage of Microchip PIC16F628 microcontroller assure that the alarm system have the capabilities to operate efficiently. The capabilities of the home alarm system is not only limited in detecting an intrusion attempt but also capable to perform certain features like set/resetting the alarm for a certain period of time, display the alarm status via LED, The alarm system alerting apparatus consist of siren, strobe light and buzzer. This thesis report provides an introductory background on the Metal Detector technology and an introduction on the thesis objective and the products available in the market. It further elaborates the design and implementation of the product. It reports the result of the product evaluation and makes recommendation for improvement. Finally, it concludes the thesis.

ABSTRAK

Projek Sistem Penggera Kediaman menggunakan Pengesan Logam ini adalah bertujuan untuk mendemonstrasi keberkesanan penggunaan alat pengesan logam untuk mengesan objek besi yang biasa digunakan oleh penceroboh untuk mengumpil pintu ataupun tingkap rumah. Projek ini akan dapat menyelesaikan masalah yang biasa dihadapi oleh alat pengesan konvensional yang ada dipasaran.. Masalah yang dimaksudkan ialah sistem penggera hanya akan mengesan berlakunya pencerobohan setelah penceroboh berjaya memecah masuk. Untuk merialisasikan projek ini, penyelidikan dan kajian yang menyeluruh telah dilakukan terhadap teknologi alat pengesan logam, litar penggera keselamatan dan juga pengawal mikro serta bahasa pengaturcaraannya. Untuk projek ini litar pengesan logam yang digunakan adalah daripada jenis Beat-Frequency Oscillator (BFO). Pemilihan litar ini adalah berdasarkan keluaran litar yang memenuhi kehendak projek. Untuk memastikan litar pengesan logam ini menghasilkan keluaran yang dikehendaki, penentukuran dan pelarasan telah dilakukan. Penggunaan pengawal mikro PIC16F628 keluaran syarikat Microchip membolehkan sistem penggera kediaman untuk beroperasi dengan cekap dan pintar. Kemampuan sistem penggera ini tidak terhad hanya untuk mengesan pencerobohan. Antara kelebihan sistem ini ialah ia boleh diset masa untuk membolehkan pengguna keluar atau masuk kedalam kediaman tanpa mengaktifkan penggera. Sistem penggera ini dilengkapkan dengan siren, lampu strobe dan juga buzzer yang akan berbunyi sekiranya berlaku pencerobohan.

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LIST OF ABBREVIATION

PCB	-	Printed Circuit Board
LED	-	Light Emitting Diode
MCU	-	Microcontroller Unit
PIC	-	Peripheral Interface Controller
	-	Programmable Integrated Circuit
IC	-	Integrated Circuit
DAC	-	Digital To Analog Converter
ADC	-	Analog To Digital Converter
UART	-	Universal Asynchronous Receiver-Transmitter
CPU	-	Central Processing Unit
I/O	-	Input / Output
SPI	-	Serial Peripheral Interface
RISC	-	Reduced Instruction Set Code
KHz	-	KiloHertz
DC	-	Direct Current
RAM	-	Random-Access Memory
PWM	-	Pulse Width Modulation
USART	-	Universal Synchronous / Asynchronous Receiver / Transmitter
SCI	-	Serial Communications Interface
PSP	-	Parallel Slave Port
VDC	-	Volts Direct Current
DIP	-	Dual Inline Package
PC	-	Program Counter

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CHAPTER I

INTRODUCTION

1.1 Problem Statements

Today we live in a dangerous world – protecting one's family's business(es), possessions is of prime concern. Security systems are ubiquitous and have become an integral part of society. The demand for security systems will increase in the future.

Commercial home alarm system nowadays mostly uses intrusion detection devices such as magnetic switch, vibration sensor, and motion detectors to detect any door or window breaking. The problem with these types of detectors is that the alarm only activates once the burglar/intruder has break an entrance.

The Home Alarm System Using Metal Detector project is one solution to solve the problem stated above. By integrating a metal detector circuit to a home alarm system, early detection can be made possible. The alarm will automatically activate once the metal detector detects the presence of metal devices used by the intruder (e.g. crowbar) thus foiling the intrusion attempts.

1.2 Project Objectives

1. To research and developed a Home Alarm System implementing Metal Detector as an intrusion detection device.
2. To research and design a home alarm system circuit that integrates the use of Peripheral Interface Controller (PIC) microcontroller.
3. Achieve high system efficiency.
4. Achieve a competitive system cost.
5. To be able to identify and troubleshoot any problems that occurs while designing the project.

1.3 Scopes of Work

The Home Alarm System using Metal Detector project is a combination of hardware and software. Both are very important to determine whether the system can function properly and as desired. Below are the scopes of work for this project;

a) Hardware part:

1. The metal detector circuit
2. Microcontroller board for the alarm system.

b) Software part:

1. PIC microcontroller is used for controlling the alarm system using 18-pin I/O (input-output).
2. PIC programming using MPLAB IDE to create the ASM file, HEX file and IC-Prog software to burn the program into the microcontroller.
3. Simulation of the project circuits by using P-Spice and Proteus software.

1.4 Breakdown of Thesis

This thesis shows the logical steps involved in understanding and gaining an appreciation of the methodology used to produce a metal detector alarm security system prototype that overcomes the drawbacks of commercial designs.

The breakdown of the thesis is as follows:

Chapter Two: This chapter discusses the literature review and background studies of the project. The technology that is used and can be applied to this project is presented in details. Relevance theory and concept are also being considered.

Chapter Three: The third chapter is about the project methodology. In this chapter, the methods and the project flow has been explained clearly.

Chapter Four: The fourth chapter gives a critical analysis of the system; a determination is made on whether the system's objectives have been met. This chapter will include theoretical and actual findings and circuit simulation results.

Chapter Five: Gives a detail explanation on the achievements, challenges encountered during project course of completion and recommends future work.

CHAPTER II

BACKGROUND STUDIES AND CONCEPT

2.1 Introduction

This chapter discusses the literature review or background studies that are related to the project. Research on existing technology that is used or can be applied is presented as detail as possible. Theory and concept that is used and are of relevance to the project are also being covered. The overall result of literature develops a conceptual frame work showing the relevance between the project and the theory and concept.

2.2 Commercially Available Intrusion Detection Devices

The integration of metal detector as an intrusion detection device in a home alarm system still does not exist. The most common existing commercial intrusion detection devices used in home alarm system are magnetic switch, glassbreak sensor

and motion detector. Although these devices are quite reliable, there are still drawbacks to it.

2.2.1 Magnetic Switch

Magnetic switch or contacts are the most basic sensors of any alarm system. These contact switches are cheap and can be easily install. Their principle of operation can be explained as follows. In an open-circuit system, opening the door closes the circuit, so electricity begins to flow. In this system, the alarm is triggered when the circuit is completed.

The drawback of magnetic switches in an intruder alarm, the switch detects the act of intrusion by opening a door or window. Once the door is opened, then only the alarm will trigger. This means that early intrusion prevention is not achieved by using this type of sensor.

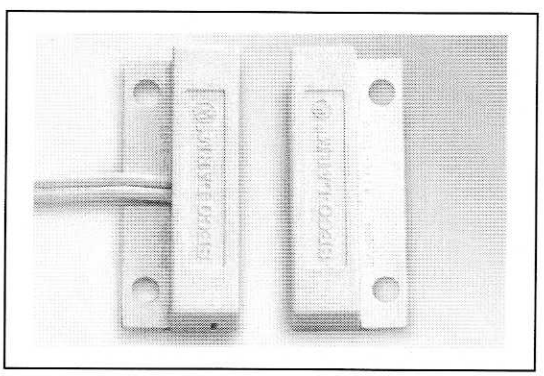

Figure 2.1 : Magnetic switch

2.2.2 Glassbreak Sensors

Glassbreak sensors are widely used in security system. They can detect the sound of breaking glass in most doors or windows, activating the security alarm at the earliest moment.

The drawbacks for this type of sensor are that it only triggered once the intruder has break the glass windows or doors. This means that early intrusion prevention is not achieved by using this type of sensor. Glassbreak sensors are also quite expensive.

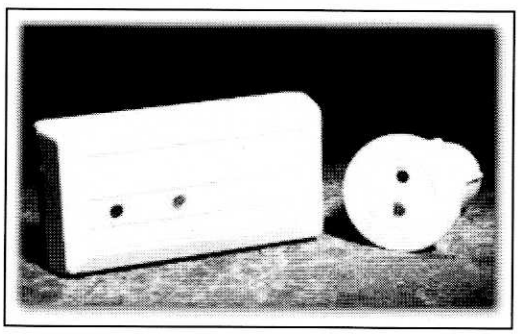

Figure 2.2 : Glassbreak Sensors

2.2.3 Motion Detectors

There are many types of motion detectors available in the market. Among them are infrared sensors, passive or active, RF proximity sensors as well as microwave and radar, or ultrasonic sensors and emitters. Cameras are also widely used as well as lasers both visible and infrared.

There are a couple of drawbacks for these types of sensors. First, the probability that the sensor will produce false alarm is high. Second, most motion sensors are expensive.

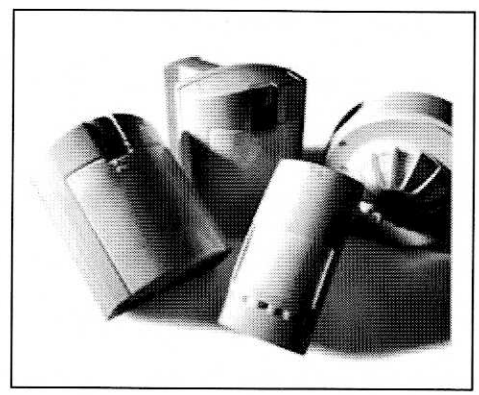

Figure 2.3 : Motion Detectors

2.3 Metal Detector Technology

Metal-detector technology is a huge part of our lives, with a range of uses that spans from leisure to work to safety. The metal detectors in airports, office buildings, schools, government agencies and prisons help ensure that no one is bringing a weapon onto the premises. Consumer-oriented metal detectors provide millions of people around the world with an opportunity to discover hidden treasures.

The idea to use a metal detector as an intrusion detection device expands the metal detector range of use. However the task is challenging and requires a lot of researches and studies.

2.3.1 Metal Detector Principles of Operation

Metal detectors are divided into two basic classes. One type will only sense ferrous (iron and steel) metals and the other will detect both ferrous and non-ferrous (copper, brass, zinc) metals. However, both classes of metal detectors use the same principles of electromagnetic induction to detect metal.

Metal detectors principles of operation can be explained as follows. A metal detector creates an Electro-Magnetic Field. When a metallic object enters the magnetic field of the detector, eddy currents are induced in the metal. The oscillator signal is damped and this damping is sensed indicating the presence of a metal. The output is an analogue signal. [2]

To clearly understand how metal detectors operates, it is important and of relevance that an explanation on electromagnetic induction and eddy current is covered in this report.

2.3.1.1 Electromagnetic Induction

Electromagnetic induction is the production of an electrical potential difference (or voltage) across a conductor situated in a changing magnetic flux.

Electromotive force (EMF) produced along a closed path is proportional to the rate of change of the magnetic flux through any surface bounded by that path. In practice, this means that an electrical current will flow in any closed conductor, when the magnetic flux through a surface bounded by the conductor changes. This applies whether the field itself changes in strength or the conductor is moved through it. [5]

Faraday's law of electromagnetic induction states that:

$$\mathcal{E} = \frac{-d\Phi_B}{dt} \qquad (2.1)$$

where

$\mathcal{E}$ is the electromotive force (emf) in volts.

ΦB is the magnetic flux in webers.

For the common, but special case, of a coil of wire, comprised of N loops with the same area, Faraday's law of electromagnetic induction states that

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} \qquad (2.2)$$

where

$\mathcal{E}$ is the electromotive force (emf) in volts.

N is the number of turns of wire.

ΦB is the magnetic flux in webers through a single loop.

Further, Lenz's law gives the direction of the induced emf, thus:
The emf induced in an electric circuit always acts in such a direction that the current it drives around the circuit opposes the change in magnetic flux which produces the emf. Lenz's law is therefore responsible for the minus sign in the above equation [5].