



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF EDDY CURRENT SENSOR TO  
DETECT DEFECT/CRACK ON METAL**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Electronic Industry) with Honours.

by

**MUHAMMAD HAZWAN BIN MOHD RASHID**

**B071610405**

**950515105725**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING  
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Author : MUHAMMAD HAZWAN BIN MOHD  
RASHID

Date:

## **APPROVAL**

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Electronic Industry) with Honours.. The member of the supervisory is as follow:

Signature: .....

Supervisor : WAN NORHISYAM BIN ABD RASHID

## ABSTRAK

Sensor arus eddy adalah antara sensor yang kerap digunakan dalam industri ujian tidak merosakkan (NDT), untuk digunakan untuk mengesan kecacatan pada permukaan logam. Terdapat beberapa industri yang biasa menggunakan teknik ini antaranya adalah minyak dan gas, perpaipan, aircraft dan pemeriksaan kimpalan. Tajuk ini tidak menekankan pada satu industry sahaja tapi untuk semua industri yang terlibat dan memerlukannya serta fokus pada asas teknik sensor arus eddy. Had keupayaan manusia untuk mengetahui kecacatan logam adalah terbatas. Hal ini demikian kerana kecacatan atau keretakan yang berlaku bukanlah suatu permasalahan yang dapat dikesan dengan mata kasar. Pada masa kini, banyak syarikat yang menggunakan subkontraktor untuk menjalankan pemeriksaan ini kerana kos yang diperuntukkan untuk membeli alat sensor arus eddy amatlah tinggi. Tujuan projek ini dijalankan adalah untuk mengkaji keberkesanan ujian sensor arus eddy dan mencipta sensor arus eddy yang keramahan pengguna serta kos yang rendah.

## **ABSTRACT**

Eddy current sensors are among the frequently used sensors in the non-destructive testing industry (NDT), to be used to detect metal defects. There are a few industries regularly utilized this technique such as oil and gas, channelling, air ship and welding inspection. This title does not emphasize on one industry only but for all industries involved and requires it and focus on the basis of eddy currents technique base. The human capability of knowing metal defects is limited. This is because the defect is not a problem that can detected with a naked eye. Nowadays, many companies use subcontractors to carry out this check because the cost to buying eddy currents is extremely high. The purpose of this project is to study the effectiveness of eddy current sensor testing and create eddy current sensors with low cost. This project has three isolated sections to facilitate development work.

## **DEDICATION**

To My Beloved Parents Mr Mohd Rashid bin Tarihep & Mrs.Azizah bin Mohd Subari

My Supportive Supervisor Mr Wan Norhisyam Bin Rashid

My Friends, Lecturers and

University Teknikal Malaysia Melaka

UTeM



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## LIST OF SYMBOLS

<b>kHz</b>	-	Kilohertz
<b>mm</b>	-	millimetre
<b>V p-p</b>	-	Voltage peak to peak
<b>LCD</b>	-	Liquid crystal display
<b>mA</b>	-	milliAmpere
<b>q</b>	-	Angle
<b>MHz</b>	-	Megahertz
<b>W/m<sup>3</sup></b>	-	Watt per cubic metre

## LIST OF ABBREVIATIONS

<b>PCA</b>	Principal Component Analysis
<b>NDT</b>	Non-destructive testing
<b>GSM</b>	Global System for Mobile Communications
<b>MPT</b>	Magnetic Particle Testing
<b>ECT</b>	Engine Coolant Testing
<b>DAQ</b>	Data Acquisition System
<b>PC</b>	Personal Computer
<b>USB</b>	Universal Serial Bus
<b>ICSP</b>	In-circuit serial programming
<b>AC</b>	Alternating Current
<b>DC</b>	Direct Current

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Nowadays, low cost eddy current testing are rarely found and maybe there is no machine eddy current in Malaysia have an affordable price to use. Oil and gas, aviation industry, metal manufacturing industry, mechanical processes, welding inspection are the industry that frequently use this technique. Besides, this project does not highlight on one industry only but for all industries and focus on the basis of eddy currents technique base. The human capability of knowing metal defects is limited. This is because human eye cannot see something that are too small and complicated view for them to analyse. Evaluation and detection of erosion and imperfections in industrial structures are critical for product quality confirmation and accident reduction(Chandra S. Angani, Ramos, Ribeiro, Rocha, & Prashanth, 2015).

The principle of eddy current formation using by eddy current sensors is use to sense displacement. The magnetic field moves or changes across the conductor or otherwise form eddy currents. Circulating flow of electrons or currents, within the conductor, cause by the relative motion. The electromagnets with magnet fields that oppose the effect of applied magnetic field are create by the circulating eddies of current. The more grounded the connected attractive field, or more prominent the electrical conductivity of the transmitter, or more prominent the general speed of movement, the more noteworthy the flows created and more prominent the contradicting field. Limitation of human ability to find out defect of the metal are the reason why this project to be choose as my final year project .Sometimes there is something that human cannot be seen by their abilities and it will affect the work that they doing, so this project also want to help human to achieve perfect work and reduce problem. For our information eddy current sensor tools that are using in industry price are high to be used .This sensor only can be used by big company and not friendly user because it is only can be use by certain people that highly trained to do so .

## **1.2 Problem Statement**

The Defect or crack that occur on the metal are the problem to human when they are make an inspection to the plate of metal because the defect is not can be detect by the naked eye of human and it must be inspect by the technique that require tool to find out the defect. There is three problem of the project have defined. Firstly, the limitation of human ability to find out defect of the metal are the main problem of this project. Besides that , high cost of eddy current sensor in market make this application are just for big industry .Lastly , a portion of the metal are inadequately in condition without inspection. Once in a while it is hard to recognize crack and not crack in metal material.

## **1.3 Objective**

1. To detect crack/defect on metal using eddy current testing sensor technique
2. To create low cost eddy current testing NDT equipment
- 3 To differentiate value current of 5 type of metal between the crack or not crack.

## **1.4 Scope**

1. Distinguish the eddy current value between cracks or not crack on metal by using Arduino microcontroller.
2. Using copper wire to create coil probe of the eddy current sensor.
3. Using 5 type of metal, aluminium, stainless steel, metal solid, copper and zinc as testing material to detect crack.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

This part will talk about the review of the recently designed project in numerous zones. The overviews for writing literature review were done from sources like insightful articles, papers and different sources. Writings for this undertaking were separated into three principle themes that are measurement technique, coil construction and type of non-destructive testing to detect crack on metal.

#### 2.2 Detect Crack using Non-destructive testing (NDT) technique

Non-destructive testing (NDT) is the survey of the structure by using a way that doesn't chance causation harm to the structure, which implies the piece of development still can be utilized even after the examination. Non-destructive testing is recognized from non-destructive evaluation (NDE) which is the stipulation of the readiness for determination of a structure by ways that don't endanger its strength. Non-destructive testing is frequently utilized for the identification of composite imperfections, and it is commonly utilized in various focuses in an exceedingly part's lifecycle. Ultrasonic, radiography, visual review, magnetic element, penetrant testing and eddy current are the example that most widely applied NDT techniques. Every one of these techniques supplements the others in different applications, while as a rule they cover in capacity. There are such huge numbers of methods accessible for NDT of strengthened concrete, so decision is our own for choice of technique relying on confinements, precision and

costing of strategy. It is designed to detect the presence or the appearance of defects in materials and production or use to precisely determine the characteristics: position, shape and size(Rida, Abdelhak, & Adib, n.d.).

### **2.2.1 Using Ultrasonic sensor to detect crack**

Ultrasonic testing is a piece of non-damaging testing methods dependent on the spread of ultrasonic waves in the object or material tried. In most normal ultrasonic testing applications, short ultrasonic pulse waves with focus frequencies running from 0.1-15 MHz, and at times up to 50 MHz, are transmitted into materials to identify interior imperfections or to portray materials. It can similarly be used on wood, cement and composites, yet with less objectives, also It is normally performed on steel and various metals and mixes anyway Numerous industries including steel and aluminium development, metallurgy, producing, aviation, car and other transportation segments are utilize by this testing.

There is project using ultrasonic testing to detect crack on rail road. The flaws in the form of cracks, blowholes, porosity in metallic pipes can be detected using the ultrasonic waves. Principle of reflection of waves are using by the ultrasonic sensor. The flaw can be detected by measuring the time interval of reflected beam. Measuring the distance and the exact location of crack is obtained using GPS module with the help of the ultrasonic sensor. GSM technique are the way of the communication. In the wake of identifying the crack the message is send to closest station with area of split. This framework is straightforward in activity and beneficial over both day and night break discovery. (Nagdevte, Zakir, Muley, & Shelar, 2017). Furthermore there is other previous project that are using ultrasonic sensor and the methodology was to examine a pulse through reverberation test along the rail which incorporates low recurrence surface waves.

The outcomes on introductory study of plates depended on thickness, despite the fact that the impedance of numerous guided wave prompts confounded sign understanding (Titus, 2016).

### 2.2.2 Using Radiography to detect crack

Radiographic Testing is usually led and utilized in industries to assessment the properties of material, and to guarantee the material is free of any blunders and polluting influences. This technique utilized high recurrence, short wavelength electromagnetic radiation that created by a radiation source to observe materials for installed imperfections. The noteworthy disclosure of X-rays by W.C.Roentgen in 1895 and radioactivity by Becquerel in 1896 and their resulting and reliable application to the examination of material substances gave the starting stage to the improvement and advancement of modern radiography. The objective of radiography is to show the presence of inadequacies or other assistant discontinuities inside the inside of the materials in examination.

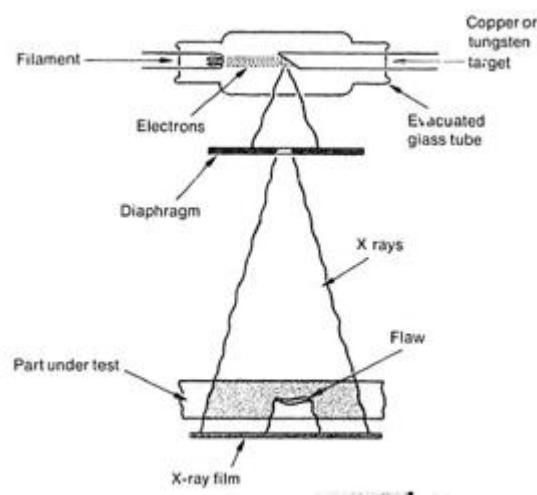


Figure 2.1: 2D view of radiography testing

Radiographic examination has a few operational confinements. To catch the film at practically right edges, the radiation goes in straight lines from its source. This blocks proficient experiment of things with complex calculation. Likewise, the data to be gathered from a radiograph, or plate, is differential retention of the radiation made the contained in thickness contrasts .The nonappearance of data or blunders happen and again on the grounds that these thickness contrasts must be orchestrated for all intents and purposes parallel to the bearing in which the radiation adventures..(Instrumentation, 1980)

### **2.2.3 Using Visual Review to detect crack**

Visual review is the fundamental strategy apply as a piece of visual NDT incorporates comprehension of the appraisal example with light, routinely in the undeniable district. The sample is then assessed with eye or by light delicate gadgets, for instance photocells, and as a usable method to recognize the surface of the blemishes that adversely affect a component. Visual inspection likewise as a standout amongst the most business techniques to assess consistent equipment unwavering quality. The equipment required for visual inspection is extremely easy going, anyway sufficient brightening is totally basic.

To organized inspection program, this is the easiest type of inspection, at times performed intentionally as a major aspect, however there visual inspection is executed as an oblivious movement as a component of everyday action. The only inspection given to material or weld is visual inspection. The prerequisite inspection method before any other test method is applied, visual inspection always been used. It works as first line of filtering the faulty of defective material and welds in most cases.(Singh & Singh, 2016)