



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE DEVELOPMENT OF SAFETY DEVICE FOR HUMAN INTERFACED AC MOTOR-BASED FOOD PROCESSING MACHINE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical And Electronic Engineering Technology (Industrial Automation and Robotic) With Honours.

by

MOHAMAD FAIZ AKMAL BIN FAIZUL

B071510178

931121-07-5435

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING
TECHNOLOGY

2019

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: THE DEVELOPMENT OF SAFETY DEVICE FOR HUMAN INTERFACED
AC MOTOR-BASED FOOD PROCESSING MACHINE

Sesi Pengajian: 2019

Saya **MOHAMAD FAIZ AKMAL BIN FAIZUL** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

- SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.
- TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.
- TIDAK TERHAD

Yang benar,

Disahkan oleh penyelia:

.....
MOHAMAD FAIZ AKMAL BIN

FAIZUL

Alamat Tetap:

No. 22 Taman Seri Sentosa,

Kilang Lama,

09000 Kulim,

Kedah.

Tarikh: 5 December 2018

.....
DR MOHD BADRIL BIN. NOR SHAH

Cop Rasmi Penyelia

Tarikh: 5 December 2018

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled THE DEVELOPMENT OF SAFETY DEVICE FOR HUMAN INTERFACED AC MOTOR-BASED FOOD PROCESSING MACHINE is the results of my own research except as cited in references.

Signature:

Author : MOHAMAD FAIZ AKMAL BIN
FAIZUL

Date: 5 DECEMBER 2018

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 Electrical and Electronic Engineering Technology (Industrial Automation and Robotic) With Honours. The member of the supervisory is as follow:

Signature:

Supervisor : DR MOHD BADRIL BIN. NOR SHAH

ABSTRAK

Terdapat banyak kejadian kecederaan serius pada manusia yang melibatkan mesin pemprosesan makanan. Ini disebabkan mesin-mesin tersebut tidak dilengkapi dengan ciri-ciri keselamatan yang boleh menghentikan mesin apabila risiko kecederaan dikesan. Bagi mengatasi masalah ini, satu peranti keselamatan dihasilkan dalam projek ini yang boleh mengesan bahagian tubuh manusia yang menyentuh bahagian berbahaya, dan seterusnya menghentikan mesin tersebut. Peranti ini dihasilkan menggunakan litar suis sentuh, litar motor mara-undur dan pengawalmikro. Bagi mengesahkan kecekapannya, peranti ini dipasang pada mesin pemerah tebu di mana penghancur berguling disambungkan ke terminal suis sentuh manakala litar motor mara-undur disambungkan ke motor mesin tersebut. Apabila bahagian tubuh manusia (seperti jari atau tangan) menyentuh penghancur berguling mesin tersebut, peranti akan dapat mengesan risiko kecederaan dengan serta-merta, lalu menghentikan motor pada mesin tersebut dalam masa 0.1 s pada kelajuan motor 1600RPM.

ABSTRACT

There are many incidents involving food processing machines that cause serious injury to human. This is due to fact that the machine does not equipped with safety features that can stop the machine when injury risk detected. To overcome this problem, a safety device is developed in this project that can detect human part touching the dangerous area, subsequently stop the machine. The device is developed by using touch switch circuit, forward-reverse motor circuit and Arduino microcontroller. To verify its efficiency, the device is installed to sugar cane juicer, where the rolling crusher is connected to touch switch terminal and forward-reverse motor circuit is connected to the motor of the machine. When human part (i.e. finger or hand) is touching the rolling crusher of the machine, the device is able to detect immediately the injury risk and stop the AC motor within 0.1s at motor speed 1600RPM.

DEDICATION

To my beloved parent's
Thank you for raised me,
Special appreciation to my supervisor
Dr Mohd Badril Bin Nor Shah

ACKNOWLEDGEMENTS

I would like to stretch my gratitude to Allah S.W.T for blessing me with good health, opportunities and courage to complete my learning journey in Universiti Teknikal Malaysia Melaka (UTeM). Without his blessing I would not be able to be here as a student who is keen to seek knowledge. Next, I would like to thank my family especially my mother and father who were always supporting me through the years, financially, practically and moral support. As nothing can make me feel happier to repay all of their sacrifices by becoming a wise man. I also would like to thank all my friends who helped me a lot during my final year project. Finally, I would like to express my special thanks of gratitude to my final year project supervisor, DR. MOHD BADRIL BIN NOR SHAH who gave me the golden opportunity to do this wonderful project. His willingness to help me to complete my final project. It is an honour to do my final project and my success I dedicated to you.

TABLE OF CONTENTS

| | PAGE |
|-------------------------------------------|--------------|
| TABLE OF CONTENTS | x |
| LIST OF TABLES | xiii |
| LIST OF FIGURES | xiv |
| LIST OF APPENDICES | xvii |
| LIST OF ABBREVIATIONS | xviii |
| | |
| CHAPTER 1 INTRODUCTION | 1 |
| 1.1 Project Background | 1 |
| 1.2 Problem Statement | 2 |
| 1.3 Objective | 4 |
| 1.4 Scope of Project | 4 |
| | |
| CHAPTER 2 LITERATURE REVIEW | 6 |
| 2.1 Introduction | 6 |
| 2.2 Transistor | 6 |
| 2.2.1 Touch Switch Circuit | 8 |
| 2.2.2 Touch Switch Device | 9 |
| 2.2.3 Capacitive Touch Sensing Circuit | 10 |

| | | |
|------------------|----------------------------------------------------------------------|-----------|
| 2.3 | Motor | 12 |
| 2.3.1 | AC Motor | 12 |
| 2.3.2 | Construction of the Stator and Rotor | 14 |
| 2.3.3 | AC Motor Operation | 16 |
| 2.3.4 | AC Motor Reverse Circuit | 17 |
| 2.4 | Microcontroller | 18 |
| 2.4.1 | PIC Microcontroller | 20 |
| 2.4.2 | Arduino Microcontroller | 20 |
| CHAPTER 3 | METHODOLOGY | 22 |
| 3.1 | Introduction | 22 |
| 3.2 | Touch Circuit Design | 23 |
| 3.3 | AC Motor Forward-Reverse Circuit Design | 24 |
| 3.4 | Integrating Touch Circuit Motor AC Motor Circuit and Microcontroller | 25 |
| 3.5 | Performance Testing | 29 |
| CHAPTER 4 | ANALYSIS AND DISCUSSION | 30 |
| 4.0 | Introduction | 30 |
| 4.1 | Comparison Analysis of the Touch Circuit | 30 |
| 4.2 | Experimental Results | 32 |

| | | |
|------------------|---------------------------------------------|-----------|
| CHAPTER 5 | CONCLUSION AND RECOMMEND FUTURE WORK | 43 |
| 5.0 | Conclusion | 43 |
| 5.2 | Recommend Future Work | 43 |
| REFERENCES | | 44 |
| APPENDIX | | 46 |

LIST OF TABLES

| TABLE | TITLE | PAGE |
|--------------|-----------------------------------------------------|-------------|
| Table 2.1: | Various Classes of Squirrel-Cage Asynchronous Motor | 17 |
| Table 2.2: | MCS-51 family | 18 |
| Table 2.3: | PIC16CXXX and PIC16FXXX family member | 19 |

LIST OF FIGURES

| FIGURE | TITLE | PAGE |
|---------------|------------------------------------------------------------------------------------|-------------|
| Figure 1.1: | Sugar Cane Machine that Resulted in Four Teenage Fingers Destroyed | 2 |
| Figure 1.2: | His Fingers Clamped into the Sugar Cane | 2 |
| Figure 1.3: | Hand destroyed by sugar cane machine | 3 |
| Figure 1.4: | Hand of a Woman Caught in Coconut Grinding | 3 |
| Figure 2.1: | Schematic Symbols for Transistor | 7 |
| Figure 2.2: | A Small Current on Base Control a Large Collector Current | 7 |
| Figure 2.3: | Touch Switch Circuit | 8 |
| Figure 2.4: | Touch Switch Device | 9 |
| Figure 2.5: | Touch Switch Circuit Connected To Relay | 9 |
| Figure 2.6: | Capacitive Touch | 10 |
| Figure 2.7: | The PCB Connects the Sensor Pad to Trace | 11 |
| Figure 2.8: | A PCB Implements a Capacitive Sensor Button | 11 |
| Figure 2.9: | A Motor an Electric Motor Used to Convert Electrical Energy into Mechanical Energy | 12 |
| Figure 2.10: | An Asynchronous Motor (dissected) | 13 |
| Figure 2.11: | Magnetic Circuit of Stator and Rotor of an Asynchronous Motor | 14 |

| | | |
|--------------|----------------------------------------------|----|
| Figure 2.12: | Stator of an Asynchronous Motor | 14 |
| Figure 2.13: | Slip Ring Asynchronous Motor | 16 |
| Figure 2.14: | Reverse Circuit of AC Motor | 17 |
| Figure 2.15: | Basic Layout of Microcontroller | 19 |
| Figure 2.16: | Arduino UNO Board | 21 |
| Figure 3.1: | Flowchart of this Project | 22 |
| Figure 3.2: | Touch Circuit | 23 |
| Figure 3.3: | Touch Circuit | 24 |
| Figure 3.4: | AC motor Reverse Circuit | 24 |
| Figure 3.5: | The Field Diagram Proposed in this Project | 25 |
| Figure 3.6: | Block Diagram Food Processing Machine | 26 |
| Figure 3.7: | Sugar Cane Juicer Food Processing Machine | 27 |
| Figure 3.8: | Coding Flowchart | 28 |
| Figure 4.1: | Two Types of Touch Circuit | 31 |
| Figure 4.2: | Not Touch the Switch Sensor | 32 |
| Figure 4.3: | The response of Touch Circuit A for person 1 | 33 |
| Figure 4.4: | The response of Touch Circuit A for person 2 | 33 |
| Figure 4.5: | The response of Touch Circuit A for person 3 | 34 |
| Figure 4.6: | The response of Touch Circuit A for person 4 | 34 |
| Figure 4.7: | The response of Touch Circuit A for person 5 | 35 |
| Figure 4.8: | The response of Touch Circuit A for person 1 | 35 |
| Figure 4.9: | The response of Touch Circuit A for person 2 | 36 |
| Figure 4.10: | The response of Touch Circuit A for person 3 | 36 |

| | | |
|--------------|-------------------------------------------------------------------------|----|
| Figure 4.11: | The response of Touch Circuit A for person 4 | 37 |
| Figure 4.12: | The response of Touch Circuit A for person 5 | 37 |
| Figure 4.13: | Not Touch the Switch Sensor | 38 |
| Figure 4.14: | The response of Touch Circuit B for person 1 | 38 |
| Figure 4.15: | The response of Touch Circuit B for person 2 | 39 |
| Figure 4.16: | The response of Touch Circuit B for person 3 | 39 |
| Figure 4.17: | The response of Touch Circuit B for person 4 | 40 |
| Figure 4.18: | The response of Touch Circuit B for person 5 | 40 |
| Figure 4.19: | Speed of Motor Running | 41 |
| Figure 4.20: | Breaking time of the motor when rolling crusher is touched by finger | 42 |

LIST OF APPENDICES

| APPENDIX | TITLE | PAGE |
|------------|-------------------------------------------------------------------|------|
| Appendix A | Coding for Digital Circuit | 46 |
| Appendix B | Coding for Analog Circuit | 49 |
| Appendix C | Sugar Cane Machine with Touch Circuit and Forward Reverse Circuit | 51 |

LIST OF ABBREVIATIONS

| | |
|------------|----------------------------|
| RPM | Rotation Per Minute |
| NPN | Negative Positive Negative |
| PNP | Positive Negative Positive |
| LED | Light Emitter Diode |

CHAPTER 1

INTRODUCTION

1.1 Project Background

Sugar cane juices machine and coconut grinder machine are the example of food processing machine. The main component of these machines is AC induction which uses AC electric sources to drive the motor. The motor AC will not stop as long as the user does not press the switch (stop) on the machine despite the occurrence of accidents in food processing machines. Usually, the machines are operating manually: user turn on or turn off the switch to activate or deactivate the machine.

Since the food processing machine usually equipped with sharp metal blade and metal rolling mechanism, there are many accident that caused injury to user has been reported. This is due to the machine does not have safety feature that can stop the machine once injury risk is detected. Thus a safety features, by all means should be equipped to the machine to prevent such incident.

The safety feature of the food processing machines should be able to detect human part touching the dangerous part of machine. Once detected, the safety system will instantly stop the motor to prevent further injury. recommendation by the examiners to conduct additional studies so that the stated objectives are met.

1.2 Problem Statement

There are many incidents that have caused serious injury to humans, as shown in Figure 1.1 to Figure 1.3. Sugar cane juice and coconut grinder machine are the common machines used by many people for food processing and also have caused many cases of such injury incidents.



Figure 1.1: Sugar cane machine that resulted in four teenage fingers destroyed (Syazwana, 2015)



Figure 1.2: Fingers clamped into the sugar cane (Mazirah, 2017)

BALING 8 Ogos - Sambutan hari raya tahun ini sudah pasti berbeza buat Mohd. Hafiz Haikal Shahrudin, 5, yang putus pergelangan tangan kanannya akibat tersepit mesin tebu.



Kejadian kira-kira 4.30 petang 31 Julai lepas itu sama sekali tidak diduga.

Ibunya, Siti Aishah Mohamad Sidek, 33, singgah di sebuah gerai menjual air tebu di Jalan Kampung Sungai Limau dekat sini untuk membeli air tebu kerana anak bongsu daripada empat beradik itu hendak minum air tebu.

Siti Aishah berkata, dia memberhentikan kereta di tepi jalan manakala Mohd Hafiz Haikal dan anak keduanya, Nurul Intan Safira menunggu dalam kereta.

Ketika ibunya sedang berurusan membeli air tebu, mangsa keluar dari kereta dan memegang mesin yang sedang memerah hatang tebu menyebabkan tangan kanannya tersepit.

Usaha mengeluarkan tangan mangsa yang tersepit di bahagian pergelangan tangan dilakukan lebih 30 minit dengan bantuan orang ramai yang berada di sekitar gerai itu.

Akibat kejadian itu, pergelangan tangan Mohd Hafiz Haikal terpaksa dipotong di Hospital Sultan Abdul Halim (HSAH) Sungai Petani kerana hancur.

Berikutan itu mangsa terpaksa menerima rawatan lebih seminggu sebelum dibenar keluar petang semalam.

Ketika ditemui pemberita di rumahnya di Kampung Banggol, Asam Jawa di sini, bapa kanak-kanak itu, Shahrudin Ismail, 33, seorang pekerja kampung, berkata dia sudah membuat laporan polis berhubung kejadian itu.

"Saya berharap ada pihak terutama Jabatan Kebajikan Masyarakat (JKM) dapat membantu mendapatkan tangan palsu untuk anak saya," katanya.

Sementara itu, Aishah berkata, dia menerima kejadian itu sebagai takdir dan ujian kepada keluarganya sempena bulan Ramadan ini.

Mohd Hafiz Haikal memerlukan rawatan susulan di HSAH setiap minggu. - BERNAMA

Figure 1.3: Hand destroyed by sugar cane machine (Arkib, 2012)



KUALA LUMPUR – Seorang wanita terpaksa menahan kesakitan apabila lengan kanannya tercucuk besi mesin kisar kelapa di Damansara Damai, Petaling Jaya, pagi tadi.

Jurucakap Jabatan Bomba dan Penyelamat Selangor berkata, pihaknya menerima panggilan kira-kira jam 11.03 pagi dan sebuah jentera dari Balai Bomba dan Penyelamat Sungai Buloh bergegas ke tempat kejadian.

Menurutnya, anggota bomba membantu mengeluarkan besi yang tercucuk pada lengan mangsa sebelum dihantar ke Hospital Sungai Buloh untuk menerima rawatan.

Figure 1.4: Hand of a woman caught in coconut grinding (Mynewshub, 2017)

The exposed, sharp and rolling parts of food processing machines always make the user vulnerable to serious injury. This AC motor-based machine is rotating at low and medium speed for food processing. This part is driven by AC motor at low or medium speed. Thus the motor should be connected to the device that can stop the motor once human part is detected.

1.3 Objective

The aims of the project are:

- a) To design a circuit that capable:
 - To detect human part touching the dangerous area of sugar cane machine.
 - To stop or brake the motor of the machine that drive the dangerous part.
- b) To develop hardware prototype of the device.
- c) To analyse the performance of the developed device.

1.4 Scope of Project

The scopes of this project including circuit design, hardware development and AC motor type. The explanation of these scopes is as follows:

a) Circuit development

The circuit consists of two parts: Touch circuit and motor reverse circuit.

These circuits is connected to a microcontroller to form a complete device.

b) Hardware prototype development

The hardware prototype of this project is developed to realize the designed circuit to show how it functions when two circuits are combined.

c) AC motor

The project is focus to the machine that is operated by single phase AC induction motor. The machine that using three phase motor or reluctance motor is not covered in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is a content of an academic paper and relevant sources, which incorporates the current information counting substantive discoveries, as well as hypothetical and methodological commitments to a specific point. Before starting the project, resources such as journals, newspapers, books and technical report need to be sought to prepare literature review. In literature review has provides about NPN transistor, motor and microcontroller.

2.2 Transistor

Transistor operates by switching a flow of electricity it same as a relay. The transistors have three pins connections; its Collector (C), Base (B), and Emitter (E). Figure 2.1 shows schematic symbols for transistor. The transistors have two types. Its NPN and PNP types both of two transistors is have same the three connection, NPN transistors are activated by positive voltage and PNP transistor are activated by negative voltage both of them same through on the base relative to the emitter (Platt, 2009).