UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AN IOT-BASED MINI INDUSTRIAL AUTOMATION TRAINER FOR SCHOOL EDUCATION IN MALAYSIA

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical andElectronic Engineering Technology (Automation and Robotics) with Honours.

by

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I hereby, declared this report entitled “Development of an IoT-based Mini Industrial Automation Trainer for School Education in Malaysia”. is the results of my own research except as cited in references.

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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 (Automation and Robotics) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Dengan perkembangan dan pemodenan teknologi semasa, automasi telah memainkan peranan besar dalam peradaban industri. Automasi adalah teknologi menggunakan pelbagai sistem kawalan untuk mengendalikan sistem atau peralatan yang kebanyakannya digunakan dalam proses mesin dan pembuatan. Automasi dapat membantu dalam meningkatkan produktiviti, kecekapan, dan keselamatan dalam menangani pekerjaan dan tugas yang dilakukan oleh manusia sekaligus mengganti beban kerja manusia dalam situasi sulit apa pun yang memerlukan ketepatan dan ketepatan. Automasi juga dapat dikendalikan dan dipantau menggunakan PLC sebagai pengawal utama dan kombinasi teknologi bantuan komputer atau antara muka manusia komputer yang juga dapat dikenal sebagai Antarmuka Manusia-Mesin (HMI) sebagai pengawal sekunder. Makalah ini menekankan pada pentingnya pengetahuan automasi yang dapat didedahkan melalui pengajaran pendidikan dengan mengembangkan kit latihan yang menggambarkan proses automasi industri. Kit latihan harus dalam ukuran mini dan boleh diterima untuk pendidikan yang mesra pengguna untuk tujuan sekolah. Kit latihan terdiri daripada antara muka PLC dan HMI sebagai pengawal, serta modul input dan output PLC seperti motor DC, suis dan bahkan beberapa sensor. Pendawaian input dan output PLC bersama dengan pengaturcaraan PLC juga akan disertakan dalam makalah ini untuk tujuan pendidikan. Projek atau kit latihan juga dapat menerapkan konsep IoT di mana kit pelatih dapat dikendalikan dan dipantau dari jarak jauh menjadikan pendidikan menjadi lebih fleksibel dengan menggunakan alat kawalan jauh. Oleh itu, pengetahuan teknologi automasi industri ini dapat disampaikan kepada generasi baru.

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ABSTRACT

With current technology development and modernisation, automation have played a big role in the industrial civilisation. Automation is the technology of using various control systems to operate a system or equipment that mostly used in machinery and manufacturing processes. Automation could help in increasing productivity, efficiency, and safety in handling work and task done by humans while also replacing human workload in any difficult situation that requires accuracy and precision. Automation could also be control and monitor using PLC as main controller and the combination of computer-aided technologies or computer human interfaces that can also be known as Human-Machine Interface (HMI) as a secondary controller. This paper emphasises on the importance of automation knowledge that could be exposed through educational teaching by developing a training kit that describe a process of an industrial automation. The training kit should be in mini-size and acceptable for education that are user friendly for school purposes. The training kit is consisting of PLC and HMI interface as the controllers, as well as PLC input and output modules such as DC motors, switches and even some sensors. PLC input and output wiring along with the PLC programming also will be included in this paper for educational purposes. The project or training kit could also implement the IoT concept where the trainer kit could be maneuvered and monitored from distance making the education to be more flexible by using smart remotes or gadget facilities that are present nowadays. Consequently, the knowledge on the industrial automation technologies today could be pass on to the new generation.

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DEDICATION

To my beloved parents Mr Saneh Bin Mawar and Mrs Endok Golah Binti Abd Latiff for their support and pray. A full appreciation to my supervisor Mr Maslan Bin Zainon for advising and helping me through this project.

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First and foremost, I would like to express my deepest gratitude to Allah S.W.T for His goodness and grace that sustained my performance in completing this Undergraduate Final Year Project (PSM) entitled Development of an IoT-based Mini Industrial Automation Trainer Kit for School Education. I would not be able to complete this project without His permission.

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Then, I would also like to express my gratitude to my supervisor for guiding, helping and supporting me throughout the process of the project to complete the project with success since the beginning.

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LIST OF ABBREVIATIONS

PLC	Programmable Logic Controller
HMI	Human Machine Interface
IoT	Internet of Things
I/O	Input and Output
TFT LCD	Thin-film transistor Liquid Crystal Display
VB module	Visual Basic module
SMF	Smart Mini Factory
CPU	Central Processing Unit
PSU	Power Supply Unit
FBD	Functional Block Diagram
LD	Ladder Diagram
ST	Structured Text
IL	Instruction List
SFC	Sequential Function Chart
PCMCIA	Personal Computer Memory Card International Association
RAM	Random Access Memory
TCP/IP	Transmission Control Protocol/Internet Protocol
HRI	Human-Robot-Interaction

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CHAPTER 1

INTRODUCTION

1.1 Background

Automation trainer kit is an educational kit used to replicate the training kit used in the industry showing the automation process in handling machinery and manufacturing. In order to develop an educational trainer kit for teaching purposes, a user-friendly controller need to be used and hence programmable logic controller (PLC) are chosen as the main controller of the system. Industrial automation has proven to incorporate with the PLCs in the manufacturing processes. PLC is a processing system that allows variation of controls of inputs and outputs using simple programming. PLCs consists of programmable memory that can be used to store instructions and functions such as logic, sequencing, timing, counting, etc. PLC can receive variety of inputs and return a variety of logical outputs. PLC is chosen as the main controllers because of its flexibility when operating a range of different control systems and its durability as well as resistance towards electrical noise. PLC wiring is also not that hard to maintain in order to change or rewire to change the control system. Therefore, with mind intact on that importance, this paper elaborates on the development of a mini industrial automation trainer kit built for school education. The trainer kit will be made from the combination of PLC, HMI interface, input and output modules like DC motor and sensors. The PLC and HMI system will also be designed with a simple user-friendly programming that could be implement to the whole project

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system. So basically, the training kit is developed to expose to the school students about the basic industrial automation operation, on how automation is implemented in the industry making task easier while increasing its productivity. The training kit system will also synchronize with the IoT elements in making the education to be delivered more conveniently. The trainer kit system could be accessed and monitor by the students through their gadgets or smartremote.

1.2 Problem Statement

The use of automation in production equipment has been established and demand since in the year 1970s. By using technologies, many manufacturers have worked on increasing the productivity, reliability, capability and flexibility of machinery systems. To achieve that objective PLC is one of the system devices that have been used as a solution to the evolution trend in producing more automation in manufacturing. PLCs then most likely be chosen by end-user manufacturers as a tool designed specifically for the use in industrial environments and are guaranteed for a long-term support by vendors (Hajarnavis and Young, 2008). Therefore, to understand an automation system, the students should be exposed to the systems used in the automation industry which is at this point, a PLC. The PLC system consists of PLC programming, PLC hardware wiring connections and the interface of I/O modules. (Bayrak and Cebeci,2012).

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According to the World Bank, to improve one country's productivity, automation is viewed as inevitable in manufacturing in view of rising labour cost which still lags behind some high-income regional economies (Tan Zhai

Yun,2018). Hence, an individual who could monitor, operate and maintain the automation system in machineries and manufacturing need to be develop for the consideration of our country's economy resource development. Along on that matter, the implementation of IoT could also be combine with the equipment used in the automation sector to align with the objective standards of Industry Revolution 4.0. Hence, with the development of the mini automation trainer kit throughout this project, an education training could be targeted at a younger age especially school students. This is to cultivate student's interests in automation technologies that they will confront in the industry the future. Thus, an information technologist, IT-wise generation could be born for a brighter future.

1.3 Objectives

The main objectives of the project are:

i. To design and develop IoT-based circuits for a mini industrial automation trainer.

ii. To design and develop a hardware for the automation trainer that is suitable to be used in school education environment.

iii. To analyse the efficiency of the automation trainer in terms of its operation cycle time for students' teaching and learningactivity.

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1.4 Scope of Project

The main aim of this project study is to design and develop a mini automation trainer kit system to show a basic automation process in industry for education purposes. There is some important scope of study that could be recognise at this stage. The scope of study is: -

i. The mini industrial automation trainer is mainly controlled by PLC (LE3U FX3U 48MR 6AD 2DA) that consists of 24 inputs/outputs and is compatible with Mitsubishi PLC software (GX-Developer) in designing PLC logic programming through ladder diagram. The PLC will be the main components in aiding the school students to understand about automation knowledge.

ii. The automation trainer uses HMI (from Nextion) which is a user interface that synchronize with the PLC to provide interactive features between the user and system through touchscreen.

iii. The automation trainer will also practice IoT features where connectivity between HMI and user's smartphone or gadgets can be linked through Wi-Fi module or linked through a same server (in form of IP address).

iv. The mini industrial automation trainer will portray the automation process in processing and assembling operations such as: - conveyor

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belting, drilling, pick and place and sorting operations. Proximity sensors will be used in object detection in the system, DC motor and pneumatic cylinders for the processing operations and LEDs as indicators.

v. The size of mini industrial automation trainer that will be developed should not be more than one fathom (6 ft or 72 inches) so that it is still portable and convenience to handle.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An overall inquiry of the development of an industrial automation trainer kit with the use of programmable logic controller (PLC) and Human Machine Interface (HMI) as controller is explained in this chapter. This area additionally grants the data about the main component or device used for the project. The most significant sources of data related to the project are taken from articles, journals, case report and websites. The sources have been analyzed and chose totally based on the analogous and relevant side of the project'sscope.

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2.2 Programmable Logic Controller (PLC) and Human Machine Interface (HMI)

Based on the design, figure 2.1 below shows the Programmable Logic Controller (PLC) which will be accustomed to control the overall system of the project. The PLC will act as a brain and as the main controller in the system that controls the process of input and output devices found in the system project to demonstrate the process of automation in the industry. The system process is determined by the PLC programming and wiring.

Figure 2.1: Programmable Logic Controller (PLC) (LE3U-48MR-6AD-2DA)

The project system is also then aid by the HMI also known as the secondary controller. The HMI is an interface made between the operators and the machine which enables the operator to maneuver parts of the process in the system through touchscreen graphical display. The design of the HMI can be shown as follows in Figure 2.2.

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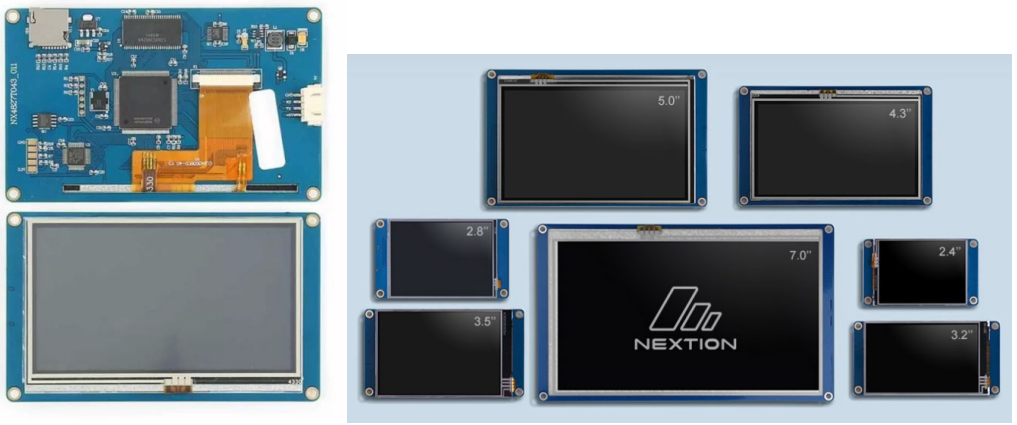

Figure 2.2: Human Machine Interface (Nextion TFT HMI Display)

2.2.1 Overview about PLC and HMI

Nowadays, the use of PLC is not unusual anymore in the automation industry. The PLC has genuinely played an important role in operating one's system in certain industry. A programmable logic controller (PLC) is an industrial electronic computer which has been made to be sturdier and more adopted for controlling manufacturing processes, robotic devices or any process that needs high accuracy, simple programming and easy maintenance and fault diagnosis. PLC can be made up from a modular device that consists of arrangements of digital and analogue inputs and outputs (I/O). PLC is also known as a controller that could be program to control machine operation stored in a non-volatile memory. Basically, PLC operates by receiving information from connected sensors input devices. Then, the data received is processed and the outputs will be trigger based on pre-programmed parameters. Looking on the inputs and outputs, a PLC can track and indicate run-time data such as machine productivity or operating temperature, automatically start and stop processes, triggering alarms when machine malfunctions and more. PLC is also chosen because of its flexibility and robustness, as well as its adaptability to most application.

In the project, the type or version of PLC used is the LE3U-48MR-6AD-2DA is a programmable controller made by Chinese and it is compatible with Mitsubishi Electric system software. The programmable logic controller uses industrial grade 32-bit that could prevent interference and with much faster speed. The PLC program is design in ladder logic programming language which compatible with the Mitsubishi GX-Developer or Gx-work2 PLC software. The

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