DEVELOPMENT OF IOT BASED MONITORING AND CONTROL SYSTEM IN INDUSTRIAL MACHINE

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

by

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I hereby, declared this report entitled DEVELOPMENT OF IOT BASED MONITORING AND CONTROL SYSTEM IN INDUSTRIAL MACHINE 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 Electronic Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Revolusi Perindustrian 4.0 telah memberi perubahan kepada industri pembuatan dalam melibatkan sistem mereka dalam teknologi rangkaian *"Internet of Things"* (IoT). Projek ini mensasarkan keadaan yang berlaku dalam industri sebenar dimana permasalah yang timbul apabila sistem yang sedia ada tidak mempunyai ciri-ciri IoT. Proses menyusun sepertimana yang ada dalam industri sebenar dibangun dalam platform kilang maya menggunakan perisian Factory I/O agar memastikan sistem lebih selamat dan cekap sebelum diaplikasikan dalam industri. Proses dikawal dengan menggunakan mikrokontroler Arduino Mega 2560 menggantikan fungsi *"Programmable Logic Controller"* (PLC) dalam operasi. Program dibangunkan mengikut arahan urutan sepertimana penggunaan PLC dan Modbus TCP/IP digunakan sebagai jalan komunikasi antara perisian dan Arduino. Ianya bergantung kepada 4 keadaan kemasukan barang ke dalam proses. Sementara itu, ESP32 melaksanakan kawalan dan pemantauan terhadap sistem melalui pelayan web sebagai aplikasi IoT. Sistem ini secara amnya boleh dipantau melalui rangkaian internet akan kemaskini perubahan yang berlaku pada urutan proses menyusun dalam masa nyata. Selain itu, terdapat ciri tambahan seperti pembilang bagi setiap barang yang telah dihasilkan dan penggera bagi kondisi tidak biasa semasa proses berlaku.

ABSTRACT

Industrial Revolution 4.0 has changed the manufacturing industry in involving their systems in Internet of Things (IoT) network technology. This project targets the situation in the real industry where problems arise when the existing system does not have IoT features. The sorting process as in the real industry is built in a virtual factory platform using Factory I/O software to ensure the system is more secure and efficient before being applied in the operation. The process is controlled using the Arduino Mega 2560 microcontroller replacing the programmable logic controller (PLC) function in the industry. The program is developed according to the sequence instructions as the use of PLC and Modbus TCP / IP is used as a communication path between Software and Arduino. It depends on the 4 conditions of item entry into the process. Meanwhile, ESP32 implements control and monitoring of the system via a web server as an IoT application. This system can generally be monitored through the internet network will update the changes that occur in the sequence of the sorting process in real time. In addition, there are additional features such as a counter for each item that has been generated and an alarm for abnormal conditions during the process.

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CHAPTER 1

INTRODUCTION

1.1 Background

The development of technology today in the industrial world has accelerated especially in the manufacturing industry. The success of this fourth revolution or known as IR4.0 empowered by the Internet of Things (IoT) in the application industry to increase productivity and improve operations through real-time data access. This technology leverages production machine communication to the cloud allowing data flow to be transferred. In addition, it provides the ability to monitor and control the process remotely which allows production to be changed quickly in real time when it is needed. This is done by controlling and monitoring the machine remotely based on real data obtained from various parts of the factory even throughout the factory.

This smart factory is simulated using 3D virtual factory which adopted to the real system. It enables to build a virtual process such as sorting process and assembler process in the actual manufacturing industry. Equivalent systems that have been designed with virtual factories allow IoT development to be significantly analysed before the system is applied. Furthermore, virtual factory assembling subsystem using a library of industrial component including sensors, conveyors, and many others. The virtual factory-based PLC training platform also interfacing controller physically by using microcontroller, SoftPC, TCP / IP and other technologies. Hence, IoT-based systems developed through virtual processes enables production machines to be controlled and monitored remotely with connections from internet.

1.2 Problem Statement

Industrial companies face problems with indirect data collection in real time where machines are only visually monitored by manual due to non-IoT-based manufacturing equipment. Companies may be afraid to replace old devices that still work well even those are 20 years or more old. Consequently, it requires the development of a new system, a lot of cost investment and replace an assembly-line equipment which disrupts production. The actual factory process is simulated using virtual factory software requires human intervention either to control or monitor it. The upgrade virtual process with IoT features can implement control systems and monitoring over the internet.

1.3 Objective

The aims of this project are based on problem statement above:

1) To design and develop machine using virtual factory platform.
2) To develop control on virtual factory system using microcontroller.
3) To develop internet-based monitoring and control system.

1.4 Scope

This project focuses primarily on the use of virtual process in control and monitoring systems through the implementation of IoT. This 3D virtual factory simulation designs and develops system into an actual sorting process in industrial manufacturing. The system develops by Arduino as a controller assisted by Arduino Ethernet Shield capable to control the virtual factory process through Modbus TCP/IP

communication. The virtual process factory also can be control and monitor via the web server. Moreover, the features such as a counter will be added monitors the value of production for maintenance to ensure quality of productivity.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on term of IoT relates to control and monitor the industrial machine application by simulation process. Review of audit and centralize various research articles on tests that have been successfully conducted by analysts or experts who are significantly different in the field of study. It also relates to identify and review existing critiques within the topic to justify this research by uncovering gaps in current research. This review adds even better understand the project development and provide a basic idea of how it can help current project development.

2.2 Related

Research on journals or sources related to the subject field will be presented in this section. The purpose of the literature review is to collect valuable knowledge, as well as to gather relevant details that might be useful in this study.

2.2.1 Control and Monitor Automatic PLC System for Packaging Industry

A Human Machine Interface (HMI) implemented for a Programmable Logic Controller (PLC) based automation in packaging process which may be remotely monitored and controlled by mobile application(Mofidul et al. 2019). An IR sensor used to detect objects and provide feedback to the Arduino Uno to move the relay. All the

conditions for relays are taken as PLC input. An HMI is designed to create a communication channel between PLC-based operators and factories through android applications and microcontroller.

Model considers one conveyor belts for items to be transport to the destined box and another conveyor belts to transport unfilled boxes and filled boxes. The PLC acts as a controller for high-speed DC motor that rotates the conveyor belt. The interface designed to control and monitor the processes depending on Bluetooth module, Arduino uno and android platform.

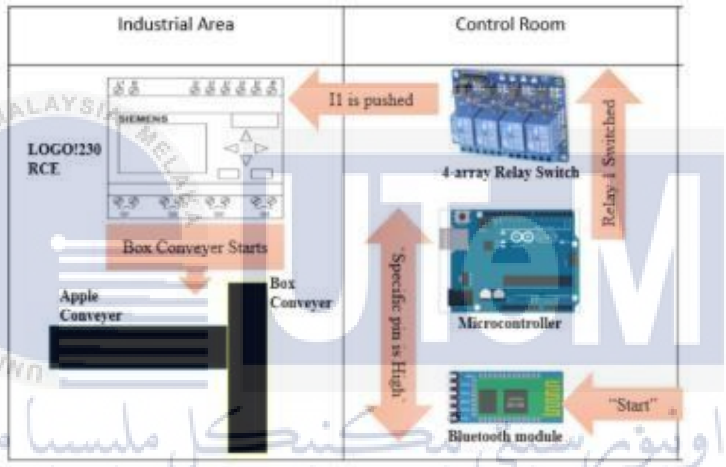

Figure 2.1: Procedure of the system

The implementation of the Software includes the PLC ladder diagram built android application and configured programs as remote control and monitoring system for Arduino. It is also applied utilizing LOGO! Soft V8 in programming and operation of the introduced model. For a quicker, straightforward, and space-saving solution, LOGO! is an ideal selection. LOGO! Soft Comfort minimizes wiring with easier installation.

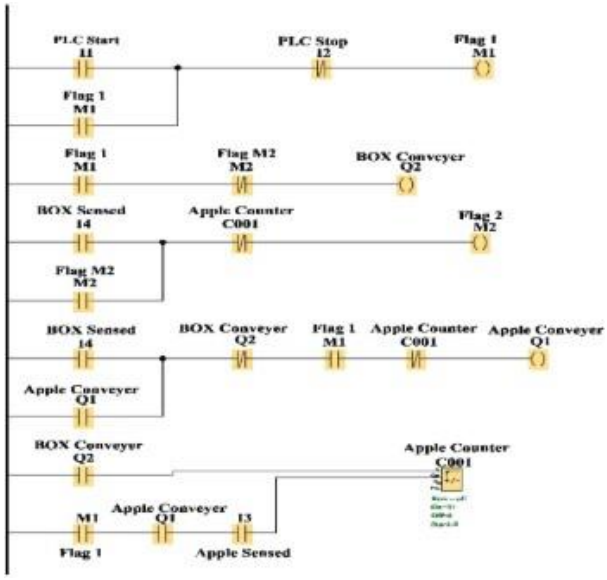

Figure 2.2: The automatic packaging system ladder diagram

Input				Output	
I1	I2	I3	I4	Q1	Q2
PLC starts	PLC stops	Apple or sample sensed	Box sensed	Apple or sample conveyor belt	Box conveyor belt
Relays				Counter	
M1		M2		C001	
Relay contacts		Relay contacts		Apple Counter	

Figure 2.3: Inputs, outputs, and configuration of PLC relay

Android Studio (emulator) is used to develop Android-based PLC monitors application as a remote control. This application provides for remote observation with a single row display and three control buttons.

Table 2.1: Summary Table regarding to 2.2.1

Author(s)	Description	Method
Mofidul et al. (2019)	This PLC with implementation of an HMI that can be controlled and monitored for a prototype of automated packaging process applications through mobile phones. Operators and factories communicate same path to minimize the overall cost of using SCADA.	Android Studio is used in sending command signals and receiving status by the Arduino Uno via Bluetooth. The Switching Relay operates in this process to provide plc input from Arduino as control mode. Arduino receives output from PLC as monitoring mode. Ladder diagram of PLC develops by LOGO! Soft V8.

2.2.2 Automation Industry Simulation Software

According to Sciences (2018) in his thesis aims to create a 3D model of the robotics laboratory which to be used with the KUKASim together with finding a suitable method for transferring code to the actual robots. KUKASim, a simulation software in which the user can make an environment and the robot programming simulation. It permits the offline programming of the robot and since a real environment can be designed, the software is helpful to attempt the program before downloading it to the robot. That could be useful so as to evade impacts and to advance the program. The software gives the chance to have a real time connection with the KUKA's virtual