DESIGN AND DEVELOPMENT OF RFID METAL-BASED ITEMS TRACKING SYSTEM FOR AUTOMOTIVE MANUFACTURING PLANT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) (Hons.)

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ABSTRAK

Sistem pengenalan frekuensi radio (RFID) digunakan secara meluas dalam pelbagai sektor terutamanya untuk tujuan pengesanan. Sistem RFID menggunakan gelombang radio isyarat yang tidak memerlukan barang yang berada dalam hubungan untuk pengesanan. Objektif utama projek penyelidikan ini adalah untuk membangunkan sistem pengesanan RFID dalam sektor industri pembuatan automotif. Projek ini merangkumi pembangunan teknologi automasi mengenai pengurusan data yang berkaitan dengan sistem RFID dan ujian sistem RFID untuk memantau aliran komponen automotif di sebuah syarikat pembuatan. Eksperimen telah dilakukan untuk mengenal pasti tetapan optimum sistem RFID. Hasil daripada pemasangan sistem dan kalibrasi telah dibentangkan dalam laporan ini. Sistem ini telah dipasang di sebuah kilang automotif menggunakan tetapan optimum dan data telah dikumpul. Keputusan eksperimen menunjukkan bahawa dua antenna diperlukan untuk prestasi pengesanan yang lebih baik. Walau bagaimanapun, peningkatan seterusnya dikehendaki untuk meningkatkan prestasi pengesanan untuk kadar kejayaan yang penuh. Ia adalah disyorkan untuk menggunakan dua antena pada setiap pintu penerimaan dalam susunan mendatar untuk mengatasi jarak pembacaan yang singkat dan masalah kelajuan tag. Pada konfigurasi sistem semasa, kadar kejayaan pembacaan yang dicatatkan adalah sekitar 50%. Ini bermakna hanya 50% daripada keseluruhan komponen dikesan dan direkodkan. Keputusan yang kurang baik ini adalah kerana kekurangan peralatan dan kesan haus dan lusuh daripada peralatan yang sedia ada.

ABSTRACT

Radio frequency identification (RFID) system is widely used in many sectors mainly for tracking purposes. RFID system uses radio waves signal which does not need the item to be in contact for identification. The main objective of this research project is to develop an RFID based tracking system for automotive manufacturing industry. This project includes development of automation technology on management of data related to the RFID system and testing of the RFID system to monitor the flow of the automotive components in a manufacturing company. Experiments were performed to identify the optimum settings for the RFID system. Results of the system setup and calibration are presented in this report. The system was set up in an automotive plant using the optimum settings and data was collected. Results showed that two antennas are required to be set up on a stand for a best tracking performance. However, further improvement is desired to improve the tracking performance to a full success rate. It is recommended to set up two antennas at each side of the receiving dock in a horizontal arrangement to overcome the shorter reading distance and tag movement speed problem. At current system configuration, the reading success rate recorded was around 50%. That means, only 50% of the desired items are detected and recorded. This poor value has been determined to be the results of the hardware limitations and wear and tear effects of existing equipment.

DEDICATION

Only

my beloved father, Baskaran A/L Appukutty

my appreciated mother, Malathi A/P Sukumaran

my adored brother, Kirubakshan A/L Baskaran

for giving me moral support, money, cooperation, encouragement and also understandings

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RFID	-	Radio Frequency Identification
OCR	-	Optical Character Recognition
DNA	-	Deoxyribonucleic acid
RW	-	Read write
RO	-	Read Only
WORM	-	Write Once, Read Many
RF	-	Radio Frequency
IC	-	Integrated Circuit
HF	-	High Frequency
UHF	-	Ultra High Frequency
IT	-	Information Technology
WIP	-	Work In Progress
MES	-	Manufacturing Enterprise Solutions Association
EPC	-	Electronic product code
RTLS	-	Real-Time Location System
GPS	-	Global Positioning System
IOT		Internet of Things
PSM		Projek Sarjana Muda
ANOVA		Analysis of Variance

CHAPTER 1
INTRODUCTION

This chapter explains briefly about this project, starting with background of the automatic tracking system using RFID technology that monitors flow of goods in a production job floor project. The next section discusses the details of the problem statement which lead to this project and followed by the objectives of the project in Section 1.3. Based on the problem statement and the objectives stated in the previous section, the scope of the project is identified. Lastly, the content of the report is overviewed in Section 1.5.

1.1 Project Background

Radio frequency identification is technology used for tracking purpose using radio waves signal. This technology has been started to be applied since 1973. RFID is said to be the new era barcode system. RFID is better than any other automatic identification method due to its advantage of no line of sight needed for the detection of the object to be tracked. RFID system contains tag, antenna reader and a host computer which has the ability to complete information collection, identification, processing and transmission (Yang and Yang, 2011). The RFID works such as a reading device inquire the tag attached to the object and obtain the stored information. The reader discharges electromagnetic waves at a specific frequency which is detected by the tag when powered. The tags holds the information storage, antenna sends the electromagnetic waves and get back the answers from the tags, and the readers which are connected to the host computer decodes the answers and reads the information from the tag.

1.2 Problem Statement

Object tracking is important in manufacturing industry to record all the incoming and outgoing inventories of the company. The goods in the production floor have to be managed and kept track well to ensure a productive and efficient process. The manufacturing process is to be integrated using computer system to automate the material handling system in the production floor. RFID system is needed by PHN Industry Sdn. Bhd. located in Alor Gajah, Melaka for tracking the incoming and outgoing automotive components in their production floor. All the automotive components will travel in the production floor in trolleys. When the incoming automotive parts enter the premise, it has to be recorded. The empty trolleys that are to be sent to the supplier back also need to be recorded. A manual recording will increase the cost of the production in terms of labour cost. Thus, an automated process is needed for recording the inventory in order to increase the efficiency and productivity of the process.

1.3 Objectives

i) To develop an RFID based tracking system for automotive manufacturing industry.
ii) To manage data related to the RFID system.
iii) To design and test the RFID system to monitor the flow of the automotive components in the production floor.

1.4 Scopes

i) To develop the interface of the system using Visual Basic software.
ii) To manage the data of the system using Microsoft SQL.
iii) To validate the data obtained from the production floor during the implementation of the RFID system.

1.5 Content of the Report

The report is organized as follows:

i) Chapter 2 consists of literature review on automatic identification system, RFID system theories and the applications of RFID in manufacturing industry.

ii) Chapter 3 describes the methodology of this project. The overall flowchart of the project is included. Moreover, it discusses the hardware and software design together with the testing designs needed to evaluate this system.

iii) Chapter 4 explains on the technical design of the antenna hanger. Together with it, all the testing and analysis planned also included to validate the system performances.

iv) Chapter 5 concludes the findings and the results obtained together with suggestions for improvement.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This section begins with the brief explanation on the application of automatic identification system chronologically starting from the oldest to the latest technology. The discussion then focuses on the RFID system which is the main scope of this report. The history, system technology, application in the manufacturing industry and the research gaps of the RFID system are discussed further.

2.2 Automatic Identification System

Based on the Thesaurus dictionary, Automatic Identification System is referred to the techniques of identifying objects automatically and inserting the data directly into the computer system without human intervention. The technologies of automatic identification system include bar codes, RFID, biometrics, magnetic stripes, Optical Character Recognition (OCR), smart cards and voice recognition.

2.2.1 Barcode system

A system to read the code was patented by Bernard Silver and Norman Joseph Woodland in 1952. According to N.M.Z. Hashim *et al*. (2013) barcode system is a

visual representation of data in the form of bars and spaces on a surface. The graphic illustration consists of thin and thick parallel lines parallel to each other. The bars and spaces are formed from different width, numbers characters and symbols. The barcode implications describe the technical details such as the encoding method and checksum specifications. The barcode type can be classified as numerical only, alphanumeric, 2D and industry symbol for barcode and labels. The barcode lines have reference number of the products which is to be defined and stored in the computer. The barcode information is read by either scanner using laser beams or camera. MATLAB is used to develop the image capturing system instead of infrared sensor. Once the information is scanned by the device, the signal is sent to be processed by the software and the product is determined. The barcode system is applied in retail stores and library to keep track of available products and easy checkout. The barcode system is rapid and reliable but need to improve to accommodate more information in minimum space (Hashim *et al.*, 2013). Figure 2.1 below shows the barcode and scanner.

Figure 2.1: Barcode and scanner (The Barcode News, 2016)

2.2.2 Optical Character Recognition (OCR)

The very first Optical Code Recognition technology was patented in 1931 by Emanuel Goldberg. But, the first OCR machine is used by the Reader's Digest in 1954 to convert typewritten sales reports into punched cards. Based on Sukhpreet Singh, OCR is a system that changes text that presents in digital image to editable

text. It is also stated in the article that the design of OCR is made up of five categories which are matrix matching, Fuzzy Logic, Feature Extraction, Structural Analysis, and Neural networks (Singh, 2013). Using this technology, an entire book can be scanned with a scanner and converted into text document (Hunt *et al.,* 2007). However, according to Line Eikvil, the performance of the system is dependent on the input document quality. The patterns of the characters are in the forms of letters, numbers and special symbols. The disadvantage of this system is the high costing only. On the other hand, this system is able to read fixed font, multi font and constrained handwriting. The application of this system is for data entry such as in banking system, text entry in office and mail sorting. This system also used in automatic number plate readers as well as for signature verification and identification (Eikvil, 1993). Figure 2.2 below shows an example of Optical Character Recognition.

Figure 2.2: Optical Character Recognition (Gadgetsgo, 2016)

2.2.3 Smart cards

Smart cards were introduced in the early 1980's. It was introduced by France's Public Telephone and Telegraph System Company to overcome theft and vandalism issues by implementing coinless public telephone system with the usage of smart cards containing pre-purchased value (Henry and Monk, 1998, p. 5). Smart cards are direct conversion of magnetic stripe cards. Generally cards are divided into card without chip and chip cards which is known as smart cards. Chip cards can be divided into memory card and processor card. Processor cards are

categorised into processor cards without coprocessor and processor with coprocessor. Nature of smart cards depends on the operating system in the card than on the microcontroller in the card. The types of operating system in the card are native and interpreter based. The applications of smart cards are access cards, telemetry module, business card, theft protection card, admission pass and Public Key Infrastructure (PKI) cards (Rankl, 2007). Figure 2.3 below is the example of the smart card.

Figure 2.3: Smart card (Advanced Card Systems Holdings Limited , 2016)

2.2.4 RFID

Radio frequency identification (RFID) is a cost-effective wireless communication technology that identifies tagged objects (Hunt *et al.*,2007). In 1973, Mario Cardullo invented the very first RFID technology which is the passive radio transponder with memory. A RFID consists of tags, reader (also known as interrogator) and data processing system. The object to be tracked should be input with the tags. The data processing system is connected to reader to process data and to provide additional information on the identified object. The RFID system is resistant to harsh environmental conditions and noise which makes the system to be highly sensitive. The RFID system also has unlimited operational life time (Iniewski, 2016). RFID is widely applied in retail and customer packaging for inventory and supply management. Besides that, RFID is common for transportation and distribution of goods in warehouses. RFID also used for security and access control such as in identification card management. In the Figure 2.4 below, it shows an RFID system in a warehouse where the lorry as the tag will pass

through the scanner which is the interrogator to collect the inventory from the warehouse.

Figure 2.4: RFID system in a warehouse (Polniak, 2016)

2.2.5 Biometric and voice recognition

Biometric system refers to the automatic recognition of individual based on their physiological and behavioural characteristics. In the mid 19th century, Alphonse Bertillon, chief of criminal identification division of Paris Police Department identified criminals using body measurements. Since then, the idea is used widely for identification and verification purpose (Anil *et al.*,2004). Physiological characteristics are related to shape of the body. For instance, fingerprint, palm vein, face recognition, DNA, palm print, hand geometry, iris recognition, retina, odour and scent of a person are called as physiological traits. On the other hand, behavioural characteristics are related to the pattern of behaviour of a person. The typing rhythm, gait and voice of a person are referred to behavioural traits. Biometric system identifies the person by searching the templates of all the users in the database for a match. The system is designed using four modules which are the sensor module (to capture the biometric data), feature extraction module (for processing of the biometric data to extract discriminatory features), matcher module (for comparing the extracted features with stored template to generate matching scores and decision making) and system database module (to store the enrolled user's biometric templates) Figure 2.5 shows the characteristics of the human which can be detected by biometric and voice recognition system.

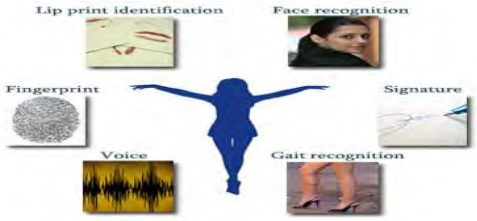

Figure 2.5: The characteristics of human detected by biometric and voice recognition system (Biometrics Research, 2016)

2.2.6 Magnetic stripes

Magnetic stripe system first application was by London Transit Authority for London Underground (UK) in early 1960's (Introduction to Magnetic Stripe & Other Card Technologies., 2016). The strips are divided into three distinct tracks with different functions. The strips are encoded magnetically with unique identification number in binary. When the strips are queried, the binary number are sent to the controller and converted to visual display into decimal digits. The magnetic strips are inexpensive and readily available to many functions yet the durability and data capacity is limited (Michael, 2003). Another limitation for this system is it requires a specially designed readers and human cannot read the information from the strips itself (Eikvil, 1993). An application for this automatic identification system is the financial transaction which involves debit and credit cards (Michael, 2003). An example of magnetic stripes application is shown in Figure 2.6 below.

Figure 2.6: Magnetic stripes card (Abhishek, 2016)