DESIGN AND CONTROL OF RADIO-FREQUENCY IDENTIFICATION BASED CONVEYOR PLATFORM ON AUTOMATED GUIDED VEHICLE

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

by

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DECLARATION

I hereby, declared this report entitled "Design and Control of Radio-Frequency Identification Based Conveyor Platform on Automated Guided Vehicle" is the result of my own research except as cited in reference.

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Date : 21 JUNE 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) (Hons.).
The members of the supervisor committee are as follow:

(Signature of Supervisor)

…….
(Official Stamp of Supervisor)

ABSTRAK

Tujuan utama projek ini adalah untuk membina dan mengawal Pengenalan Radio Frekuensi (RFID) platform penghantar berdasarkan Kenderaan Automatik Berpandu (AGV). Tujuan kajian ini adalah untuk memudahkan kerja-kerja setiap sektor pembuatan. Walaupun terdapat banyak AGV bersepadu dengan teknologi RFID dalam Sistem Pembuatan Fleksibel (FMS), walau bagaimanapun, AGV yang dilengkapi dengan platform penghantar hanya boleh mengendalikan bahan-bahan yang boleh dibawa ke destinasi tetap tanpa keupayaan membuat keputusan sama ada destinasi mana yang hendak dituju. Oleh itu, ia tidak boleh memutuskan apa-apa tugasan untuk dilakukan di mana-mana stesen pemprosesan; sama ada proses pemungghan atau proses memunggah diperlukan. Pelaksanaan RFID platform penghantar berdasarkan AGV dijangka membolehkan pengendalian keupayaan bahan-bahan dalam persekitaran FMS. Dalam projek ini, teknologi semasa RFID telah dikaji untuk menyiasat proses integrasi yang diperlukan untuk berkomunikasi dengan AGV. Prototaip RFID platform penghantar berdasarkan AGV telah dibina dan diprogramkan untuk mengendalikan apa-apa proses pemungghan atau proses memunggah secara automatik di stesen-stesen yang ditetapkan. AGV telah diuji dan telah mencapai kebolehpercayaan 100% dalam melaksanakan tugasnya.

ABSTRACT

The main purpose of this project is to design and control a Radio-Frequency Identification (RFID) based conveyor platform on an Automated Guided Vehicle (AGV). The aim of this study is to facilitate the work of each of the manufacturing sector. Even though there are many AGV integrated with RFID technology in Flexible Manufacturing System (FMS), however current AGV equipped with conveyor platform can only handle materials which goes to a similar fixed destination without decision making capability. Therefore, it cannot decide what task to perform at any processing station; either loading or unloading process is required. The implementation of RFID based conveyor platform AGV is expected to enable the handling of materials capability in an FMS environment. In this project, current RFID technology was studied to investigate the integration process needed to communicate with the AGV. A prototype of the RFID based conveyor platform on an AGV was built and programmed to automatically handle any loading or unloading process at a designated stations. The AGV was the tested and has achieved 100% reliability in performing its task.

DEDICATION

Only for

my beloved father, Mohd Ali Bin Mohd Ali

my appreciated mother, Rosanita Binti Sahhari

my adored brother, Farhan Nazmi Bin Mohd Ali

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

To my supervisor, Dr Mohd Hisham Bin Nordin without your guidance, none of my success would be possible.

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AGV	-	Automated Guided Vehicle
CATIA	-	Computer Aided Three Dimensional Interactive Application
COM	-	Command
CW	-	Counter Clockwise
FMS	-	Flexible Manufacturing Sysytem
RF	-	Radio Frequency
RFID	-	Radio-Frequency Identification
PSM	-	Projek Sarjana Muda
USB	-	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 Project Background

Automated guided vehicle (AGV) is a type of driverless mobile vehicle designed essentially to move material, tow objects behind them in trailers and also transport individuals (Bakar *et al.* 2015). It basically moves with guidance usually by using line following capabilities or by using magnetic line embedded in a floor of a manufacturing plant or warehouse. This AGV basically will move from one station to other stations where it has been programmed. In most cases, human involvement is highly required in order to load or unload materials from or to the AGV.

However, due to high involvement of human in loading and unloading operation, injuries often occur. Injury data from the warehousing and storage industry indicates there are a significant number of musculoskeletal injuries occurring within this sector (BLS, 2013). Some of the higher risk back injury jobs within distribution centers are those where people are manually unloading and loading trailers or containers (Lavender *et al*. 2012). In the inbound operation with "floor-loaded" trailers, people are manually moving each individual box to a pallet or an extendable conveyor. Likewise, in the outbound operation, many trailers are floor-loaded by removing material from extendable conveyors and manually stacking the material within the trailers. Given that the rationale for floor-loading rather than pallet loading is to minimize unused space in the containers or trailers, people in these jobs will be placing cases from floor level to levels very near the ceiling of the trailer or container, which for trailers in the United States is approximately 2.8 m.

Articulating belt conveyors that can be interfaced with the extendable conveyor as in Figure 1.1 used for loading and unloading trailers have been developed to bridge the gap between the wall of boxes being loaded or unloaded and the extendable conveyor used for moving materials into or out of the trailer. Ideally, the articulating conveyor is designed so the distal end can be laterally and vertically shifted so that it can be positioned directly in front of the loading or unloading site, as this potentially allows the handled materials to be slid, rather than lifted, when unloading operations are performed. Likewise, when performing a loading function, a well-positioned articulating belt conveyor should allow material to be essentially pushed or guided into position. As a result, the biomechanical loads experienced by the operator should be reduced, as there should be less actual lifting, thereby reducing the risk of employee injury.

Figure 1.1: Current conveyor (Roberts, 2013)

Many ergonomic interventions are introduced with the assumption that they will improve the health and safety of the targeted workers. However, there is often little evidence gathered as to whether these interventions actually reduce the physical demands on workers. Therefore, for improvement, a conveyor platform (AGV) which require no or minimal human intervention have been developed and have been used in certain industries. Figure 1.1 is one of the examples of a conveyor platform (AGV).

Figure 1.2: Example of a conveyor platform AGV (Buono, 2016)

This type of (AGV) move materials from one location to another based on fixed instruction which has been programmed earlier and normally have fixed destinations. Therefore, by moving one step further, this project is aiming to design and develop an automated radio-frequency identification (RFID) based load transfer mechanism using conveyor platform on (AGV) in order to improve material handling processes in manufacturing plant. The use of (RFID) will enhance the capability of the conveyor platform (AGV) in handling high variety productions with multiple choices of destinations. In order to make this project success, research, analyzing data, codes programming, designing and other process must be conducted.

1.2 Problem Statement

Even though there are many (AGV) integrated with (RFID) technology in Flexible Manufacturing System (FMS), however current (AGV) equipped with conveyor platform can only handle materials which goes to a similar fixed destination without decision making capability. In other words, these types of (AGV) have no direct communication with the product it‟s carrying. Therefore, it cannot decide what task to perform at any processing station; either loading or unloading process is required. As a result, it cannot decide how to control its conveyor mechanism, either in material receiving mode or material delivery mode. Furthermore, it also cannot decide which destination it should go without the (RFID) communication and decision making system which is important in (FMS) environment.

Therefore, the implementation of (RFID) based conveyor platform (AGV) is expected to enable the handling of materials capability in an (FMS) environment.

1.3 Objective

- To control an (RFID) automated conveyor platform to perform loading and unloading operations based on the (RFID) decision making system.
- To analyze the performance of the (RFID) automated loading and unloading mechanism based on the (RFID) decision making system

1.4 Scope of Project

- The conveyor platform will be programmed and controlled using RFID-Arduino microcontroller.
- The (RFID) automated conveyor platform will be attached to an existing (AGV) including wiring and interfacing.
- Program and testing (RFID) system between (AGV) and product.

CHAPTER 2
LITERATURE REVIEW

This chapter presented some overviews of previous works that have been carried out with similar interest related to this project. Literatures that give information about the (RFID) automated conveyor platform has been studied to show how it has been developed. It also concerned with the loading and unloading transfer mechanism using height adjustable conveyor platform on (AGV).

2.1 Automated Guided Vehicle

Organizations nowadays especially industrial are finding ways to amend work efficiency, reduce the cost of human operators in logistics, and cycle time. This is when the utilization of robots has an advantage for simplifying the operation of the whole process. AGVs are mostly used in manufacturing plants, warehouses, distribution centers and terminals (Bakar *et al*. 2015).

A lot of AGVs nowadays have been designed or modified with conveyor placed upon it to facilitate the work of loading and unloading while it can save the time and also prevent injuries to workers who have been working long time.

Figure 2.1: Current automated guided vehicle in factory (Buono, 2016)

2.1.1 Conveyor Platform AGV

Automated guided vehicle is a versatile robot that follows markers or wires in the floor, or uses vision, magnets, or lasers for navigation. They are regularly utilized as a part of modern applications to move materials around a manufacturing facility or warehouse. Currently in the world of consumer society, where the corporations which are seeking to improve work efficiency, minimize the cost of human operators in logistics, and also bring the production cycle time down, make an accurate utilization of robots can promote the operation of the working process by simplifying it to a greater extent. Such progress is rendered by (AGV) a type of mobile vehicle that works without human intervention. Compared to the previous trends the navigation in AGVs more often than not use signal paths, lane paths. The AGV's are completed by the use of sensors for navigation is laser scanner, optical sensors, and magnetic sensors. Modern (AGV) differs from the conventional ones, instead of using fixed paths many modern AGVs are free-ranging (Sankari, 2013).

From previous studies, do not have any development which uses an (RFID) system in use (AGV) to further facilitate loading and unloading works in the manufacturing sector for navigation system.

2.2 Selection of Sensor for AGV Decision Making System

There are several ways that an (AGV) might communicate with the stations it‟s approaching. Among the suitable communication devices that can be used are by camera, barcode reader and (RFID) reader.

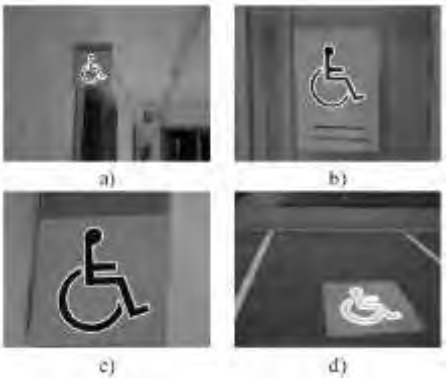
2.2.1 Camera

An (AGV) can communicate with any station through specific image acquired by a camera. This specific image can be of various types such as serial number, QR code, color, shape and also symbol. These specific images are normally adhered to the stations or products that send specific signals of their identification to the camera. The camera will then acquires these images and through image processing software and database program, it will then decipher the hidden message or required tasks to be completed.

Table 2.1 summarizes the types of images that are used as a mean of communication through camera as a medium for image acquirement for further processing.

Table 2.1: Types of image for identification

Image	Description
	Serial number

	QR Code
	Color
	Shape
	Symbol

2.2.2 Barcode Reader

A barcode is an optical machine-readable representation of data relating to the object to which it is attached. Initially Barcode efficiently spoke to information by shifting the width and dividing of parallel lines, and might be alluded to as liner or one-dimensional. Later they advanced into rectangles, dots, hexagons and other geometric patterns in two dimensions (2D). Although 2D systems use a variety of symbols, they are generally referred to as barcodes as well. Barcodes originally were scanned by special optical scanners called barcode readers. The different regions of barcode are as follows:

Figure 2.2: Barcode structure (Wang, 2015)

A Barcode is an optical machine-decipherable representation of information identifying with the question which it is connected. Initially Barcodes deliberately spoke to information by fluctuating the width and separating of parallel lines, and might be alluded to as straight or one-dimensional. Later they developed into rectangles, dabs, hexagons and other geometric examples in two measurements (2D). In spite of the fact that 2D frameworks utilize an assortment of images, they are for the most part alluded to as Barcodes also. Barcodes originally were scanned by special optical scanners called Barcode readers. Figure below show the different regions of barcode (Wang, 2015).

Figure 2.3: Working of barcode (Wang, 2015)

2.2.3 Radio-Frequency Identification (RFID)

(RFID) is used for a wide variety of applications ranging from the familiar building access control proximity cards to supply chain tracking, toll collection, vehicle parking access control, retail stock management, ski lift access, tracking library books, theft prevention, vehicle immobilizer systems and railway rolling stock identification and movement tracking.

There are a few techniques of identification, the most common of which is to associate the (RFID) tag unique identifier with an object or person. An (RFID) system will typically comprise the following:

- An RFID device tag
- A connection to an enterprise system
- A tag with an antenna and transceiver

Figure 2.4: RFID system (Roberts, 2006)

Figure 2.5: FRID tag (Sarma, 2001)