DEVELOPMENT OF MOBILE ROBOT CONTROLLER BASED ON BLUETOOTH COMMUNICATION SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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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.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) (Hons.). The member of the supervisory is as follow:

……

(DR FAIRUL AZNI BIN JAFAR)

ABSTRACT

In today's era of well improved structure, demands in modern and new technology growth rapidly since it contributes a significant contribution in much kind of aspects. One of the most important and frequently used is the wireless communication system. In wireless communication system, Bluetooth has established itself as one of the vital communication system. In general, Bluetooth communication system lets users make effortless and fast connections between two devices or more. Due to low cost, low power consumption and short-range radio link, it is affordable for consumers to have it. Furthermore, there are many smartphones being produces which has the Bluetooth connectivity built-in the devices. The main objective of this project is to control the navigation of a mobile robot which is used as a prototype for an Automated Guided Vehicle (AGV*)* through Bluetooth communication system by using Android smartphone. This project will apply the wireless connection provided by Bluetooth and be able to control the AGV from smartphone. The structure for this project is divided into two main parts which is hardware and software. In hardware part, the Arduino microcontroller is used in order to enable the Bluetooth connection in 10 meters radius. In order to control the navigation of the mobile robot, an Android application is develop by using MIT App Inventor 2 software in software part. This project uses the hand gestures to move the mobile robot instead of pressing the keypad. The experimental result shows that when the human hand is moved towards certain gestures, then the robot tyre is moving towards the decided direction. All in all, the mobile robot is able to navigate following the instruction of the hand gestures.

ABSTRAK

Dalam era yang canggih serta pesat membangun, permintaan bagi permintaan dalam teknologi yang moden dan baru meningkat dengan cepat kerana ia menyumbang sumbangan yang penting dalam pelbagai aspek. Antara sumbangan yang terpenting dan selalu digunakan adalah sistem komunikasi tanpa wayar. Dalam sistem komunikasi ini, Bluetooth telah mengukuhkan kedudukannya sebagai salah satu sistem komunikasi yang penting. Secara umumnya, komunikasi ini membolehkan pengguna melakukan penyambungan di antara dua peranti atau lebih tanpa kesukaran dan cepat. Oleh kerana kos yang rendah, penggunaan tenaga yang sedikit dan pautan radio jarak pendek, ia menjadikannya mampu dimiliki bagi pengguna untuk memiliknya. Tambahan pula, terdapat banyak telefon pintar yang dihasilkan mempunyai sambungan Bluetooth terbina dalam peranti. Tujuan utama bagi projek ini ialah untuk mengawal navigasi robot mudah alih yang digunakan sebagai prototaip untuk sebuah *Automated Guided Vehicle (AGV)* melalui sistem komunikasi Bluetooth menggunakan telefon pintar Android. Projek ini akan mengaplikasikan sambungan tanpa wayar yang disediakan oleh Bluetooth serta mampu mengawal AGV daripada telefon pintar. Stuktur projek ini terbahagi kepada dua bahagian utama iaitu perkakasan dan perisian. Dalam bahagian perkakasan, litar mikropengawal Arduino digunakan untuk membolehkan sambungan Bluetooth dalam radius 10 meter. Untuk mengawal pergerakan AGV, satu aplikasi Android dibina menggunakan perisian MIT App Inventor 2. Projek ini menggunakan isyarat tangan untuk menggerakkan AGV bukannya menekan pad kekunci. Keputusan eksperimen menunjukkan apabila tangan manusia digerakkan pada pergerakan tertentu, tayar robot

mudah alih akan bergerak ke arah yang dikehendaki. Keseluruhannya, robot mudah alih mampu dipandu berdasarkan arahan daripada isyarat tangan.

DEDICATION

This report is dedicated to my lovely parents, Muhamad Sabri bin Che Mat and Maznah binti Mohd Saleh and also my supportive and caring family members who always stood by my side in whatever circumstances. Also, I sincerely grant my highest gratitude to my project supervisor, DR Fairul Azni bin Jafar, lecturers and friends who always help me with helpful guidance and direction from the beginning to the end of my project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

AGV	-	Automated Guided Vehicle
RFID	-	Radio Frequency Identification
LADAR	-	Light Detection and Ranging
CCD	-	Charge-Coupled Device
LED	-	Light Emitter Diode
HF	-	High Frequency
WSN	-	Wireless Sensor Network
PLC	-	Programmable Logic Controller
GPS	-	Global Positioning System
SMS	-	Short Messaging System
OS	-	Operating System
FYP	-	Final Year Project
GUI	-	Graphical User Interface
PCB	-	Printed Circuit Board
AMC	-	Advance Manufacturing Centre
Kbps	-	Kilo byte per second
Mbps	-	Mega byte per second

MHz	-	Mega hertz
m	-	Meter

CHAPTER 1
INTRODUCTION

In this chapter the introduction of the mobile robot which includes the background of (Automated Guided Vehicle) AGV is discussed. Next, the motivation which is the project inspiration is discussed along in this chapter. The problem statement, objectives, scopes and report structure is also been discussed.

1.1 Background

In current industrial environment, robot especially mobile robot plays an important role since the capabilities in completing tasks that are impossible to be completed by humans due to limited abilities. Robots are known have the higher ability in doing repetitive works with constant performance, working in dangerous area which could danger human life and make the job faster with less rest time. According to Dudek and Jenkin (2000), mobile robot can be defined as an autonomous system which capable of traversing along a terrain with natural or artificial obstacles. The chassis is equipped with wheels, tacks or legs and possibly a manipulator setup mounted on the chassis for handling of work pieces, tools or special devices. Various preplanned operations are executed based on a preprogrammed navigation strategy taking into account the current status of the environment. Most commonly known and used mobile robot in industries nowadays is Automated Guided Vehicle (AGV).

Automated Guided Vehicle (AGV) is a material handling systems that uses independently operated, self-propelled vehicles guided along defined pathways (Groover, 2008). AGV mostly is used in manufacturing industries nowadays since it is more reliable in moving raw materials or finished products. Due to its effective working abilities, AGV play as key elements in enhancing lean manufacturing environments. It is because, material handling process is one of the important processes in the manufacturing, the implementation of AGV also will increase the productivity especially in material handling process. Normally, the process will took part from raw material through the finished goods. Throughout the processes, workers commonly struggle with fatigue which could slow down the process of delivery. So, the implementation of AGV will be able to eliminate the problem since AGV can operate continuously. Figure 1.1 shows the example of AGV use in manufacturing fields.

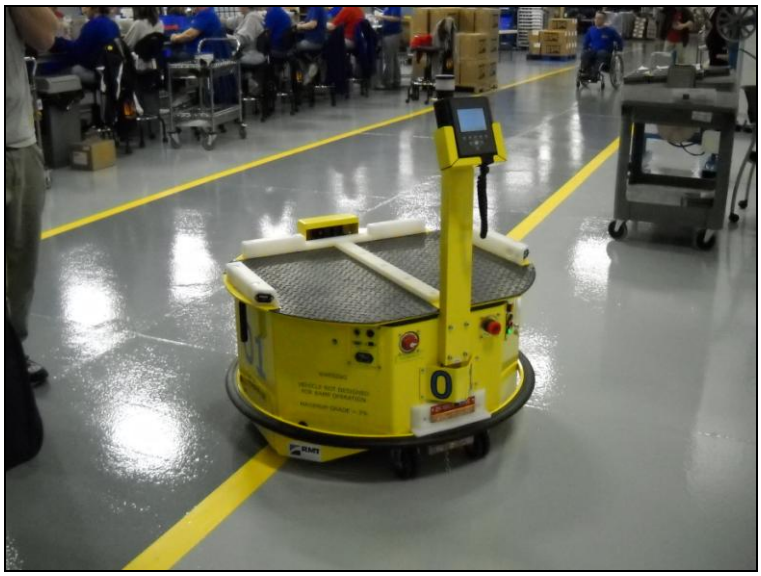

Figure 1.1: AGV use in production plant. (Source: http://news.thomasnet.com/fullstory/Intelligent-AGV-enhances-lean-manufacturing-environments-582126)

As mention earlier, AGV commonly uses in manufacturing facility or warehouse. It is due to the purpose of increasing the efficiency since it was made automated and eliminates workers that usually do certain job in warehouse such as

towing a trolley into production line. Basically, AGV is operated with the help of smart systems that developed specifically for the AGV. In current technology of AGV system, it is navigating through the uses of several technologies such as embedded guided wires, paint strips, self-guided vehicles etc.

The goal of this project is to develop a system that can control the navigation of mobile robot through the use of Bluetooth smartphone. Instead of using sensors to track the guided paths, the navigation of mobile robot can be controlled by using smartphones that has Bluetooth connectivity. By using this technique, it is believe that the handling of mobile robot navigation would become easier since the method to be use is using new technology.

1.2 Motivation

This project is an inspiration of current technology in gaming. Basically, in order to playing games the users are no longer use keypad to control the games but by using hand gesture as shown in Figure 1.2. With the existent of smartphone and its application in the market nowadays, this kind of technology gives different kind perspective of idea in this project. It is because, instead of using the technology in playing games, it can be implemented in mobile robot system in order to control the navigation.

Figure 1.2: The example of games controlling method using hand gesture. (Source: http://news.paktron.net/2011/06/90-percent-of-gamers-will-be-on.html)

1.2.1 Why Bluetooth?

In this project, the aim is to sending the command by using a Bluetooth communication system. Kanma *et al*. (2003), You *et al.* (2006) and Nasereddin & Abdelkarim (2010) have established project by the used of Bluetooth. Meanwhile, Piyare and Singh (2007) and Baum *et al*. (2007) came out with similar approach but in different method by using RFID. Both projects have achieved their primary goal. Thus, in order to achieve this ongoing project aim, the selection of communication system needs to be well determined in which it must be reliable in short range, low cost, low power consumption and others. Based on this criterion, Bluetooth communication system has been selected compared to communication systems. Hallberg and Nilsson (2002) in their studies have claimed that Bluetooth is the best suitable short range communication system for positioning task. In order to create an automatic process, a communication system needs a very good service discovery which is only available by Bluetooth. Muller (2000) said that with its omnidirectional capability, the Bluetooth device must first discover the intended recipient- a Bluetooth device must perform a

discovery operation that will probably reveal several other Bluetooth devices within range. According to You *et al.* (2006), radio control signal systems have limited data transmission capacities compared to Bluetooth which has full duplex data transmission at 115.2 Kbps. Meanwhile in the used of infrared rays, it requires a clear line-of-sight to enable the AGV to move. Table 1.1 illustrates the summary of the evaluation between Bluetooth and Radio Frequency Identification (RFID) communication systems.

Table 1.1: Summary of evaluation for Bluetooth and RFID. (Source: Hallberg and Nilsson, 2002)

	BLUETOOTH	**RFID**
Positioning task	Yes	Yes
Network	1 Mbps	N/A
Exchange of position	Yes	No
Security	Very Good	Good
Range	100m/20m/10m	0m – 20m
Power consumption	Low	Low
Angle dependency	No	No
Accuracy	Range/ (Triangulation)	Range/ (Triangulation)
Automization	Yes	Some
Reliability	Very Good	Good

As stated in the table, both communications have similar accuracy. But, Bluetooth seems to be more accurate than RFID. It is due to its operation called pairing. The terms pairing refers to the structure and the global acceptance of Bluetooth technology means any Bluetooth enabled device, almost everywhere in the world, can connect to other Bluetooth enabled devices located in proximity to one another. Once pairing between two devices was done, the Bluetooth enabled electronic devices for example mobile phone can communicate wirelessly through short range, ad-hoc networks known as piconets. Umar (2004) defined that piconet is consisting of a master and between one and seven slave devices. The master is the device in a piconet whose clock and hopping sequence are used to synchronize all other devices (i.e. slaves) in the