DEVELOPMENT OF REMOTE CONTROLLED MOBILE ROBOT THROUGH WI-FI OR IOT PLATFORM

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ABSTRAK

Tujuan utama projek ini adalah untuk mewujudkan komunikasi antara robot mudah alih dengan platform IoT, untuk mengawal robot mudah alih melalui Wi-Fi atau platform IoT dan menilai prestasi robot kawalan jauh menggunakan Wi-Fi atau IoT. Robot mudah alih semasa dan automatik kenderaan berpandu (AGV) hanya boleh diarahkan atau diprogramkan apabila ianya disambungkan ke komputer tempatan atau pusat kawalan. Tanpa sambungan Wi-Fi, AGV tidak boleh dipantau atau dikawal dalam masa sebenar, yang merupakan salah satu daripada syarat sistem pembuatan yang fleksibel menuju ke arah Industri 4.0. Berdasarkan tujuan tersebut, robot mudah alih kawalan jauh yang dikawal melalui sambungan Wi-Fi dan melalui sambungan internet telah dibina. Beberapa ujian telah dilakukan termasuk ujian kebolehpercayaan, ujian jarak dan ujian persekitaran. Untuk ujian kebolehpercayaan, robot dikawal mengikut arahan tertentu menggunakan pengawal. Ujian ini dijalankan untuk menyiasat sama ada robot mudah alih akan mengikuti arahan tersebut atau tidak. Untuk ujian jarak, robot mudah alih dikawal dengan meletakkan robot mudah alih dengan pengawal pada jarak 200 m sehingga mencecah ke 20 000 m. Ujian ini dijalankan untuk menyiasat sama ada jarak antara pengawal dan robot akan memberi kesan kepada prestasi. Akhir sekali, untuk ujian persekitaran, robot dikawal dengan meletakkan ia di tiga kawasan yang berbeza. Ujian ini dijalankan untuk mengkaji sama ada isyarat luar memberi kesan kepada prestasi robot mudah alih. Keputusan daripada ujian ini menunjukkan bahawa robot mudah alih boleh dikawal selagi ada sambungan internet.

ABSTRACT

The main purpose of this project is to establish a communication between a mobile robot with IoT platform, to control mobile robot through Wi-Fi or IoT platform and to evaluate the performance of the remote control mobile robot using Wi-Fi or IoT. Current mobile robot and Automated Guided Vehicle (AGV) can only be instructed or programmed when it is connected to the local computer or central controller. Without Wi-Fi connection, this type of AGV cannot be monitored or controlled in real times, which is one of the requirements for flexible manufacturing system towards Industry 4.0. Based on this purpose, a remote controlled mobile robot which is controlled through Wi-Fi connection and over the internet connection has been developed. Several tests had been carried out including reliability test, distance test and environment test. For the reliability test, the mobile robot was controlled by commanding specific direction using a controller. The test was carried out to investigate whether the mobile robot will follow the direction of the controller or not. For the distance test, mobile robot was controlled by placing the mobile robot at a distance of 200 m to 20 000 m to the controller. The test was carried out to investigate whether the distance between the controllers and the mobile robot will affect the performance. Lastly, for environment test, the mobile robot was controlled by placing it at three different areas. The test was conducted to study whether the outside signal will affect the performance of the mobile robot. The results from these tests show that the mobile robot can be controlled as long as there is internet connection.

DEDICATION

Specially dedicated to my beloved parents, Sohaimeh bin Tempal and Aminah bt Jayus and family for the support, beliefs and motivation.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

IoT	-	Internet of Things
IoRT	-	Internet of Robotic Things
AGV	-	Automated Guided Vehicle
RFID	-	Radio Frequency Identification
EPC	-	Electronic Product Code
DOE	-	Design of Experiment
PSM	-	Projek Sarjana Muda
PSM I	-	Projek Sarjana Muda 1
PSM II	-	Projek Sarjana Muda 2
FKP	-	Fakulti Kejuruteraan Pembuatan
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

This chapter presents a brief introduction about the project. The first topic is project background development of remote controlled mobile robot through Wi-Fi or IoT platform. Then, the detail of the problem statement of the project and followed by the objectives of the project. Based on the problem statement and the objectives of the project, the scope of this project is identified. Finally, it presents the report structure of this project.

1.1 Project Background

According to (Betters, 2014), the first person who mentioned the “Internet of Things” is Kevin Ashton while working for Procter & Gamble in 1999. Then he talk deeply in (Ashton, 2009), he said that “I could be wrong, but I'm fairly sure the phrase Internet of Things started life as the title of a presentation I made at Procter & Gamble (P&G) in 1999. Linking the new idea of RFID in P&G's supply chain to the then-red-hot topic of the Internet was more than just a good way to get executive attention.” He also mentioned, “The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so.”

Nowadays Internet of Things (IoT) is one of the important things in the world. IoT is an internet working of mechanical, electrical, digital machine that collect and transfer the data without requiring human interaction. The meaning of without requiring human interaction is such that the IoT can control remotely and sense the object through the network and wireless technologies. The benefits of IoT will give a high impact to the manufacturing, infrastructure, food services, hospitality, transportation, oil, gas and mining. Many of the big companies already using the IoT include Google, Microsoft and Hitachi.

The aim of this project is to establish communication mobile robot with IoT platform, controlling mobile robot through Wi-Fi or IoT platform and evaluate the performance of the remote control mobile robot using Wi-Fi or IoT. Based on the objective, research is done on topic of the IoT, Industry 4.0 and Wi-Fi. Then, the idea to create design of experiment is developed. Basically development remote controlled mobile robot using Wi-Fi or IoT, need to have a hardware and software. The hardware and software that will be use is Arduino robot and ESPresso Lite.

1.2 Problem Statement

Current mobile robot and Automated Guided Vehicle (AGV) can only be instructed or programmed when it is connected to the local computer or central controller. Without Wi-Fi connection, this type of AGV cannot be monitored or controlled in real times, which is one of the requirements for flexible manufacturing system. For advanced application, without connection through internet, it limits the capability of controlling or monitoring from other remote area for the benefits of saving time and cost without having to be present at manufacturing industry. Therefore, it is proposed that an AGV or mobile robot to be equipped with IoT capabilities.

1.3 Objective

i. To establish communication of mobile robot with IoT platform.
ii. Controlling mobile robot through Wi-Fi and IoT platform.
iii. Evaluate the performance of the remote controled mobile robot using Wi-Fi or IoT.

1.4 Scope

i. By using ESPresso Lite as an IoT platform to create communication with mobile robot.
ii. Able to control the mobile robot by using ESPresso Lite.

1.5 Report Structure

The report is organized as follows:

i. Chapter 2 consists of literature review on IoT, Industry 4.0 and Wi-Fi. This chapter gives definition of IoT, explains the essential IoT technologies, elaborates application of IoT, and explains the meaning of Industry 4.0, nine pillars of technology and Wi-Fi.

ii. Chapter 3 describes the methodology of this project. This chapter discusses the overall flowchart of the research methodology, functional block diagram, operational flowchart and design interface for IoT platform. Then, it shows the experiment setup and design of experiment.

iii. Chapter 4 elaborates and discusses on design of experiment. Basically, it involves the procedural steps on how to develop of the remote controlled mobile robot through Wi-Fi or IoT platform. Next, the result and discussion on design of experiment.

iv. Chapter 5 concludes the main results obtained and futures research.

CHAPTER 2

LITERATURE REVIEW

In this chapter, there are 3 main topics IoT, Industry 4.0 and Wi-Fi. The first topic that is IoT, it will give a definition of IoT, explain the essential IoT technologies and elaborates the application of IoT. Next topic is Industry 4.0, which explains the meaning of Industry 4.0 and nine pillars of technology. Last topic is about Wi-Fi and summary for this chapter.

2.1 Internet of Things (IoT)

IoT refers to the objects network connections per day, which often accompany universal knowledge. IoT will make the flexibility of the Internet increase by integrating each object to interact with embedded systems that will leads to highly distributed network devices communicate with humans and other tools (Feng, 2012).

The idea of Internet of Things can be viewed as an expansion of the current connection between people and applications through the new measurement of "Things" correspondence and coordination. IoT will include esteem and expand the abilities of customary and restricted abuse of programmed recognizable proof and information catch (AIDC) and other interfacing "edge" advancements and illustrations of imagined IoT applications will be given in the accompanying areas (Harald, 2010).

The paradigm in Internet of Things (IoT) that is quickly making progress inside the modern telecommunications technology facilities provided. The fundamental thought of this idea is the widespread presence around us of many things or objects which, through unique addressing schemes, that can connect with each other and collaborate with their neighbors in order to achieve the same goal such as mobile phones , Radio-Frequency Identification (RFID) tags, actuators, sensors, etc (Hamraz, 2013).

2.1.1 Internet of Robotic Things (IoRT)

“Connected robots give intelligent devices the ability to manipulate the world around them, rather than simply sending and receiving passive data.”(mcorley, 2016) “As the IoRT becomes more prevalent, it will become harder and harder to tell robots apart from everyday objects such as toasters and laundry machines that also will become increasingly intelligent and aware, notes Egerstedt.”(Shein, 2016).

Robotic devices need ways to execute in the real world once a course of action is decided upon. Seems like a virtually insurmountable engineering challenge up until recently. Currently, for robotic devices to manipulate the environment in ways that were previously unthinkable, new advances in machine actuation, vision and grasping are making it possible (Robotics Online Marketing Team, 2016).

The research study shows the introduce of the concept Internet of Robotic Things (IoRT), where use intelligence to determine a best course of action, intelligent devices can monitor events, fuse sensor data from a variety of sources and then act to control or manipulate objects the physical world, and in some cases while physically moving through that world. By business models built upon passive interaction to physical and dynamic relationships between the physical and digital world, the incorporation of the robotics aspect into the wider IoT transforms the landscape currently dominated (ABIresearch, 2014).

2.1.2 Essential IoT technologies

2.1.2.1 Radio frequency identification (RFID)

Data capture and automatic identification is allowed by Radio frequency identification (RFID) through a reader, radio waves and a tag. The tag can store more data than traditional barcodes. The form of the Electronic Product Code (EPC) contains data of the tag, by the Auto-ID Center a global RFID-based item identification system developed (Lee, 2015).

RFID technology can be used in writing and reading EPC. Management efficiency was improved, data flow significantly was reduced, and the management process was simplified through introduction of static EPC and dynamic EPC. Wired networks were available based on Internet and LAN. Transmission task were taken by both wireless network and wired network (Zhengxia, 2010). "The passive RFID tags are not battery powered and they use the power of the reader‟s interrogation signal to communicate the ID to the RFID reader."(Cristian, 2014).

2.1.2.2 Wireless sensor networks (WSN)

Crucial role in the IoT will be played by sensor networks. The fact, to better track the status of things, they can cooperate with RFID systems. A very large number of nodes is may consist in sensor networks. As today there is a scarce availability of IP addresses that would result in obvious problems (Luigi, 2010).

Sensing can be deployed only on the several sensors that perform. Communications topology and the positions of the sensors are carefully engineered. Data are fused and Computations are performed when they transmit time series of the sensed phenomenon to the central nodes. Sensor networks which are densely deployed either very close to the phenomenon or inside, it is composed of a large number of sensor nodes (Akyildiz, 2002).

2.1.2.3 Middleware

To make it easier for software developers to perform input/ output and communication middleware is a software layer interposed between software applications. Its feature, the software services that are not directly relevant to the specific IoT application, the details of different technologies is fundamental to free IoT developers is hiding (Lee, 2015).

2.1.2.4 Cloud computing

"Cloud computing provides an ideal back-end solution for handling huge data streams and processing them for the unprecedented number of IoT devices and humans in real time." (Lee, 2015).

2.1.2.5 IoT applications

Myriad industry-oriented and user-specific IoT applications are still under the IoT facilitates the development. Whereas networks and devices provide physical connectivity, IoT applications enable human-to-device and device-to- device interactions in a reli-able and robust manner. IoT applications on devices need to ensure that data/messages have been acted and received upon properly in a timely manner. As example, the status of transported goods such as fresh-cut produce, fruits, meat, and dairy products is monitor by transportation and logistics applications. Appropriate actions are taken automatically to avoid spoilage when the connection is out of range during transportation; the conservation status (e.g., humidity, shock, temperature) is monitored constantly (Lee, 2015).

2.1.3 Application of IoT

Table 2.1 shows the description and examples of the IoT application Domain in industry, environment and society.

Table 2.1: IoT Application Domains - Description and Examples (Harald, 2010).

Domain	Description	Indicative examples
Industry	Activities involving financial or commercial transactions between companies, organizations and other entities	Manufacturing, logistics, service sector, banking, financial governmental authorities, intermediaries, etc.
Environment	Activities regarding the protection, monitoring and development of all natural resources	Agriculture & breeding, recycling, environmental management services, energy management, etc.
Society	Activities/ initiatives regarding the development and inclusion of societies, cities, and people	Governmental services towards citizens and other society structures (e-participation), e-inclusion (e.g. aging, disabled people), etc.

2.1.3.1 Aerospace and aviation (green operations, systems status monitoring)

The 'on-condition' remote observing of the air ship by utilizing shrewd gadgets with detecting capacities accessible inside the lodge or outside and associated with the air ship observing frameworks is another developing application range that structures the reason for pervasive sensor systems. The system will be utilized for recognizing different conditions, for example, pressure, vibrations, temperature and so forth. The information gathered offers reduces maintenance, access to tweak usage trends, allows condition-based maintenance, facilitates maintenance planning, and waste and will be utilized as contribution for assessing and diminishing the vitality utilization amid air ship operations (Harald, 2010).

2.1.3.2 Automotive (V2V and V2I communication, systems status monitoring)

A 'thing' is considered as the vehicle itself, empowering it to make programmed crisis calls or breakdown calls when proper, gathering however more information that could reasonably be expected from encompassing 'things'. The utilization of remote identifiable gadgets makes a difference the partners to pick up knowledge into where everything is so it is conceivable to quicken get together procedures and find autos or parts in a small amount of the time. Remote innovation is perfect in real-time locating systems (RTLS) and interfacing with other IoT sub systems, enhancing management and vehicle tracking and supporting car producers better in overseeing the way toward testing and checking vehicles falling off the mechanical production system (Harald, 2010).

2.1.3.3 Telecommunications

IoT will make the likelihood of combination of various telecommunication technologies and make it new. Things can connect the systems and encourage distributed correspondence for particular reason or to build strength of interchanges channels and systems. Things can shape specially appointed distributed systems in misfortune circumstances to keep the stream of indispensable data going in case of failure of the telecommunications infrastructure (Harald, 2010).

2.1.3.4 Intelligent Buildings (home automation/ automatic energy metering/ wireless monitoring)

Many studies have been done on the advantages and the possibility of "smart homes". As the advances develop and wireless communication became much cheaper, the scope of utilization is turning out to be much more extensive (Harald Sundmaeker, 2010).

Smart Home (SH) guarantees the possibilities for the client to gauge home conditions (e.g., luminosity, temperature, humidity, and so on.), control home HVAC (heating, ventilation and air conditioning) apparatuses and control their status with least client's intercession (Moataz, 2013) .

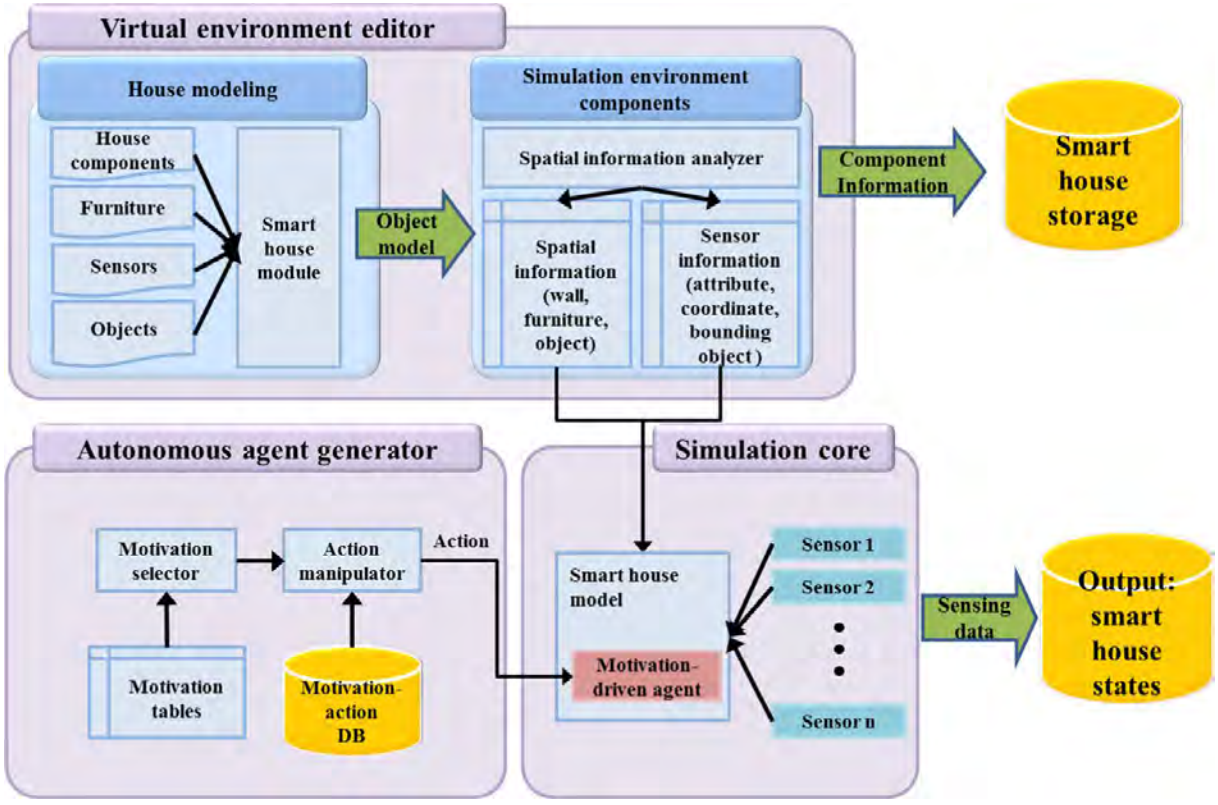

Figure 2.1: Example of Architecture of the proposed simulator (Wonsik, 2016).