



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF ITEM TRACKING SYSTEM FOR ASSET
REGISTRATION USING UHF RFID WITH CLOUD DATA
STORAGE AND ONLINE MONITORING**

This report is submitted in accordance with the requirement of Universiti Teknikal
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours. The member of the supervisory is as follow:

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(Mr. Muhammad Salihin Bin Saealal)

ABSTRAK

Projek ini adalah mengenai sistem pengesanan item yang direka untuk tujuan mengesan item menggunakan Internet of Things (IoT) Teknologi. Pengesanan inventori adalah satu proses yang mengekalkan satu sistem yang inskripsi penambahan item untuk inventori dan apa-apa keluar dari inventori sedia ada. Proses pengesanan dilakukan dengan membangunkan satu aplikasi yang membolehkan pengguna untuk memasukkan data, menyimpan dan mengedit data untuk Pangkalan Data SQL melalui Microsoft Azure Web Service. Sistem pengesanan item dilakukan dengan menggunakan Windows 10 aplikasi dan template Windows Application Form. Pengkomputeran awan adalah paradigma baru dan infrastruktur pengkomputeran teragih berskala besar (C.A. Lee, 2010). Microsoft Azure untuk pengkomputeran dan keupayaan penyimpanan berskala besar, akses yang mudah oleh pemaju untuk penyelenggaraan yang mudah, kelestarian, dan mudah alih. Microsoft Azure mempunyai janji untuk menjadi platform pilihan untuk Pengkomputeran Prestasi Tinggi (HPC) aplikasi (D. Agarwal & S.K. Prasda, 2012). Windows 10 dilakukan dengan menggunakan Visual Studio 2015, Windows Platform Universal template, untuk mengemas kini data untuk Pangkalan Data SQL di mana ia kemudiannya boleh digunakan sebagai kod dikongsi untuk platform lain seperti, Android, iOS dan Aplikasi Windows Phone. Windows Application Form dilakukan dengan menggunakan Visual Studio 2015 menggunakan template Windows Application Form untuk mengedit GUI bagi tujuan pemantauan. Bahasa pengaturcaraan C # digunakan sebagai bahasa berorientasikan objek yang membolehkan pemaju untuk membina pelbagai aplikasi yang selamat dan teguh berjalan di atas .NET Framework. C # boleh digunakan untuk mewujudkan aplikasi Windows pelanggan, aplikasi pangkalan data, perkhidmatan XML Web, dan tujuan lain. Visual C # menyediakan editor kod maju, mudah pereka antara muka pengguna dan penyahpejijat bersepadu untuk membuat ia lebih mudah untuk membangunkan aplikasi berdasarkan C # bahasa .NET Framework.

ABSTRACT

This project is about the item tracking system, designed for the purpose of tracking an item using the Internet of Things (IoT) Technology. Inventory tracking is a process of sustaining a system that inscription the addition of items to an inventory and any outgoing from that existing inventory. The tracking process is done by developing an application that allows a user to insert data, store, and edit the data to the SQL Database thru Microsoft Azure Web Service. The item tracking system is done by using a self-developed Windows 10 application and a Windows Application Form. The Cloud computing is a new paradigm and infrastructure for large scale distributed computing (C.A. Lee, 2010). The Microsoft's Azure for large scale computing and storage capabilities, easy accessibility by developers for easy maintenance, sustainability, and portability. It has the promise to be the platform of choice for High Performance Computing (HPC) applications (D. Agarwal & S.K. Prasda, 2012). The Windows 10 application interface is done by using Visual Studio 2015, Universal Windows Platform template, to update data to the SQL Database where it can then be used as a shared code for other platform such as, Android, iOS, and Windows Phone Application. The Windows Application Form is done by using Visual Studio 2015 using a Windows Application Form template to edit the GUI for the monitoring purposes. Programming language C# is used as an object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework. C# can be used to create Windows client applications, database applications, XML Web services, and other purposes. Visual C# provides an advanced code editor, convenient user interface designers and integrated debugger to make it easier for developing applications based on the C# language and the .NET Framework.

DEDICATION

To my beloved parents who taught me to keep my dreams alive. Understand to achieve anything requires faith and belief in myself, vision, hard work, determination, and dedication. It is also dedicated to my supervisor who taught me that to remember all things are possible for those who believe.

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List Abbreviations, Symbols and Nomenclatures

RFID	-	Radio Frequency Identification
IoT	-	Internet of Things
HPC	-	High Performance Computing
UART	-	Universal asynchronous receiver/transmitter
GPS	-	Global Positioning System
NMEA	-	National Marine Electronics Association
LF	-	Low Frequency
HF	-	High Frequency
UHF	-	Ultra-High Frequency
NFC	-	Near Field Communication
WIPI	-	Wireless Internet Platform for Interoperability
GUI	-	Graphical User Interface
FQDN	-	Fully Qualified Domain Name
ODS	-	Operational Data Store
OS	-	Operating System

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter provides an introduction to this project. It starts with background, project overview, problem statement, description of a prototype, objective, scope and thesis outline of the development of item tracking system for asset registration using UHF RFID with cloud data storage and online monitoring.

1.1 Background

The item tracking system is designed for the purpose to track an item that tagged with a RFID tag using the Internet of Things (IoT) Technology. This technology allows a user to insert data, store the data to the database in Microsoft Azure, and track the item using a self-developed Windows 10 application interface. The detection of an item with RFID tag will be sent from RFID module and Reader to Arduino that connected using UART pins. The data collected in Arduino will send to Raspberry Pi 2 Model B using Serial Port and post it to database in Microsoft Azure. The user may retrieve the data using a Windows 10's application. The code will be programmed using Visual Studio 2015 and programming language used is C# in order to enable the usage of .Net Framework for Microsoft Windows Application.

The processes of managing data and record using a web-based application have become an advanced technology at the current time. Thus, developing a tracking system with online monitoring will provide a more reliability and efficiency solution for item tracking.

1.2 Problem Statement

The tracking system has been a very useful application in the global. It can be applied to a car for tracking or even an asset to know its location. The tracking system can be done using the barcode and GPS technology. However, the process is a lack of convenient. Global Positioning System (GPS) started in 1973 to overcome the limitations of previous navigation systems. However, the cost is very high for applying this technology in an industry that has a lot of inventory.

Consequently, technology such as Radio-Frequency Identification (RFID) and Internet of Things (IoT) is a much reliable and effective ways to track items in the industry. RFID is the use of radio waves to read and capture information stored in a tag attached to an item. Furthermore, a tag can be read from up to several feet away and does not need to be within direct line-of-sight of the reader to be tracked. Therefore, an item has to be tagged with a RFID tag and a reader to detect the tag will ease the process and give a more accurate position of the item. The combination of RFID and IoT technology will enhance the process of item tracking by performing asset tracking thru a Windows10 application.

1.3 Description of Prototype

- I. User friendly
 - i. Perform an item tracking thru a Windows 10 application.
 - ii. Allowing user to add an item for tracking by filling up some simple information
 - iii. Perform tracking asset thru online
 - iv. Easy assembly of hardware for tracking purpose

1.4 Objectives of Project

Item Tracking System using RFID and IoT technology is a very trending usage for industry usage recently. There has been a very close connection with the GPS technology but RFID is very applicable in industry usage that consists of many assets for the purpose of tracking. The data collected will be stored in a private server and database. Therefore, it is very safe to keep industry asset in cloud storage. The objectives of this project are:

- a) Create a database for data storage of RFID tag.
- b) Design an application that will help to increase the efficiency of item tracking based on cloud storage and online monitoring for registering and monitoring items.

1.5 Scope of Research

By narrowing the needs for this project, a few guidelines are proposed to ensure that the project will achieve the objectives. The scopes covered in this project are:

- a) Item tracking based on the RFID tracking system
- b) RFID module and reader connect to the Arduino Uno using UART pin
- c) Arduino Uno used as a sub device to retrieve data from RFID reader.
- d) Arduino Uno connects to the Raspberry Pi 2 using the serial port.
- e) Create a database at Microsoft Azure using Visual Studio 2015 using ASP .Net Web Application template.
- f) Developed a background application using Visual Studio 2015 that run on Raspberry Pi 2 Model B IoT core to collect data from Arduino Uno and send to cloud storage.
- g) Develop a Window 10 application for the user to update data
- h) Develop a Windows Application Form

1.6 Thesis Outline

The structure and layout of the thesis are as follow:

- Chapter 1 – Introduction: This chapter discusses a short introduction on the project which covers the objectives, scopes of the project and the problem statements.
- Chapter 2 – Literature Review: This chapter describes what is item tracking system using online monitoring and existing project with item tracking system which has been done using barcode and GPS technology.
- Chapter 3 – Methodology: This chapter discourses the method used for developing the project and also approach taken in order to complete the project.
- Chapter 4 – Result and Discussion: This chapter deliberate about the item tracking system using online monitoring and the cloud storage. This part will stress on hardware and software.
- Chapter 5 – Conclusion and Recommendations: This chapter concludes the entire project and future expectations that can be done for the future project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides the literature review based on the previous researches as well as theoretical readings based on inventory tracking method, RFID technology and platform in developing applications. The literature review done based on the previous researches will help improving the methodology of this project and the result will be recorded successfully.

2.1 Inventory Tracking

Inventory tracking is a process of sustaining a system that inscription the addition of items to an inventory and any outgoing from that existing inventory. The tracking system also provides information that makes it possible to restock the inventory in a proper manner. The objective of any successful tracking effort is to make sure the inventory is kept at a level that helps the business meet its goals. Since there are many different types of inventories, the strategies used as part of inventory tracking will vary from one setting to the next. When it comes to tracking activity in a finished goods inventory, the inventory methods applied will make it easy to account for any goods that are recently produced and added to the total inventory, as well as document any shipments of goods to customers that reduce the total inventory.

2.1.1 An Adaptation of The Web-based System Architecture in The Development of The Online Attendance System

In this paper by (Mahfudzah Othman, Siti Nurbaya Ismail, Haslinda Noradzan, 2012), the new Online Attendance System has been developed as the enhancement of the previously developed system known as Attendance Register System. This system is being developed using the concept of web-based system architecture. System developments involved the integration of various open source technologies. For example, Structured Query Language (MySQL), Hypertext Preprocessor (PHP) and Apache Web Server. Therefore, it makes the new system much more efficient. The processes of managing data and record using a web-based application have become one of the desire technologies at the present time (M. Othman et al, 2009).

The ability for supporting multiuser and capability in managing numerous access of records are the reasons which inspire many developers to develop online or web-based applications as it save time and cost (M. Othman et al, 2008). Figure 2.1.1 shows the web-based system architecture that illustrates the integration of various open source technologies such as the relational database management system, middleware, web server, web browser and the Internet (J. Greenspan & B. Bulger, 2001).

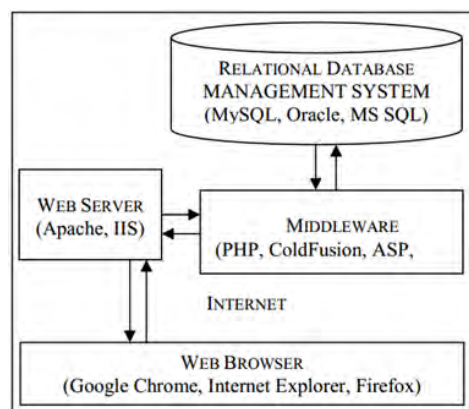


Figure 2.1.1: Web-Based System Architecture (M. Othman et al, 2012)

This application will be situated at Relational Database Management System which client can only access the system through the web browser. For example Google Chrome, Internet Explorer, Firefox, and even Microsoft Edge.

This application is developed thru a middleware in which the coding session are being done there. In the present, the Attendance Register System has been developed using the barcode scanner for the purpose of recording the student's attendance (S. Jonathan et al, 2007). Therefore, by assimilating with the web system, records and corrections of any attendance can be done through the web browser, thus, soothe the process of recording and reporting the attendance (Harumi et al, 2006).

2.1.2 Design and Implementation of an Accurate Real-Time GPS Tracking System

In this paper by (Hind Abdalsalam Abdallah Dafallah, 2014), an accurate and genuine real-time tracking system using Global Positioning System (GPS) and Global System for Mobile Communication (GSM) allows a localization and mobile tracked item which will transmit the position back to the tracking centre.

There is various type of usage using GPS tracking such as children tracking, car or any asset tracking. Tracking ensures several services which include localization of stolen items, keep track of item path movement and track movement of children for missing purposes. Figure 2.1.2 below shows the GPS tracking system which includes a Garmin 18-5 HZ GPS receiver with a capability of DGPS (differential GPS) (GARMIN, 2005), PIC16F877 Amicrocontroller unit (Microchip Technology) and SIMCOM 300 GSM modem (SIMCOM).



Figure 2.1.2: GPS Tracking System (Dafallah, 2014)

The working of the tracking system is that the Garmin 18-5 HZ GPS receiver receives a location coordinates which contains a lot of information from satellites with a resolution of 5 readings/second in NMEA (M. Othman 2012). Consequently, the microcontroller will extract the longitude and latitude from the information, then the GSM modem via serial communication will send an SMS which includes the longitude and latitude of the mobile tracking device. However, the accuracy relies on the weather and satellites coverage.

2.2 RFID Technology

RFID stands for Radio-Frequency Identification. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card. It provides a unique identifier for that object similar to a bar code or magnetic strip must be scanned to get the information. The RFID device must be scanned to retrieve the identifying information.

A RFID system is made up of two parts: a tag and a reader. RFID tags embedded with a transmitter and a receiver. The RFID part on the tags have two parts: a microchip that stores and processes information, and a device that receives TV and radio signals to receive and transmit a signal. The tag contains the specific identifying number for one clearly stated/particular object. In order to read the information on a tag, a two-way radio transmitter-receiver called a called an interrogator or reader emits a signal to the tag using an antenna. The tag responds with the information written in its memory bank. The interrogator will then transmit the read results to an RFID computer program.

2.2.1 Simulation of Attendance Application on Campus based on RFID (Radio Frequency Identification)

In this paper by (Dania Eridani & Eko Didik Widiyanto, 2015), the development of attendance simulation using RFID with the database to makes

the attendance process much more simple and well-structured. This application was performed by laying the tag near the reader and the data will be saved directly into the database. Hence, displaying out the attendance information system. RFID uses the detection of an electromagnetic signal as an identification which is one of the wireless technology (K. Domdouzis, 2007). Figure 2.2.1 below shows RFID's two important components which are a RFID reader and RFID tags.



Figure 2.2.1: RFID Reader and Tags (D. Eridani & E. Widiyanto, 2015)

Low-frequency RFID is being implemented in the student's card for the attendance purposes. This is due to a lower frequency on RFID, the shorter the read range of the RFID (Classic RFID, 2008). The low-frequency RFID tag makes it suitable for developing an attendance system. Thus, students may have to get close the tag with the reader in order to complete the attendance process. Furthermore, RFID technology has an advantage in terms of contactless and able to perform in every environment (D. Eridani et al, 2011).

2.2.2 An Innovative Cloud-Based RFID Traceability Architecture and Service

In the paper by (Nour El Madhoun & Fouad Amine Guenane, 2014), RFID has had to become a very important technology in the area of item tracking. It can automatically identify items that are attached with a RFID tag through radio waves and enable the process of reading thru a RFID module without any contact between the reader and the tags. In order to improvise a better environment for item tracking, uses of Internet of Things (IoT) has become a very important role in the tracking system. Thus, the collaboration

between RFID and IoT is a must to perform the tracking (P.J. Benghazi et al, 2009). This method is done by performing a cloud data storage that linked the items with RFID tag to the internet. Hence, the network of networks will enable the tracking of items thru online monitoring.

There are two categories of tags that are using RFID technology which are active tags and passive tags (K. Finkenzeller & R. Waddington, 1999). An active tag required a power supply to produce radio waves that will be captured by the RFID module for further usage whereas a passive tag depends on the radio frequency energy from the reader by electromagnetic induction (J. Wiley & Sons, 2005). A UHF RFID system enables a fast exchange rate of data and able to detect several tags at a time. Thus, a UHF RFID tag is much more practical for item tracking.

Table 2.2.1: Different types of frequency (N. Madhoun & F.Guenane, 2014)

Types of frequency	Range of frequency (Hz)
Low Frequency (LF)	125K - 134K
High Frequency (HF)	13.56M
Ultra-High Frequency (UHF)	860M - 960M

This system uses the IoT technology which enables the RFID tags that captured by the reader to be stored in the cloud storage. So, it is very important to control and trace all the operations made to in order to ensure the confidence in the sector environment. Therefore, a platform between RFID and the cloud storage must be linked in order to perform a full system for the purpose of item tracking (B.A. Supriya & I. Djearmane, 2013).

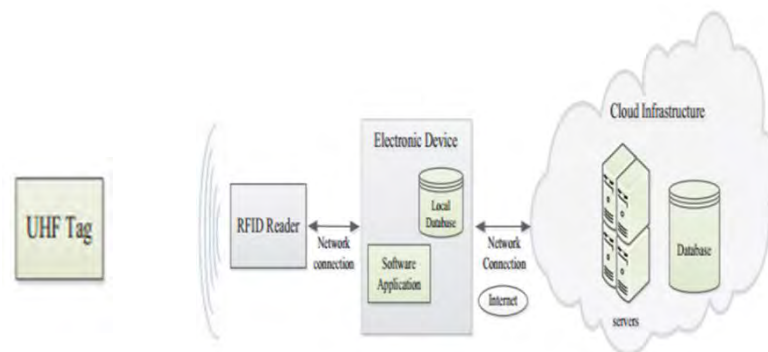


Figure 2.2.2: Architecture of RFID Tracking System (N. Madhoun et al, 2014)