INVENTORY MANAGEMENT AND PAYMENT SYSTEM USING RFID AS A MEDIUM

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A thesis submitted in fulfillment of the requirements for the award of the degree of

Bachelor Of Computer Science

Faculty of Systems Computer & Software Engineering

University Malaysia Pahang

JULY 2012

ABSTRACT

This thesis deal with developing inventory management and payment system using RFID as a medium of data transfer. Every retail outlet such as supermarket and shop worldwide has their own inventory management and payment system. It is important that both of the system work together to ensure precise and accurate item flow in and out and to ensure no mistake in payment process and in inventory management. Traditional inventory system and payment system using price tag and barcode usually fail to integrate together to deliver up-to-date inventory and also slow down the payment process. To overcome this, Automatic Identification and Data Capture (AIDC) or Automatic Identification and Mobility (AIM) technology is chosen to be used as a medium of data exchange. Radio Frequency Identification (RFID) is chosen to get precise and up-to-date inventory information and ensures faster payment process. This method overcomes the problem of manually calculating the inventory, manually key-in price for price tag and also overcome the process of scanning barcode tag. Therefore, experience or inexperience employee could use this system. Last but not least, customer would automatically be involved in using this system without the need to undergo any training.

ABSTRAK

Thesis ini membentangkan tentang pembangunan sistem pembayaran dan pengurusan menggunakan teknologi pengenalan melalui frekuensi radio (RFID) sebagai medium panghantaran maklumat. Setiap kedai dan prasaraya di dunia mempunyai sistem pengurusan stok dan sistem pembayaran. Kedua-dua sistem ini haruslah berfungsi bersama untuk memastikan ketepatan barang keluar masuk agar tiada kesilapan semasa proses pembayaran dan pengurusan stok. Sistem tradisional atau lama seperti menggunakan kod bar dan pelekat harga jarang sekali dapat memberikan stok barang yang terkini dengan tepat selain itu proses tradisional atau lama ini juga melambatkan proses pembayaran. Untuk mengatasi masalah ini, teknologi pengenalan data secara automatic dipilih untuk mendapatkan keputusan yang diinginkan. Teknologi pengenalan melalui frekuensi radio (RFID) dipilih untuk mendapatkan stok yang terkini dan mempercepatkan proses pembayaran. Kaedah ini mengatasi masalah pengiraan stok secara manual, masalah mengisi harga ke dalam mesin pengiraan secara manual dan masalah membaca kod bar satu per satu. Oleh yang demikian, pekerja yang berpengalaman mahupun tidak berpengalaman dapat menggunakan sistem ini dengan mudah. Akhir sekali, pelanggan secara tidak langsung terlibat dengan sistem ini tanpa memerlukan sebarang latihan.

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UMP	Universiti Malaysia Pahang
RFID	Radio Frequency Identification
SQL	Structured Query Language

CHAPTER 1

INTRODUCTION

This chapter will introduce the project including the project background, problem statement behind the project proposal, the project objectives, the project scope and the thesis organization of the entire paper.

1.1 Background

Large or medium sized retail outlet need to keep track of the number of item in their stock, how much is going out and in each day and how much more is needed to ensure that the number of the item will never be out-of-stock or depleted. Thus, each retail outlet has their own ways of doing that. One of the most traditional and mostly used methods is manual calculation. This is done during the calculation of current stock and when new stock arrives. Worker will usually calculate and key-in the data into the computer.

Moving on, payment system using barcode and price tags as input for payment calculation are the most common and widely used method nowadays. In this paper, it is called

traditional payment system as it is the oldest and most common ways of payment compared to online payment, credit card online purchase etc. This method usually required a lot of time to complete as example during barcode scanning process or during manually key-in the price to the cash register. Though, this traditional payment system does prove that they are the most convenient method to payment calculation but wouldn't be better if somehow these processes could be done faster?

No matter how we see it, both payment and inventory share a common similarity and need to depend on each other. Somehow, these entire problems can be solved if RFID device is implemented into the current system by which both the retail outlet and their customer could benefit from. Payment time could be shortened and stock calculation could be made faster and more accurate whereas the security of product could also be increased to avoid thief.

1.2 Problem Statement

Problem faced by current system is that it is hard to know the exact number of item if the inventory and payment system are not integrated together. Example, Supermarket A set a limit on Product B. Number of Product B need to be more than 50 item per day and should not be more than 100 items and the inventory is updated every 2 days. Imagine if number of item available is 60 items and during two days of its business hour, the items are all bought up. Only after two days will the management team realized that the item is out-of-stock. Even after the management team realized that the item is out-of-stock and order the item, the item might not arrived overnight and this usually happen to item which supplier is far away.

Other than that, manually calculating number of stock could also be time consuming and troublesome to the worker. Imagine if there are 1000 new and different item arrived at one time and it needs to be calculated manually which will later cause time to be wasted on only calculating and keying in the data into the computer.

Price tags are the slowest payment method as the price tag cannot be scanned and solely depend on the cashier speed. The cashier also might mistakenly key-in the prices into the machine. Other than that, price tags are hard to manage if there are changes in the prices. Example, prices of a certain product is discounted or increased, thus the overall prices of all the price tag on the product need to be changed with new price tag which contribute to waste of resources and time wasting as it consume a lot of time. Nevertheless, barcode does not experience this problem but using barcode also has its own problem.

In barcode payment method, cashier scanning the item being bought might forgot or unconsciously missed to scan the bar-coded item. This will cause the company to suffer a loss in sense of capital or profit. Nevertheless, item hidden or not scanned will also contribute to the loss. Thus, this shows that there is a lack of security in traditional payment system. Last but not least, barcode will also cause waste of resources and time wasting similar to price tags if there are changes to the barcode. Such example is if the current barcode need to be changes with a new barcode. In traditional barcode system, current bar-coded item in stock might need to be replaced with new barcode if somehow the new item received from the supplier change their barcode.

1.3 Objective

The objectives of this project are:

I. To develop Inventory Management and Payment System for retail using RFID as a medium throughout inventory and payment calculation.

II. To enhance existed inventory management and payment system to a more time efficient and secure RFID Payment system.

III. To create an error free system for both inventory and payment calculation.

1.4 Scope

The scopes of this project are:

I. To totally replace barcodes and price tags with RFID tags in accordance to user requirement

II. To adapt RFID technology for automatic calculation of stock inventory or payment system.

III. To ensure no error during RFID scanning process, item and price calculation and equip the system with error handling action if any error occur.

1.5 Thesis Organization

This thesis consists of six (6) chapters. Chapter 1 will discuss on introduction to the research, background, the problem statement, scopes and objectives. Chapter 2 will discuss Literature Review made available from other research on the library or the web. Chapter 3 will discuss on Research Methodology by which method, technique or approach taken in this project is used. Chapter 4 will explain the implementation phase by which the system will be integrated. Next, Chapter 5 will discuss on the result or conclusion gained from the developed system. Last but not least, Chapter 6 will conclude the whole project.

Chapter 2

Literature Review

This chapter will review what is Automatic Identification and Data Capture (AIDC), RFID detail, previous and current retail inventory management and payment system, platform or operating system available, database available, programming language available and software requirement methodology existed. A comparison for AIDC, platform, database, programming language and software requirement will also be conducted to determine and justify the best one of its category.

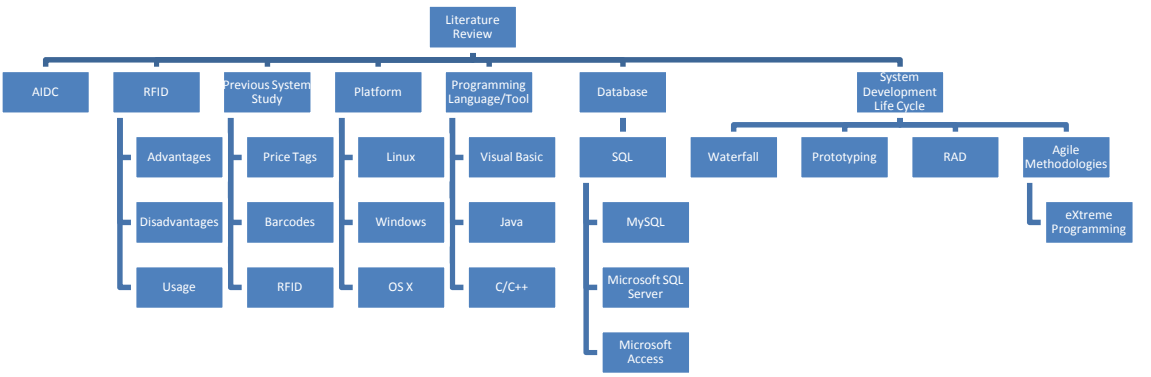

Figure 1 Literature Review List

2.1 Automatic Identification And Data Capture (AIDC) Technology

As the name mention, AIDC is a method of automatically identifying objects, collecting data about them, and entering the data directly into computer system with less or without human involvement. Its purposes are to identifying, tracking, recording, storing and communicating essential business, personal, or product data. It is important that AIDC and Automatic Identification and Mobility (AIM) refer to the same technology. There are several types of AIDC.

Table 1 AIDC Type And Description

AIDC Type	Description
Barcode	Black and white images which are encoded with information which is readable only through specific encoder through barcode reader. Require contact or line of sight for communication.
Radio Frequency Identification (RFID)	A system that transmits the identity in the form of a unique serial number of an object or person wirelessly, using radio waves and does not require contact or line of sight for communication. RFID data can be read through the human body, clothing and non-metallic materials.
Biometrics	Automated methods of recognizing a person

	based on a physiological or behavioral characteristic such as face, fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice.
Electronic Article Surveillance	Technology used to identify items as they pass through a gated area. Tag or label is affixed to an item and is then deactivated when the item is purchased. Gate is use to sense if the tags is active or deactivated and sound an alarm if necessary. Commonly used anywhere there is a chance of theft from small items to large.
Optical Character Recognition (OCR)	Scanning data which is in human readable form such as font or character which depend on printer-based technology, with costs determined by the type and quality of printer. No encoded error control.
Card Technology	Technology placed on a card to provide "access" to something. Such examples are magnetic stripe, smart cards, and optical cards. Often the card will have printing on it which may involve technologies such as Dye Diffusion Thermal Transfer (D2T2) direct-to-card printing.

Voice Recognition	A speaker-dependent systems which converts human speech into electrical signals and transforms these signals into coding patterns with assigned meanings use as automated input devices in applications where an operator's hands and eyes are occupied, enabling source data capture in real time.

There are other type of AIDC technology which exists and not listed on the table such as Radio Frequency Data Communication (RFDC), Direct Part Marking (DPM), Real-Time Locating Systems, Contact Memory, Magnetic Ink Character Recognition (MICR), Optical Mark Recognition (OMR) and Machine Vision.[20]

After much analysis, it is determined that only a few types AIDC are suitable for project proposed and they are; barcode, RFID, and OCR. Comparison of each AIDC technology's advantage and disadvantages are as follow:

Table 2 AIDC Advantages & Disadvantage

AIDC Type	Advantage	Disadvantage/Restriction
Barcode	I. Already implemented and widely accepted. II. Cheap as it is manufactured in large volume.	I. Require contact or line of sight for communication. II. Need human involvement to scan.

		III. Need specific scanner and encoder to read the data
OCR	I. Data is in human readable form II. Cheap as it can be printed from ordinary printer	I. Low quality but it depends on the printer. High quality cost more. II. Limited data as it is in human readable form III. Need specific scanner and encoder to read the data.
RFID	I. Does not require human involvement. II. Does not require contact or line of sight as it uses radio frequency. III. Can read longer distance tags compared to barcodes.	I. Need specific scanner and encoder to read the data. II. Strength depends on type of tag and scanner used.

After enough evaluation on all the AIDC software suitable to be used in retail system, it is decided that RFID will be used as a medium for data identification and capture technology for this project. Further explanation of RFID will be described below.

2.2 Radio Frequency Identification (RFID)

RFID is a system by which the identity of an object or person is transmitted wirelessly using radio waves.[20] As mention earlier, RFID does not require contact or line of sight for communication. RFID radio waves can be read through the human body, clothing and non-metallic materials.[20] RFID provides fast data collection with precise identification of objects with unique IDs without line of sight, thus it can be used for identifying, locating, tracking and monitoring physical objects.[1] RFID work by transmitting a signal through an antenna through the electromagnetic or electrostatic coupling in the radio frequency section of the electromagnetic spectrum[19] and a receiver will then read the signal. Each signal have a distinct, different and specified radio waves frequency and by reading it, the machine or scanner can identify what data are on the tags.[16] The RFID technology works in a similar pattern as the bar code identification.[19] but provides a more convenient and automatic approach for object identification.[2]

The RFID system comprises of an antenna or a transceiver, that marks the radio frequency and transmits the data to a processing device, and a tag or transponder, which is an integrated circuit comprising the radio frequency circuitry and the data to be transmitted and a control section.

A reader directs the radio frequency (RF) transceiver to transmit RF signals, receives the encoded signal from the tag through the RF transceiver, decodes the tag's identification, and transmits the identification with any other data from the tag to the host computer.

A tag is the device, which is attached with the item, which is to be tracked or loaded. The tag consists of electronic chip used to store data that can be broadcast via RF waves to the reader. The main function of the tag is to respond to a transmitted request from the reader for the data stored within the tag[16]. There are mainly two types of RFID tags: active and

passive RFID tags. The active tag contains a battery and transfers signals autonomously, whereas, a passive tag contains no battery and requires an external source to evoke signal transmission. [19] Passive tag has infinite lifetime, are smaller and lighter than active tags, and less expensive. On the other hand, they require more power from the reader and they have a shorter read range.[16]

The control section can passed the information obtained by the reader from the tag to the host PC or the LAN. [16] RFID operates in several frequencies ranging from 850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz which offer a transmitting range of more than 90 feet[19] or 10-30 KHz(VLF) to 30-300 GHz(UHF)[16]. Each of the frequency has its advantages and disadvantages for operation. The lower frequencies 125-134 kHz and 13.56 MHz work much better near water or humans. [16]

Read range is the maximum possible communication distance between tag and reader for proper functioning. It depends upon operating frequency sensitivity of the receiver, antenna orientation. The maximum distances between tag and the reader is not only a function of the power output of the reader, but also of the power available within the tag to respond, as well as of various environmental conditions, the kind of antenna used, and the frequencies at which the system operates. [16]

2.2.1 RFID Advantages

Radio Frequency Identification (RFID) is a promising new technology that is widely deployed for supply-chain and inventory management, retail operations, and more generally, automatic identification. The advantage of RFID over barcode technology is that it does not require direct line-of-sight reading. Furthermore, RFID readers can interrogate tags at greater distances, faster and concurrently. One of the most important advantages of

RFID technology is that tags have read/write capability, allowing stored information to be altered dynamically.[8]

The proliferation of RFIDs within many spheres of everyday life raises numerous privacy- and security-related concerns. In particular, RFIDs can be used to facilitate automatic aggregation of data about people's movements and/or shopping preferences through the use of covert readers to track RFID equipped items carried by consumers.[10]

Other than that, RFID is price efficiency and accurate.[11] Mass production has enabled low cost RFID systems to be distributed over large areas. In production and distribution systems, RFIDs manage products and follow them throughout the delivery route.[11]

2.2.2 RFID Disadvantages

Current RFID system deal with many problems, some of them are that RFID data are temporal, streaming, and in high volume, and have to be processed on the fly. Thus, a general RFID data processing framework is needed to automate the transformation of physical RFID observations into the virtual counterparts in the virtual world linked to business applications[1], radio communication used in RFID is naturally unreliable and prone to be interfered or corrupted and could lead to unreliable object identification and generate unclean raw database[2] and passive RFID data are noisy and inconsistent , with many false negatives as a result of radio frequency interference, limited read range, tag orientation and other intermittent environmental phenomena[3].

It is well known that streams of passive RFID data are noisy and inconsistent, with many false negatives as a result of RF interference, limited read range, tag orientation and other intermittent environmental phenomena.[3]

2.2.3 Current RFID Usage or Application

Radio Frequency Identification (RFID) technology has been applied in real environments such as supply chain, military management, healthcare system etc.[7] In many applications, such as supply chain automation, identification of products at check-out points, security, and access control, have been developed to take the primary function of RFID systems.[6]

Data mining is one of the most active research areas where a large number of RFID tags are uploaded to a server to extract hidden patterns of conveyance.[6]The RFID system is also used in passports for national security. Norway, Korea, and Germany already produce ePassport containing the biometric information of the traveller.[4]

Healthcare applications make use of RFID systems in various ways; in a hospital, RFID tags are used to track drugs and assure that patients are given the correct dosages of drugs. To monitor elderly people behaviour at home, he/she wears a bracelet equipped with a small RFID reader that reads RFID tags installed everywhere in the apartment, for example toothbrush, faucet, sofa, and bed.[4]

In vehicular applications, the RFID tag is generally mounted on the vehicle and the reader on the roadside unit. An Automatic Toll Collection (ATC) system with roadside RFID readers identifies passing vehicles by reading their tags and then charges the fare. The European Union is spending 8.1 million Euros on RFID tracking systems to issue automated tickets for minor traffic violations after reading the Electronic License Plates (ELP). In these applications, the RFID reader is (almost) stationary while the RFID tags are moving at vehicle speed. This keeps costs low due to cheap price of the RFID tags.[4]

Mass production has enabled low cost RFID systems to be distributed over large areas. In production and distribution systems, RFIDs manage products and follow them throughout the delivery route. This interest in RFID is highlighted by many recent white papers published by technology providers (e.g. Intermec, Texas Instruments), consulting firms (e.g. BearingPoint; Accenture), infrastructure providers (e.g. HP; Sun Microsystems), enterprise software providers (e.g. SAP), and solution providers (e.g. IBM).[9]

In the academic community as well, this emerging phenomena is reflected in various fields of research such as innovation management, project management, environmental management, e-commerce, supply chain management and warehousing, information systems, and decision support systems.[9]

In retail, products are organized according to layout plans, so-called planograms. Compliance to planograms is important, since good product placement can significantly increase sales. Currently, retailers are about to implement RFID installations consisting of smart shelves and RFID-tagged items to support in-store logistics and processes. In principle, they can also use these installations to implement planogram compliance verification: Each antenna is supposed to detect all tagged items in one location of the planogram. But due to physical constraints, RFID tags can be identified by more than one RFID antenna.[6]

2.3 Studies on Previous or Current Payment and Inventory Management System

This sub-review will discuss on the previous or current system of inventory management and payment system used in retail sector.