Automated Attendance System using Active RFID

by

Mohammad Afshar Bin Jamalulalam

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Communication Technology
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Approved by,

(Mr. Izzatdin A. Aziz)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHAMMAD AFSHAR BIN JAMALULALAM

ABSTRACT

The main focus of this project is to enhance the integrity and the authenticity of data, whereby, conventional system couldn't ensure the safety of the data. As the result, many employees neglect the importance of attitude in working environment. This project offers a safety towards the data, and in the same time helping in monitoring the movement of employees. Given a number of time, this project will undergo several phases which are planning, analysis, design and implementation. Lastly, the success of this project will be determined, and a conclusion should be made based on the result obtained, whether the objective has been met or not.

Acknowledgement

It has been an honour working with some of the individuals that made the completion of this project come true. I would like to firstly single out my one and only great supervisor for this project, Mr. Izzatdin A. Aziz with his contribution and effort in helping me to complete this project.

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CHAPTER 1
INTRODUCTION

RFID (RADIO FREQUENCY IDENTIFICATION)

Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.[1][2]

An RFID tag is an object that can be stuck on or incorporated into a product, animal, or person for the purpose of identification using radiowaves. Some tags can be read from several meters away and beyond the line of sight of the reader.[1]

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a (RF) signal and perhaps other specialized functions. The second is an antenna for receiving and transmitting the signal. A technology called chipless RFID allows for discrete identification of tags without an integrated circuit, thereby allowing tags to be printed directly onto assets at lower cost than traditional tags.[1]

Today, a significant thrust in RFID use is in enterprise supply chain management, improving the efficiency of inventory tracking and management. However, a threat is looming that the current growth and adoption in enterprise supply chain market will not be sustainable. A fair cost-sharing mechanism, rational motives and justified returns from RFID technology investments are the key ingredients to achieve long-term and sustainable RFID technology adoption. RFID tags come in three general varieties:passive, active", or semi-passive (also known as battery-assisted). Passive tags require no internal power source, whereas semi-passive and active tags require a power source, usually a small battery.[1]

1.1 Background of Project

The analysis for this project is defined as a technique used to monitor movements of employees as well as to ensure the authenticity of the data. In other words, conventional methods used in organization currently couldn't be trusted 100 percent, by using punch card and swipe card for access doors has its own weaknesses. Advance technology could overcome this problem by implementing wireless platform to monitor the movements of employees. This is important as the organization depends on its workers whereby, the wages of the employee is determined using the current conventional system. Therefore, without constant monitoring, the current system's effectiveness is questionable.

There are 3 types of RFID application which are widely used, which are:

- Active RFID
- Passive RFID
- Semi Passive RFID

Active

Unlike passive RFID tags, active RFID tags have their own internal power source, which is used to power the integrated circuits and broadcast the signal to the reader. Active tags are typically much more reliable (e.g. fewer errors) than passive tags due to the ability for active tags to conduct a "session" with a reader. Active tags, due to their onboard power supply, also transmit at higher power levels than passive tags, allowing them to be more effective in "RF challenged" environments like water (including humans/cattle, which are mostly water), metal (shipping containers, vehicles), or at longer distances. Many active tags today have practical ranges of hundreds of meters, and a battery life of up to 10 years. Some active RFID tags include sensors such as temperature logging which have been used to monitor the temperature of perishable goods like fresh produce or certain pharmaceutical products. Other sensors that have been married with active RFID include humidity, shock/vibration, light, radiation, temperature, and atmospherics like ethylene. Active tags typically have much longer range (approximately 500 m/1500 feet) and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. The United States Department of Defense has successfully used active tags to reduce logistics costs and improve supply chain visibility for more than 15 years.[3]

Passive

Passive RFID tags have no internal power supply. The minute electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the CMOS integrated circuit in the tag to power up and transmit a response. Most passive tags signal by backscattering the carrier wave from the reader. This means that the antenna has to be designed to both collect power from the incoming signal and also to transmit the outbound backscatter signal. The response of a passive RFID tag is not necessarily just an ID number; the tag chip can contain non-volatile EEPROM for storing data.[2][3]

Passive tags have practical read distances ranging from about 10 cm (4 in.) (ISO 14443) up to a few meters (Electronic Product Code (EPC) and ISO 18000-6), depending on the chosen radio frequency and antenna design/size. Due to their simplicity in design they are also suitable for manufacture with a printing process for the antennas. The lack of an onboard power supply means that the device can be quite small: commercially available products exist that can be embedded in a sticker, or under the skin in the case of low frequency RFID tags.[2]

In 2006, Hitachi, Ltd. developed a passive device called the μ-Chip measuring 0.15×0.15 mm (not including the antenna), and thinner than a sheet of paper (7.5 micrometers).Silicon-on-Insulator (SOI) technology is used to achieve this level of integration. The Hitachi μ-Chip can wirelessly transmit a 128-bit unique ID number which is hard coded into the chip as part of the manufacturing process. The unique ID in the chip cannot be altered, providing a high level of authenticity to the chip and ultimately to the items the chip may be permanently attached or embedded into. The Hitachi μ-Chip has a typical maximum read range of 30 cm (1 foot). In February 2007 Hitachi unveiled an even smaller RFID device measuring 0.05×0.05 mm, and thin enough to be embedded in a sheet of paper.[8] The new chips can store as much data as the older μ-chips, and the data contained on them can be extracted from as far away as a few hundred metres. The ongoing problem with all RFIDs is that they need an external antenna which is 80 times bigger than the chip in the best version thus far developed.[2]

Alien Technology's Fluidic Self Assembly, SmartCode's Flexible Area Synchronized Transfer (FAST)and Symbol Technologies' PICA process are alleged to potentially further reduce tag costs by massively parallel production. Alien Technology and SmartCode are currently using the processes to manufacture tags while Symbol Technologies' PICA process is still in the development phase. Alternative methods of production such as FAST, FSA and PICA could potentially reduce tag costs dramatically, and due to volume capacities achievable, in turn be able to also drive the economies of scale models for various Silicon fabricators as well. Some passive RFID vendors believe that Industry benchmarks for tag costs can be achieved eventually as new low cost volume production systems are implemented more broadly.[4]

Non-silicon tags made from polymer semiconductors are currently being developed by several companies globally. Simple laboratory printed polymer tags operating at 13.56 MHz were demonstrated in 2005 by both PolyIC (Germany) and Philips (The Netherlands). If successfully commercialized, polymer tags will be roll-printable, like a magazine, and much less expensive than silicon-based tags. The end game for most item-level tagging over the next few decades may be that RFID tags will be wholly printed – the same way a barcode is today – and be virtually free, like a barcode. However, substantial technical and economic hurdles must be surmounted to accomplish such an end: hundreds of billions of dollars have been invested over the last three decades in silicon processing, resulting in a per-feature cost which is actually less than that of conventional printing.[4]

Semi-passive

Semi-passive tags are similar to active tags as they have their own power source, but the battery is used just to power the microchip and not broadcast a signal. The RF energy is reflected back to the reader like a passive tag.[1][2]

Other than THREE(3) widely or commonly used RFID application, there is ONE(1) type which differs from the other THREE(3) types which is Antenna Types.

Antenna types

The antenna used for an RFID tag is affected by the intended application and the frequency of operation. Low-frequency (LF) passive tags are normally inductively coupled, and because the voltage induced is proportional to frequency, many coil turns are needed to produce enough voltage to operate an integrated circuit. Compact LF tags, like glass-encapsulated tags used in animal and human identification, use a multilayer coil (3 layers of 100–150 turns each) wrapped around a ferrite core.[5]

At 13.56 MHz (High frequency or HF), a planar spiral with 5–7 turns over a credit-card-sized form factor can be used to provide ranges of tens of centimeters. These coils are less costly to produce than LF coils, since they can be made using lithographic techniques rather than by wire winding, but two metal layers and an insulator layer are needed to allow for the crossover connection from the outermost layer to the inside of the spiral where the integrated circuit and resonance capacitor are located.[5]

Ultra-high frequency (UHF) and microwave passive tags are usually radiatively-coupled to the reader antenna and can employ conventional dipole-like antennas. Only one metal layer is required, reducing cost of manufacturing. Dipole antennas, however, are a poor match to the high and slightly capacitive input impedance of a typical integrated circuit. Folded dipoles, or short loops acting as inductive matching structures, are often employed to improve power delivery to the IC. Half-wave dipoles (16 cm at 900 mHz) are too big for many applications; for example, tags embedded in labels must be less than 100 mm (4 inches) in extent. To reduce the length of the antenna, antennas can be bent or meandered, and capacitive tip-loading or bowtie-like broadband structures are also used. Compact antennas usually have gain less than that of a dipole — that is, less than 2 dBi — and can be regarded as isotropic in the plane perpendicular to their axis.[5]

Dipoles couple to radiation polarized along their axes, so the visibility of a tag with a simple dipole-like antenna is orientation-dependent. Tags with two orthogonal or nearly-orthogonal antennas, often known as dual-dipole tags, are much less dependent on orientation and polarization of the reader antenna, but are larger and more expensive than single-dipole tags.[5]

Patch antennas are used to provide service in close proximity to metal surfaces, but a structure with good bandwidth is 3–6 mm thick, and the need to provide a ground layer and ground connection increases cost relative to simpler single-layer structures.[5]

HF and UHF tag antennas are usually fabricated from copper or aluminum. Conductive inks have seen some use in tag antennas but have encountered problems with IC adhesion and environmental stability.[5]

1.2 Problem Statement

Punch Card and swipe card currently used doesn't provide an effective solution for monitoring purposes, even the swipe card has been implemented thoroughly inorganizations as an electronic punch card, it still can't monitor the movements of employees because of its drawbacks having a line of sight connection. With these, it can't guarantee the employees movement at the office. With these, the companies can't avoid unnecessary cost for overpay to employees especially for overtimes.

1.3 Objectives and Scope of Study

The objectives of this project include:

- To investigate whether wireless system works can monitor the employees movement.
- To analyze the effectiveness of using active RFID platform as a solution of monitoring employees movement in working environment. Example : office, plants

The scopes of work that will be involved in this project are to compare and develop a new attendance system which is more effective in monitoring and tracking compared to other system. Besides that, the design process of this project will determine the effectiveness of this system for its implementation in the future. This system will be implement in offices environment, for Plant environment, it has not been determined the safety of this system. For experimenting purposes of this system, The venue of the experiment conducted is at UTP itself (to be specific, Building 2)

CHAPTER 2

THEORY & LITERATURE REVIEWS

In this project, the author intended to use Active RFID application as it suits with the requirement needed. Active RFID is widely used in long range tracking device and it is even implanted in human being for medical purposes, tracking inventories, and tracking animals even it is distance away.

What differentiate Active RFID and other current system is stated in Table 1 Below.

Variables	ACTIVE RFID	PASSIVE RFID	BARCODE	MAGNETIC STRIP
Distance	More than 3 feet and some tag may transmit signal several kilometers away	less than 3 feet	Up to 1 meter	Less than 1 cm
Propagation	Beyond line of sight and the signal can propagate through obstacles	Line of sight	Line of sight	Line of sight
Power supply	Yes	No	No	No

Table 1.1 : Active RFID Vs Passive RFID, Barcode and Magnetic Strip

2.1 Theory

2.1.1 RFID Characteristics [13]

There are six key characteristics of RFID that affect the communication between a tag and reader: Range, Range Adjustment, Propagation, Directionality, Multi-Tag Collection and Memory.

Range [13]

Range is defined as the maximum distance for successful Tag-Reader communication. Read range difference will vary and can be very-short, short, or long.

- Very Short Range: approx. up to 60cm (2 ft)
- Short Range: approx. up to 5 m (16 ft)
- Long Range: approx. 100+ m (320+ ft)

Range Adjustment [13]

Range Adjustment will also play a role in RFID tag read functionality. Range adjustment is the ability to adjust range and is categorized as very good or poor. Very good range adjustment can be fine-tuned to a specific distance. Tag-Reader communication is guaranteed within the specified range and tag-reader communication outside the range is impossible. Whereas poor range adjustment cannot be adjusted well at all. When there is a signal fall-off pattern or a reflection, tag-reader communication in the physical area is not guaranteed.

Propagation [13]

Propagation is the ability to perform tag-reader communication through or around objects and material. With very good propagation, the radio frequency can penetrate through objects allowing successful communication between tag and reader. Plus, very good propagation allows for penetration through water, liquids and human tissue and may even go through metal. Whereas poor propagation works on in line-of-sight and any obstacle such as a wall, people or vehicles between the tag and reader will prevent any successful communication.

Directionality [13]

Directionality is the ability to achieve directional RF coverage using directional antennas. There are two types of directionality: Omni-directional and Directional. Omni-directional coverage has similar RF coverage in all directions. With directional coverage, the RF coverage is much stronger in one specific direction.

Multi-tag collection [13]

Multi-tag collection is the ability to quickly and reliably collect large number of tags within a designated area.

Memory [13]

Memory is key in RFID communication — it determines the read only, read/write, or write once read many capabilities in the tag-reader communication. Some tags have small memory size at 16 bits and others have larger memory with 512 kBytes or more.

Frequency Ranges [13]

RFID also has various frequency ranges. Range determines the distance of RF communication and what type of RFID technology should be used for a specific implementation. Low-frequency (30 KHz to 500 KHz) systems have short reading range and are commonly used in asset tracking and security access implementations. High-frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) systems, offer long read ranges (greater than 90 feet) and high reading speeds. High-frequency systems are used for railroad car tracking and automated toll collection.

RFID Technologies [13]

There are various RFID technologies available today. These include: Very Short Range Passive RFID, Short Range Passive RFID, Active Beacon, Two-way Active, and Real-time Locating Systems (RTLS).

- Very Short Range Passive RFID can communicate a distance up to 60 centimeters. Due to this very short range, applications are limited to barcode-like "chokepoint" scenarios such as reading items on conveyor belts, manual or human involvement with handheld scanning and assets that are processed one at a time.
- Short Range RFID communicates a distance up to 3.5 meters. This increased chokepoint distance accommodates a greater variety of scenarios such as identifying assets that are moved by forklifts through a warehouse or crates that are transported from one slot to another. However, significant issues still remain with the shorter range. 915 MHz is the only band providing short range with passive tags and this band is not available in Europe today. Plus, the time to collect multiple tags increases with the number of tags to collect, reducing the speed assets are allowed travel. Due to the short range, multiple readers are required for good coverage in chokepoint area and adding readers will increase deployment costs.
- Active Beacon Long Range RFID communicates a distance of 50 to 100 meters. With this long range, a chokepoint implementation is difficult or impossible. For example, assets on a conveyor belt cannot be distinguished from assets sitting in storage and applications are therefore limited to scenarios of continuous tag collection such as taking inventory when collecting all tag data is required or searching for a specific tag. With Active Beacon RFID - there is no ability to write to the tag.
- Two-Way Active RFID tags have long range communication at a distance of 50 to 100 meters. Again with this long range, chokepoint implementation is difficult or impossible and applications are therefore limited to scenarios of continuous or on-demand tag collection.

- Real-Time Location Systems (RTLS) have long range communication of 50 to 100 meters. RTLS has the ability to locate tags to within 10 feet but resolution decreases in crowded environments and it is difficult to translate the data information to a logical location such as the specific parking slot a trailer might be located. It is not possible to write to the tag due to the long range distance and also involves a costlier infrastructure due to the number of readers required and the expensive processing equipment.

Below is a summary of the RFID Technologies available today:

Technology	Advantages	Disadvantages
Very short range passive	- Very low-cost tag - Global frequency	- Requires significant process changes - Limited multi-tag capability
Short range passive	- Low-cost tag - Sufficient range for dock doors and similar portals	- No global frequency - Many readers/antennas required for coverage - Slow multi-tag collection
Active beacon	- Low-cost active - Wide area monitoring	- Limited chokepoint/portal capability - No means of disabling beacon (air cargo)
Two-way active	- Highly reliable communication - Support for advanced functionality (memory, sensors)	- Expensive tag - Limited chokepoint/portal capability
REAL TIME LOCATION SYSTEM	- Physical finding/ locating - Wide area monitoring	- Very expensive infrastructure - Precision does not support "logical" locating (e.g. specific parking slot)

Table 1.2 : Advantages and Disadvantages of RFID Technologies

Active vs. Passive Technology [13]

RFID tags are categorized as either active or passive. Active RFID tags typically have both read and write capabilities so tag data can be rewritten and/or modified. Active RFID tags can transmit specific data or instructions to a reader (where the tag has been or important information about the items in the container). A passive tag can not actively send information as it is read only. Plus, active tags are powered by an internal battery which gives them a longer read range.

Passive RFID tags operate without a separate external power source and obtain operating power generated from the reader. They have shorter read ranges than active tags and require a higher-powered reader. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Passive tags are lighter, have smaller form factors and are less expensive then the more powerful active tags.

Active and Passive RFID are two fundamentally different technologies, each with unique advantages. While often considered competing technologies, they actually complement each other, balancing cost and capability. Active and Passive RFID offer tremendous potential for combined use within many applications, including air cargo and intermodal cargo management. Along with technical performance and regulatory issues, this opportunity for combined use must also be considered when selecting a frequency for Active RFID.

Active Tag (Active RFID Tag)[6]

An RFID tag is an active tag when it is equipped with a battery that can be used as a partial or complete source of power for the tag's circuitry and antenna. Some active tags contain replaceable batteries for years of use; others are sealed units. (Note that It is also possible to connect the tag to an external power source.)

Advantages

The major advantages of an active rfid tag are:

- It can be read at distances of one hundred feet or more, greatly improving the utility of the device
- It may have other sensors that can use electricity for power.

Disadvantages

The problems and disadvantages of an active RFID tag are:

- The tag cannot function without battery power, which limits the lifetime of the tag.
- The tag is typically more expensive, often costing $20 or more each
- The tag is physically larger, which may limit applications.
- The long-term maintenance costs for an active RFID tag can be greater than those of a passive tag if the batteries are replaced.
- Battery outages in an active tag can result in expensive misreads.

Features

Active RFID tags may have all or some of the following features:

- longest communication range of any tag
- the capability to perform independent monitoring and control
- the capability of initiating communications
- the capability of performing diagnostics
- the highest data bandwidth
- active rfid tags may even be equipped with autonomous networking; the tags autonomously determine the best communication path.

2.2 Literature Review

There are so many literature reviews found about Active RFID applications and its usage. ONE(1) good example is its usage in military assets. Such important and expensive assets must be monitored constantly for security reason. The Tobyhanna army depot has begun deploying WhereNet's active RFID asset tracking system to enhance its repair operations for radar systems. The system helps Tobyhanna track the location and movements of parts with a high degree of accuracy in real time.[7]

According to Frontline Solutions:

"After using active tag technology in a pilot that began last November, the army selected the WhereNet active-tag Real-Time Locating System. Tobyhanna personnel assign active RFID transmitters called WhereTags to items ranging from components to complete systems. The wireless architecture consists of locating sensors and port devices."[8]

Apart from tracking assets, the question is whether RFID system could be used in tracking human? Research had been done in tracking animals movement. But, it is applicable to human whereby sensitive issues will be rise such as human rights, human privacy and health concerned matters. It is undeniable the usage of RFID will violate human constitution. But, for this project, the issue is about work ethics, monitoring employees movement. So far, the current trend in Malaysia, is still using Smart Card, whereby the efficiency, reliability, and availability of this application is questioned.

Quoting from a research paper regarding smart card application by Keith E. Mayes, Kostantinos Markantonakis and William G. Sirett from University of London.

"A typical Smart Card would have a similar capability to accept an application that is endorsed in this manner so where is the problem? The concern arises because the card has little means to predict or check anything about the run-time behaviour of the new application."

"For Example, consider the case of security guard monitoring / controlling an entrance to a business park. He may know very little about what goes on in the many businesses, but, he can check that every arrival has a valid ID and that the IDs are appropriate for access to a particular area/building." [9]

By all meaning, there are no perfect system in this world, no matter how good a system is, it still has its flaws and drawbacks. By this, Smart Card is no longer an option in monitoring employees' movement.

Current RFID state

As there are so many researches done for RFID and its reliability in monitoring movement and its pros and cons whether this system is applicable in monitoring human movements, not only for employees, but also normal users such as children. This system could react as a radar and avoid unnecessary incidents such as children kidnapping that recently happen in Malaysia and shocked Malaysian citizens.

In the coming future ubiquitous society, Radio Frequency Identification (RFID) tags will be affixed to every product and person. This technology is anticipated to be a key technology that will be utilized by various ubiquitous services where these tags will be used to identify things and people and will automatically take advantage of contextual information such as location. On the other hand, a problem is arising where the excellent tracking ability of RFID is abused and personal privacy is being violated. [10]

An active tag is an RFID tag that incorporates a battery, and can communicate with a reader that is several tens of metres away (there are tags that can communicate at

several hundreds of meters). While passive tags can only respond to an electromagnetic wave signal emitted from a reader, active tags can also spontaneously transmit an ID.
There are various types of transmission opportunities such as the very common periodic transmission type, or the unscheduled transmission type such as when there are changes in vibration or temperature or when a button is pushed. In many cases, the ID data comprise several tens of bits.[10]

Generally, systems that employ active tags comprise the tags, a reader, and a server. The tag spontaneously transmits its ID. For example, if the tag is a periodic transmitting type, the tag transmits its ID once every several seconds. When the reader receives the ID, it notifies the server of the ID via the network, and based on the ID the server executes the target service.[10]

There are some examples of Active RFID applications used for monitoring and described as below :

Behavior tracking of kindergarten children

Parents or guardians can view their children in kindergarten via the Internet by utilizing the active tags. Active tags are attached to the nametags of the children, and the classrooms and sports grounds are equipped with a reader and a Web camera. Based on this, by accessing the Internet the children can be viewed in real time and in their actual surroundings. The parents or guardians can automatically select video images of their children. [10]

Monitoring grade school children on their way to and from school.

Since the incidences of abduction and brutalization of children as they are on their way to and from school has increased, the application of active tags has been investigated. The backpacks etc. of the children are equipped with a tag and readers are installed along the route to school and at the school gate. When a child passes by a location that is equipped with a reader, the ID is transmitted and the school and the parents or guardians are notified. By using this system, at an early stage the teachers and the parents or guardians can become aware of any abnormalities in the commute to school.[10]

With this, by implementing RFID applications, it would be an assistant in our daily life as well as securing it. Regarding the issues aroused, such as privacy is merely an option when it comes to monitoring children movement. But, what about monitoring employees movement? This issue, is more towards the abuse of the system by an excellent tracker.

Application Privacy Issues

On the other side of this convenient system, there is the increased anxiety caused by privacy violation stemming from automatic identification using the active tags. This section evaluates the threat to privacy that can occur by transmitting an ID, which at most comprises several tens of bits. First, the characteristics of the many currently used active tags are clarified.[10]

- The active tag transmits its ID without the knowledge of the owner. More specifically, the owner does not have to perform an action such as consciously pushing a button as in the case of an immobilizer. The tag periodically and automatically transmits the ID.[10]
- Anyone that possesses a reader can receive the ID. These two characteristics lead to the consequence that anyone possessing a reader can receive the ID without the owner being aware. Whether or not this idea can actually be connected to the violation of privacy depends on the characteristic of the ID being disclosed as described below.[10]

Among the key privacy issues are notifying individuals of the existence or use of the technology; tracking an individual's movements; profiling an individual's habits, tastes or predilections; and allowing for secondary uses of information.[10][11]

Privacy issues included:[10]

- Ensuring that only authorized readers or personnel have access to information,
- Maintaining the integrity of the data on the chip and stored in the databases,
- Ensuring that critical data is fully available when necessary. Other issues with
- Implementing the technology included the potential for various attacks,
- Such as counterfeiting
- Cloning,
- Replay,
- Eavesdropping;
- Possibility of electronic collisions when multiple tags and/or readers are present; and the presence of unauthorized components that may interfere or imitate legitimate system components.

Besides that, in such way, the tracker could know the identity of the user and its location, which violates the privacy of the user. Quoting from U.S Privacy Act of 1974, E-Government Act of 2002, there are ways to overcome this matter.

Prevention of Privacy Violation

- A mechanism that can deactivate, or "kill," a tag at the point of sale, can prevent tracking of the individual and item once the tag leaves a place.
- Another proposed method is blocking technology. Devices that can disrupt the transmission of all or selected information contained on a tag would be embedded in an object that is carried or worn near RFID tags that the individual wants blocked. This technology, however, has not yet been fully developed. One challenge to its development may be the constant proximity required between the blocker tag and the tag in order to disrupt data transmission. Consumers may not consistently remember to juxtapose the tags, thereby reducing the effectiveness of the technology. A physical method of blocking currently in use is aluminum-

  coated Mylar bags, which can absorb or diffuse RFID signals when placed over the tag. An example is in toll payment systems where aluminum-coated

Mylar bags are issued along with the tag so that drivers can place their tags in the bag to prevent them from being read inadvertently.

- Government and industry groups have also proposed using an opt-in/opt-out framework. This framework would provide consumers with an option to voluntarily participate in RFID transactions that gather data about them. Consumers would be informed of the existence of the tags and the type of information that would be collected and could then decide whether to participate in the transaction or opt out. A concern of this hybrid system is the potential disparity in benefits received between consumers who opt in versus those who opt out, similar to customer loyalty cards, and the notion that this framework might penalize consumers who articulate their privacy preferences.

CHAPTER 3
METHODOLOGY

3.1 Elements Determination

Upon completing the Final Year Project Part 1, there are several steps needed to be made, by performing analysis and studies, is to ensure the project will be a success and lab works are needed to conduct experiments and to understand more about RFID. For this project, Waterfall model is used in organizing the project and to ensure the project meets its objective and scope.

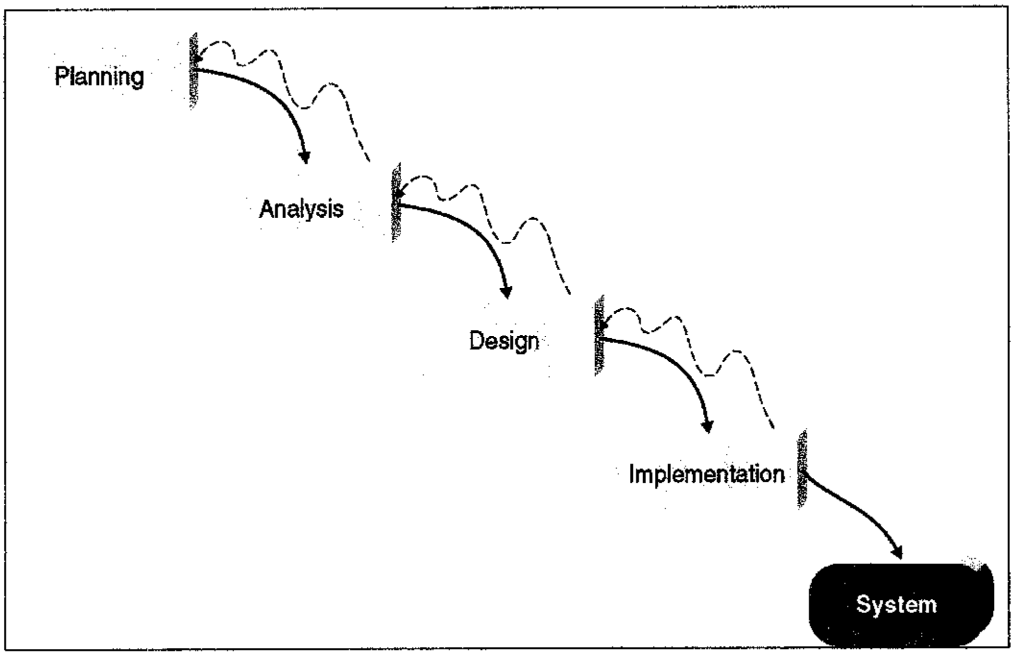


Figure 3.1 : System Development

1. Planning; In this phase, the author had to ensure the task that had to be carried out for this project. Hence, the author planned all the tasks by doing a Gant chart for it, please refer to Chart 3.1(PG24).
2. Analysis; In this phase, the author had analysed the hardware and software that will be used in designing or executing the Automated attendance system and also trying to analyze the current system, besides that, the author had to

decide the type of testing to be implemented and the suitable location for this system, the author decided the system will be simulated or tested at UTP building 2;

3. Design; A process of developing the system flow and it's coding as well.
4. Implementation; Going through a process of developing the real prototype and test it. There are 3 types of testing, Distance, Propagation and availability testing The result of the testing will be included in Chapter 4: Results and Discussions.

Until now, all the part in the waterfall model has been executed. From planning to implementation of the system.

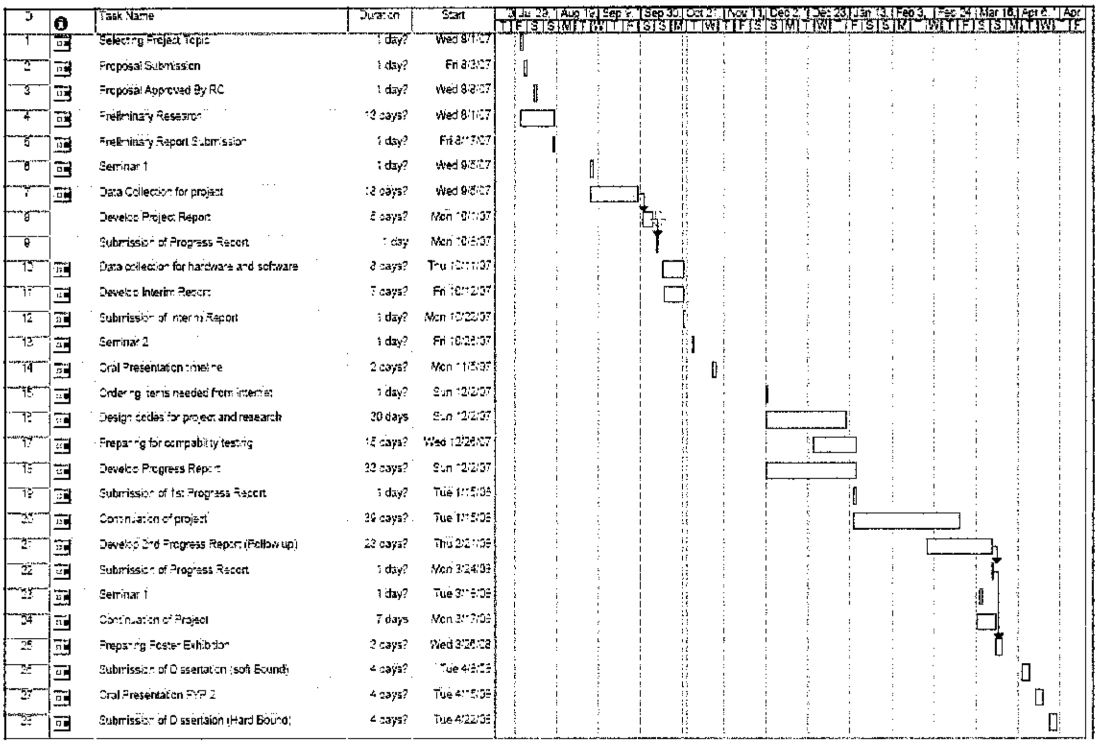


Chart 3.1 : Gant Chart for FYP 1 and 2

3.2 Sample Preparation

3.2.1 Experiment Protocol

In this project, the author will use Active RFID application to realize this project. Active RFID reader and Tags are required for the development of this project. But, the problem with this TWO(2) hardware is most of it has been embedded with its own programming language and licensed. To solve this problem, the author decided to look for programmable RFID application.

There are TWO(2) types of programmable active RFID reader and tags which are used for monitoring movements of aging people at old folks home in Hong Kong and monitoring assets as well which are :

1. RF8315R-u Active RFID Receiver USB
2. RF40315RT Active RFID 40 Meters Transmitter and Receiver

The author has to choose either both of it considering the advantage and disadvantage of the application. The results will be shown at Chapter 4, Discussion and Result. After choosing the components, the prototype design of the application has been developed and as shown at next page.

3.3 Sample Testing

3.3.1 Testing Setup

At this phase, the author will setup an apparatus for the testing, the location of this test is at Building 2, UTP. The reason of doing it at Building 2,UTP is to simulate a real scenario for this system, to ensure its effectiveness. The item prepared in this test are :

1. Laptop
2. Active Tag
3. Active Reader
4. USB RS232 Converter cable
5. Measuring tap

There are TWO types of tests will be conducted, which are Testing for Distance and Testing for Propagation. The testing for Distance is to measure the signal transmitting radius for the tag, how far the signal could be read by the active reader. The second test is about the propagation of the tag, the ability of the signal transmitted from the tag to propagate through obstacles which will categorized through THREE main building 2 material, which are Concrete, Glass, and Metal. The result will be presented at Chapter 4 : Result and Discussion.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Data Gathering and Analysis

After doing some research with the items stated in chapter 3, the author decided to choose only ONE(1) from it by measuring the item's reliability and specifications given by the manufacturer, Ananiah Electronics.

Active RFID Reader Specifications [14][15]

RF8315R-u Active RFID Receiver USB	RF40315R Active RFID Receiver
1. Operating Temperature = 0 - 50C 2. Operating Frequency = 315 MHz 3. Data Output ID sent by RF8315T(4 characters) plus 1 space 4. Capacity = 160 ID simultaneously 5. Build-in Watchdog = Yes. 2.3 seconds 6. Port = SERIAL PORT (USB) 7. Type = 9600 Baud, 8 bit words,1 stop bit,1 start bit, no parity	1. Operating Temperature = 0 - 50C 2. Operating Frequency = 433 Mhz 3. Data Format = 4 characters 4. Receiver Output RS232, 9600 Baud, 8 bit words,1 stop bit,1 start bit, no parity 5. Transmitter Power Supply 2 X CR2032 (4,000 hours) 6. Receiver Supply Voltage 9VDC via wall adaptor if necessary 7. Effective Radius 40 meters (line of sight) 8. Receiver Supply Current 4mA Typical

Table 4.1 : Comparison between Active Reader Specification

4.2 Result and Discussion

4.2.1 Hardware Recommended

The importance of choosing a right tools and hardware will determine the effectiveness of this project. Basically, RF4031R has a longer range of frequency radius, which it can achieve until 40 meters radius of signal distribution. But, the problem of this hardware is, the signal bounces on the obstacles making "faulty" reading occurs. It clearly shows, this hardware is only suitable for outdoors purposes rather than indoor, as there are less obstacles at outdoor such as walls. This will affect the effectiveness of this project if RF4031R is used in this project.

Hence, the author decided to choose RF8315-u as an ideal reader for this project. Even it reaches only 8 meters radius of frequency distribution, but, the key benefits of this hardware are, it's PLUG N PLAY, which makes it easy to use, and synchronize with author's PC for programming purposes and it uses USB port. Even though the maximum radius for this hardware can receive signal is only 8 meters radius, but, if the antenna is replaced with 9" wire, the effective radius could be increase until 14 meters, which makes it suitable for indoor purposes. Besides that, the design of this hardware is super heterodyne which means it's built for maximum stability. Super heterodyne design is the most stable but expensive design. This is particular suitable for challenging working conditions such as strong wind, serious raining and fast moving objects. Although this design has so many advantages, it cannot receive short distance signal (within 1 meter). As a result this receiver cannot report the ID send by RF8315T within 1 meter.

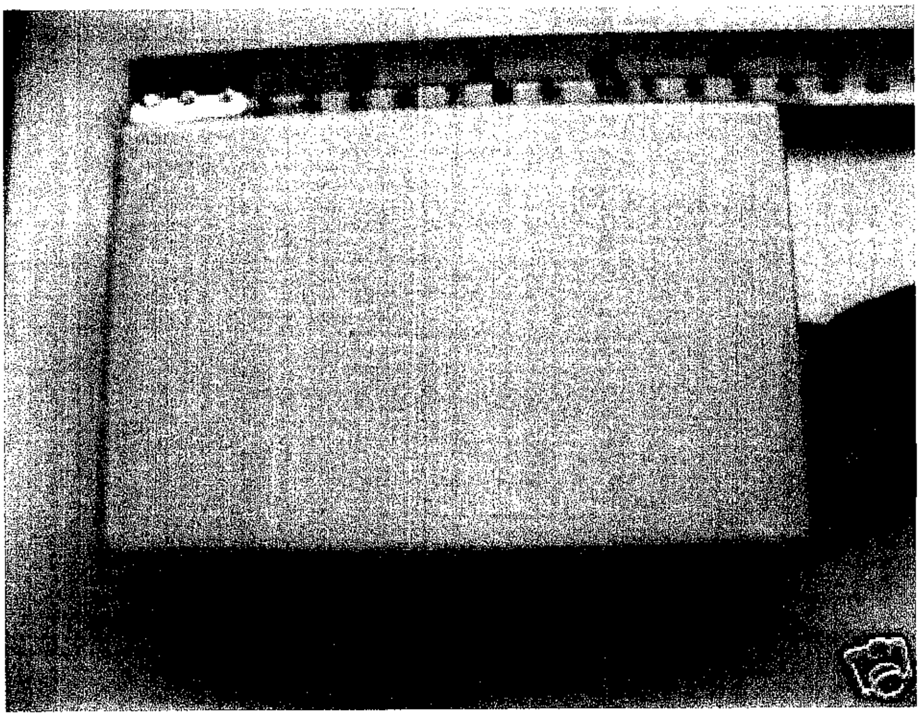


Figure 4.1 : RF8315R-u Active RFID Receiver USB

For the tag or transmitter of this project, the author chose RF40315RT Active RFID 8 Meters Transmitting Module (See figure below) for its small size (1.8cm x 4.6cm x 1.1cm) and its capability of transmitting signal until 40 meters radius (Line of Sight) and it is suitable for indoor purposes which means in office area. For the time being, the author will focus on monitoring the employees inside the office rather than outside. This is to ensure the maximum capability of this system to meet its requirement, which is to monitor the employees' movement.

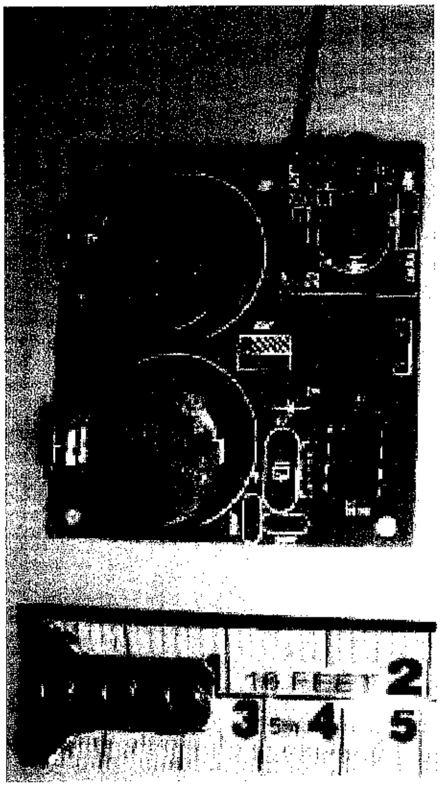


Figure 4.2 : RF40315RT Active RFID 40 Meters Transmitting Module

Specification of RF40315RT [16]

Power Input	3V
Power Consumption	4mA when transmitting, 19uA when idle
Operating Temperature	0 - 50C
Operating Frequency	315 MHz
Data Output	4 characters (A-Z, a-z, 0-9). All transmitters carry unique ID
Effective Radius	40 meters(Line of Sight), 8 – 12 meters indoor
RF output power	< 2mW

Table 4.2 : Specification of RF40315RT

The key benefits of using RF40315RT are: [16]

- Terminal block for connecting external 3V power
- Can send data up to 40 meters (Line of sight) but, 8-12 meters if separated with objects with included antenna
- Super small dimension
- No setup required
- A jumper to select the RF output power (indoor or outdoor application)
- Anti-collision algorithm is employed. RF8315R can handle 160 transmitters at the same time.

For the purchasing of both hardware, which are RF8315R-u Active Receiver USB and RF8315T-x Active RFID 8 meters Transmitting Module, the author found the hardware and ordered it via EBAY, www.ebay.com and the costing are as shown below.

ITEM	COST
RF8315R-u Active Receiver USB	**50 USD**
RF40315RT Active RFID Transmitter	**31.95 USD**
[illegible]	**81.95 USD = RM 275 (-+)**

Table 4.3 : Costing of Automated Attendance System Hardware

Apart from that, the design of the hardware and the software is also important as it determines the functionality and usability of this project. In this project, the author decides to place the active tag at back of the card, and the programming language to be used in this project is Visual Basic. The author uses Visual Basic 2005 as the platform for this project because it is easier to understand rather than using C++.

Front View

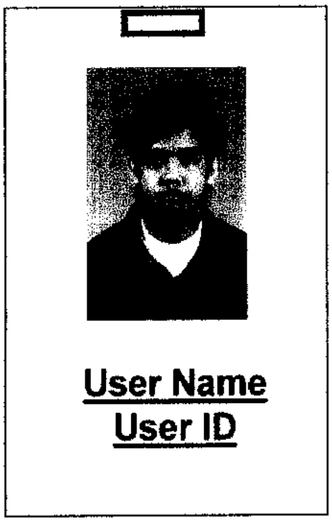


Figure 4.3 : The front view of User card

Rear View

Figure 4.4 : The rear view of User card

The design of the employees ID card is like other smart cards. The difference is it is implanted with active RFID at the back of the card. Apart from that, the thickness of this card differs from other smart card, as active RFID tag has its own power supply.
For the system flow of this program, the author designed it to be a simple system as the functionality of this system is important rather than its appearances (please refer to page 37 at appendices, chart 2 and Diagram 1). As this system differs than the current system because it doesn't require a line of sight or direct contact with the reader, the author faced with difficulties to determine whether the reader could read the signal

transmitted by the tag or vice versa. For programming language, the author chose Visual Basic for the programming and Microsoft Access as the database for the record.

The source code is as shown below.

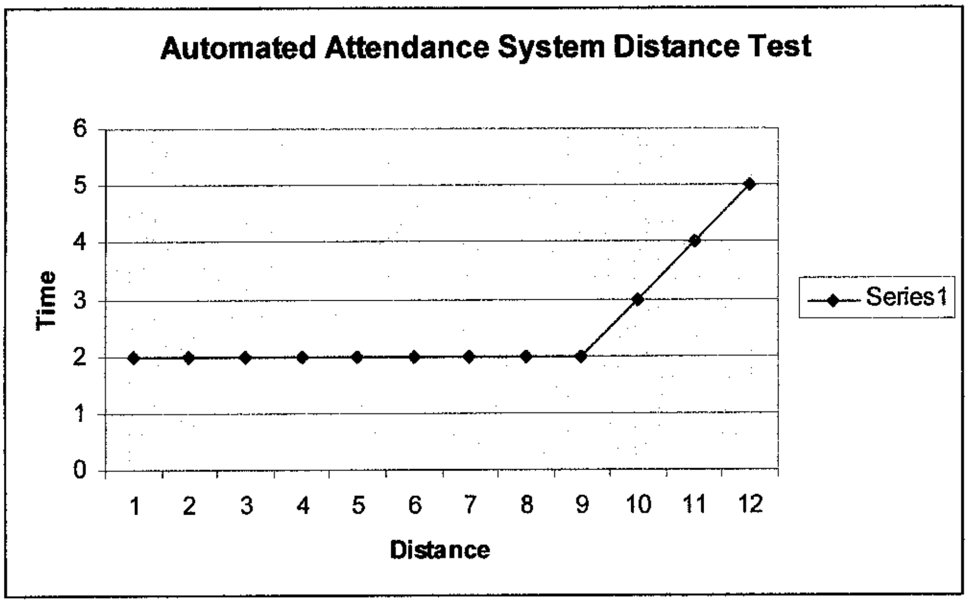
Sample Program

```
Option Strict Off
Option Explicit On
Friend Class Form1
   Inherits System.Windows.Forms.Form

   Private Sub Command1_Click(ByVal eventSender As System.Object, ByVal
eventArgs As System.EventArgs) Handles Command1.Click
      If rfidAX1.OpenPort(CInt(nCommPort.Text)) Then
         MsgBox("System initiated")
      Else
         MsgBox("Comm port open error")
      End If
   End Sub

   Private Sub Command2_Click(ByVal eventSender As System.Object, ByVal
eventArgs As System.EventArgs) Handles Command2.Click

rfidAX1.ClosePort()
   End Sub


   Private Sub rfidAX_rfidData(ByVal eventSender As System.Object, ByVal
eventArgs As AxRFIDX.__rfidAX_rfidDataEvent) Handles rfidAX1.rfidData
      If List1.Items.Count > 100 Then List1.Items.RemoveAt((0))
      List1.Items.Add(eventArgs.sID & " " & CStr(eventArgs.dDataTime))
      List1.SelectedIndex = (List1.Items.Count - 1)
```

```
        Me.RFIDtabTableAdapter.InsertQuery(eventArgs.sID, "",
CStr(eventArgs.dDataTime), "")
        Me.RFIDtabTableAdapter.Update(Me.AutomatedattDataSet.RFIDtab)

    End Sub

    Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        'TODO: This line of code loads data into the 'AutomatedattDataSet.RFIDtab'
table. You can move, or remove it, as needed.
        Me.RFIDtabTableAdapter.Fill(Me.AutomatedattDataSet.RFIDtab)

    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click
        Me.RFIDtabTableAdapter.Fill(Me.AutomatedattDataSet.RFIDtab)
    End Sub



Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        If cmbOpt.Text = "Name" Then
            Me.RFIDtabTableAdapter.FillByEmp(Me.AutomatedattDataSet.RFIDtab, "%"
& txtOpt.Text & "%")
        Else
            Me.RFIDtabTableAdapter.FillByRFID(Me.AutomatedattDataSet.RFIDtab,
"%" & txtOpt.Text & "%")
        End If
    End Sub
```

```
    Private Sub DataGridView1_CellContentClick(ByVal sender As System.Object,
ByVal e As System.Windows.Forms.DataGridViewCellEventArgs) Handles
DataGridView1.CellContentClick

    End Sub
End Class
```

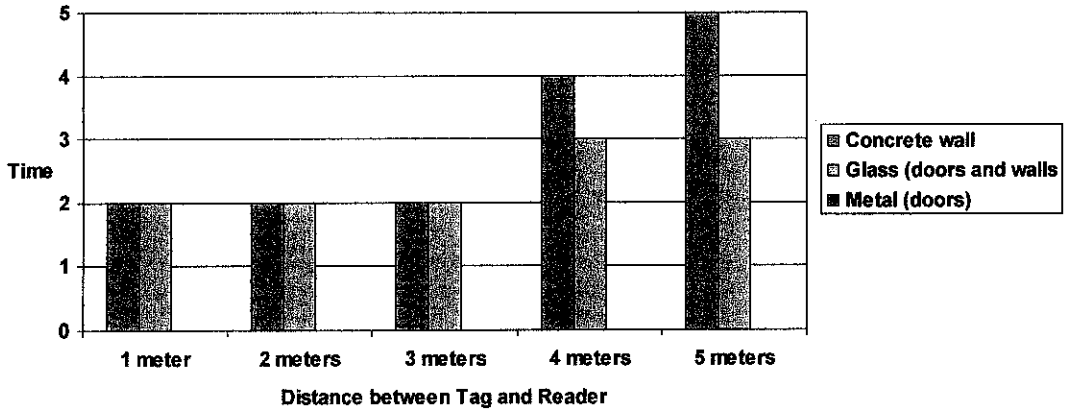
4.2.2 Testing for Distance



Graph 4.1 : Time Vs Distance (Distance Test)

Summary of testing is determined by graph 1, whereby, The Time VS Distance plot is used. From 1 meter to 9 meters apart, the reader could read the signal at its ideal time, which is every 2 seconds, when it reaches 10 meters, the reader started to read at a time duration of 3 seconds, at 11 meters, it increases to +- 4 seconds, when it reaches 12 meters, the reader could read at a time duration of +- 5 seconds. Unfortunately, when it reaches more than 12 meters, the reader couldn't read any signal from the active tag.

4.2.3 Testing for Propagation



Graph 4.2 : Time Vs Distance (Propagation Test)

Summary of testing is determined by Graph 2, whereby, The Time VS Distance plot is used. Categorized by the material of the obstacles, which are concrete, glass and metal, For concrete walls, the signal could be received or read by reader at its ideal time which is 2 seconds from 1 meter to 3 meters, the time increases when the distance increases. For Glass, the reader could read at idle time which is 2 seconds from 1 meter to 3 meters, the time increases for 1 second for 4 to 5 meters. For metal, there are no signals received by the reader.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Throughout the project, the author's objective has been met as the proof of concept which active RFID is an alternative solution to track and monitor employees' movement. There are many things the author learnt from this technology, whereby, it is very useful and can be used in monitoring employees at their work site. Of course there are no such things as a perfect system, but, the RFID system could narrow down the faulty which occurs in other system such as Biometric and Smart card system. Having its own advantage of operating using radio waves at long distance and its autonomous ability, resulting active RFID is a good application for monitoring purpose.

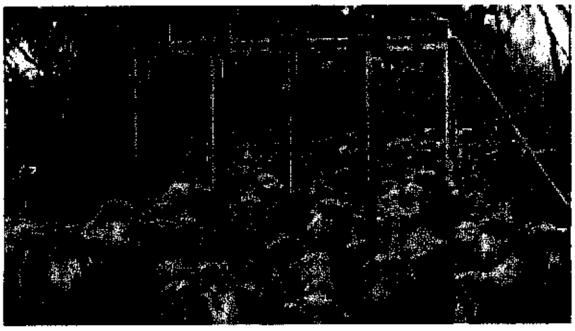
5.2 Recommendation

With further enhancement, such as the improvisation of the hardware and its algorithm, the system could be implemented in tracking not just employees, but, much more wider scope in our daily lives.

APPENDICES

Appendix 1

Reference : www.rfid.com.au/rfid_animalid.htm



ELECTRONIC LIVESTOCK IDENTIFICATION

Texas Instruments RFID (TI-RFID™) low frequency (LF) RFID technology has been used to identify millions of livestock animals around the world. These systems track meat and dairy animals, valuable breeding stock and laboratory animals involved in lengthy and expensive research projects. The Australian National Livestock Identification System (NLIS) is the first and the largest implementation of RFID for animal tracking in the world.

RFID transponders are worn as ear tags or as an inter-ruminal capsules. Farm management can be fully automated for such processes as feeding, weighing, disease management, and breeding practices.

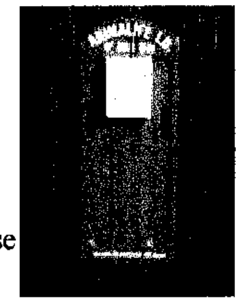
Low frequency (LF) RFID, with an operating frequency of 134.2 kHz, has been adopted internationally for animal identification applications following many years of development, exhaustive testing and practical field evaluation.

The International Standards Organization (ISO) and the Australian/New Zealand standards for the electronic identification of animals are based on LF 134.2 kHz RFID technology. (ISO11784/11785, AS5018/5019) The Texas Instruments LF RFID technology was selected by the ISO as the basis for these standards.

TI-RFID™ 134.2 kHz LF technology has been adopted by the NLIS in Australia after exhaustive field testing of all available technologies. Through these trials the TI-RFID half-duplex (HDX) technology was demonstrated to have superior performance under practical conditions. NLIS tags have now been in use for several years, with great success.

Over a period of 10 years or more, suppliers of non-conforming technologies have challenged the use of LF RFID for livestock. Despite these challenges TI's LF 134 kHz ?HDX? RFID still delivers the best cost: performance ratio for the livestock industry.

Texas Instruments 134.2 kHz LF RFID uses frequency modulation and half duplex techniques. This unique approach gives the most robust performance and best read-range in its class. The tags are passive components (i.e. no battery), which combined with TI's legendary quality and reliability, means they continue to operate for many, many years.



The ISO standards also encompass full duplex (FDX) 134 kHz technology. Although full duplex tags are cheaper and suppliers often claim that they will perform as well as HDX technology, these claims

have not been supported during field evaluation with walk-through readers. For this reason, HDX tags are used almost exclusively for livestock where performance and

reliability are important. FDX tag performance is adequate where animals can be individually handled and scanned with hand-held readers.

TI HDX transponders used for livestock identification are factory programmed with a unique 64-bit code which is tamper proof and cannot be duplicated. All animal data is stored in secure data-bases where it can only be accessed by authorized users.

The leading suppliers of cattle identification products have now integrated TI-RFID technology into their ear tags. Eartag manufacturers are carefully qualified by Texas Instruments, and must obtain ICAR (international) and NLIS approvals before releasing their products. These tags are now being rolled out progressively in Australia , state by state, to support the NLIS implementation. Millions of tags have been deployed to date (2007).

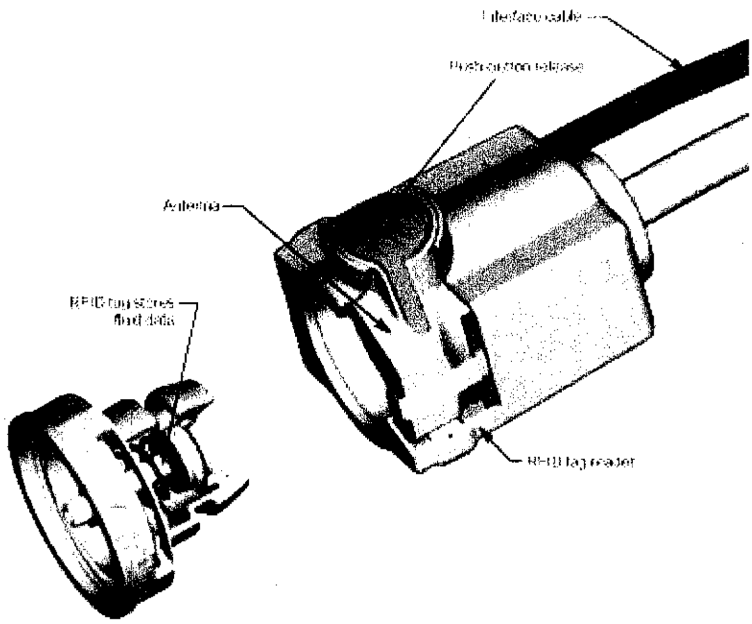
Appendix 2

Reference : http://www.medicaldesign.com/articles/default.aspx?ID=12200

Is This the Right Drug? RFID Tag Tells.

Fluid couplings fitted with RFID tags can verify correct connections in medical devices. This is useful where misconnections are the difference between life and death.

Rick Garber
Business Unit Manager
Smart Technology
Colder Products Co.
St. Paul, Minn.

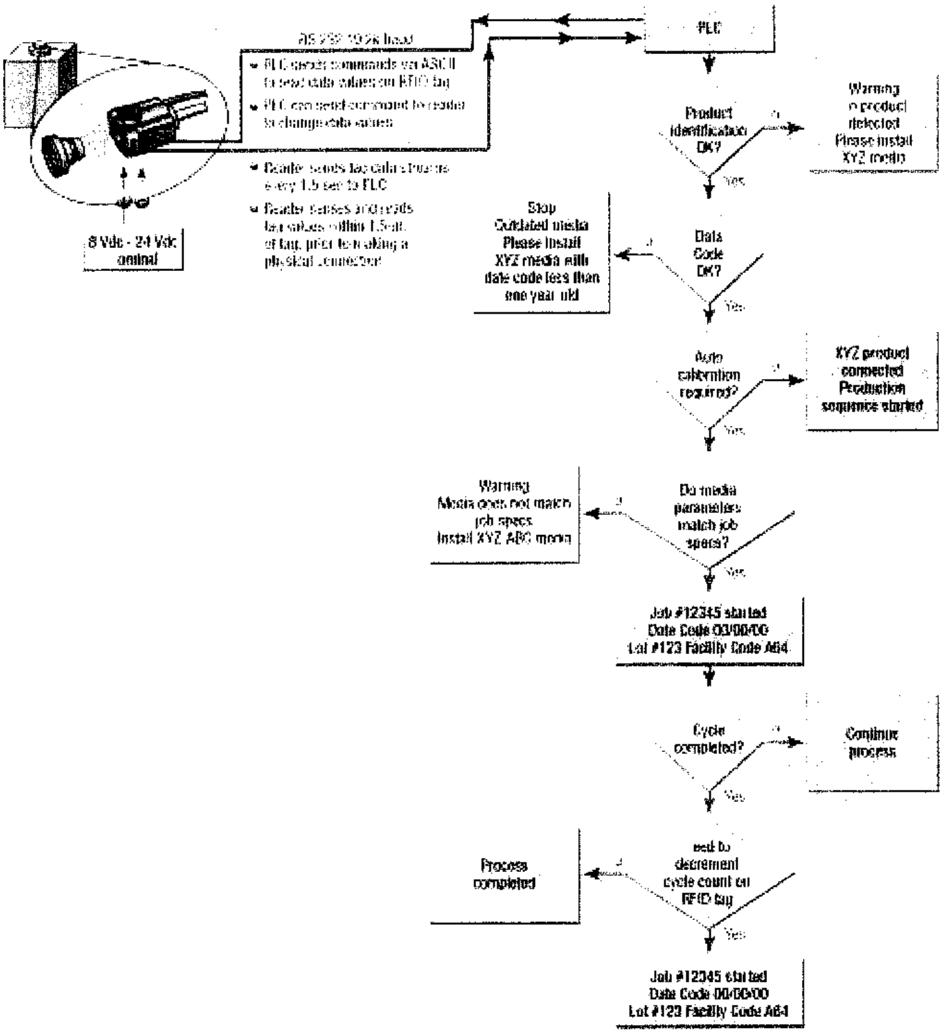


RFID tags in fluid couplings can store date codes, batch codes, filling sequence, product identification, and product parameters such as viscosity and particle size.

It seems everyone is talking about RFID. Radio-frequency identification can instantaneously transfer information across short distances and has been used to track everything from highway tolls to cattle. The technology is set to redefine the supply chain and brand-protection industries by only allowing connections between specified products. It is clear that RFID technology has enormous potential. But what impact will it have in the medical field?

One application is in fluid handling. Smart Coupling Technology combines fluid couplings with RFID. So if someone connects the wrong IV bag to a medical device, the system prevents fluid flow. Misconnections in fluid handling can be costly, significantly delay production, and potentially harm operators or end users. In the medical industry the right fluid connection is critical because the cost of errors is high. RFID helps prevent mistakes caused by unavoidable human error. In addition, the technology captures and records data, verifies internal process control, and electronically documents regulation compliance data.

How it works



An RFID tag is applied to the insert portion of a coupling on a fluid container or bag. The tag is programmed with unique product data determined by the customer and may include product ID, stocking history, package size, date code, and other product characteristics. The body portion of the coupler contains an RFID interrogator, or reader, that captures information from the tag before the connection takes place.

The reader converts data from the tag into a machine-readable format, and relays this information by an RS-232 interface to the control system, often a programmable logic controller (PLC) or computer. Based on this information, the control system makes a decision about whether to permit the connection. In the case of a misconnection, the system could, for example, sound an audible alarm or not turn on a pump or both. All this takes place in a fraction of a second.

A stand-alone system can serve those without data-control systems. In this configuration,-the reader senses the tag and acts on the information transmitted. In the event of an unintended connection, the reader notifies the operator by sounding an alarm or illuminating a red LED as part of a green/red light, go/no-go scheme. Other options include using a solenoid to lockout the coupler. A solenoid can lock the thumb latch to prevent joining the coupling insert and body.

Smart couplings read and write before connection, at up to 1.5-in. before the halves mate depending on coupler size. Reading at this close proximity prevents errors and misreading other tags. However, read range can be altered by changing antenna size or output power. Using "gate antennas," certain configurations can transact at 1.5 m and still conform to EMI standards.

An RFID tag on one side of the coupling sends messages to the reader, which relays information to a control system. The control system determines whether to permit the connection or to send an error message to the operator.

Better than bar coding

Unlike RFID, bar codes are read-only. This means data is inalterable after it's entered into a bar code. The codes cannot reflect changes, for example, to a container of liquids after its initial filling. Bar codes can also be harmed in transit or with excessive handling, and they are hindered by physical constraints. They have the same limitations as mechanical keying, namely the two halves of the coupling require specific rotational orientation to mate. Bar codes must also be clean and free of condensation.

RFID tags, on the other hand, can be written and rewritten, documenting and storing transactions in the production process. While bar codes are the first widelyaccepted identification technology, RFID is the next level.

Smart coupling in medical devices

There are critical situations in which avoided misconnections more than justify the cost of implementing RFID technology. Companies working with high-cost fluids are good candidates for the technology. One application, for example, places a $900 fluid in a 5-liter container. In these cases, misconnections are extremely costly.

Safety concerns also arise. When the fluid in question is potentially flammable, combustible, or harmful to operators, RFID technology can ensure their safety and protect the production facility. RFID is also cost-effective for manufacturers who have complicated fluid processes and require comprehensive data tracking.

Applying RFID technology to a medicalfluid line assures the proper medication is reaching patients. The reader verifies information regarding the medication before it is allowed to reach the patient. This technology can prevent human error and potentially save lives. In addition, by creating a detailed, electronic trail, this technology can help hospitals verify critical medical procedures.

Applications are numerous. RFID technology can be applied to balloon catheters in heart-assist pumps, for example, to make sure the correct catheter goes to the right patient and the pump is operating correctly for the given catheter. The technology could also be used in kidney dialysis and drug delivery identification. In anesthesiology equipment, RFID tags can correctly identify gas lines. For cleaning equipment, such as an endoscope reprocessor, the technology can verify that the correct sterilization chemicals are being used and that the correct connections have been made.

Where sterility is extremely important, disposable versions of the smart coupling can be used. The electronics are removed from the coupler body and autoclaved while the tubing and coupler are easily disposed.

Appendix 3 : Flow Chart of the Automated Attendance System for Employee using Active RFID

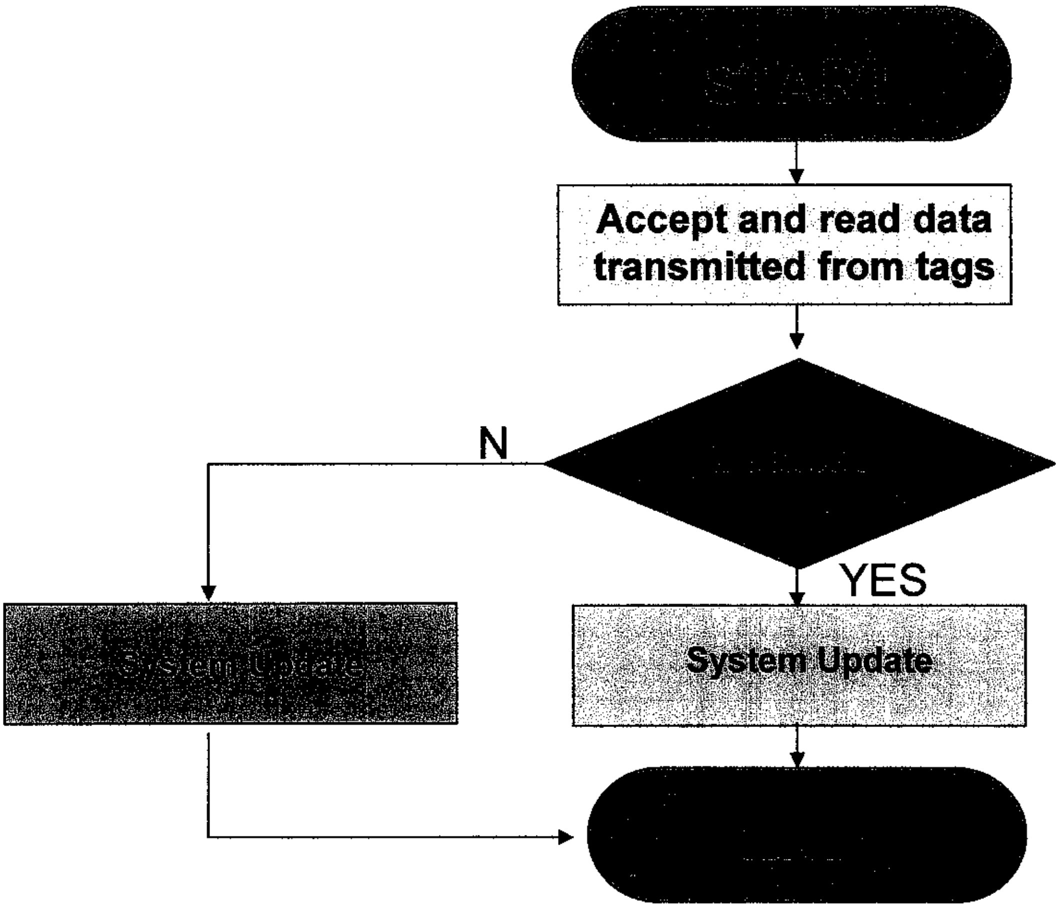


Chart 2 : Automated Attendance System Flow Chart

Appendix 4 : Automated Attendance System using Active RFID System diagram

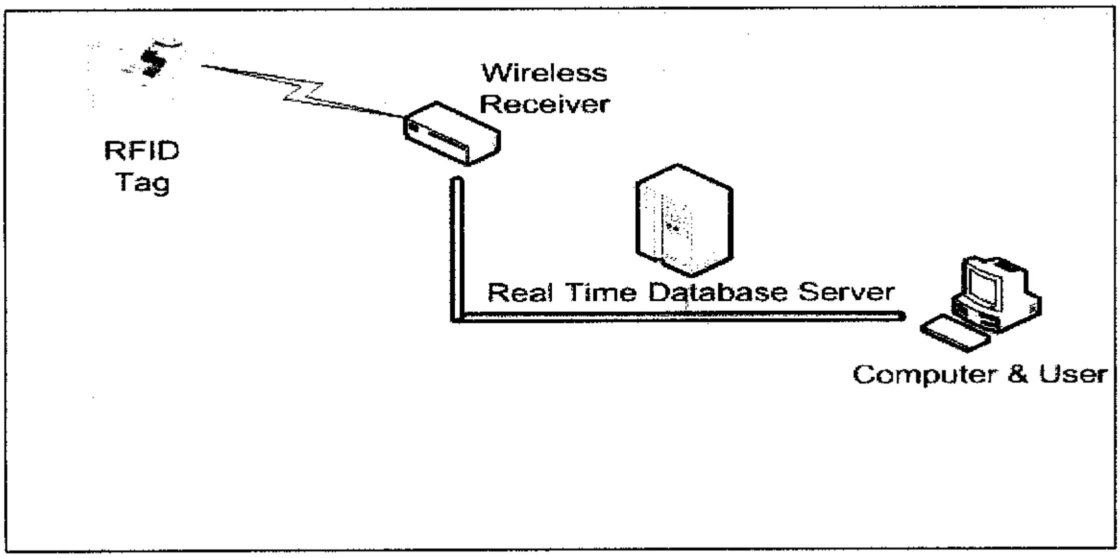


Diagram 1 : Automated Attendance System Diagram

Appendix 5

Reference : RFID Exchange for tags, readers, software, consultancy,

www.rfidxchange.com

rfidXchange

Global Source for objective advice and information

RFID Applications are limited only by imagination! Many will become cost effective as the price of individual tags reduces with volumes manufactured, and other opportunities will be enabled as the technology develops. You can limit the search of the RFID Exchange database for companies to those that support the application areas below. Just click on the application title below:

- Supply chain automation - the key early driver for developments and implementation of the technology
- Asset tracking - tracking of assets in offices, labs, warehouses, pallets and containers in the supply chain, books in libraries
- Medical applications - linking a patient with key drugs, personnel giving the drugs, biometric measurements
- People tracking - security tracking for entrance management or security, contact management at events, baby tags in hospitals to manage access to post-natal wards
- Manufacturing - tracking of parts during manufacture, tracking of assembled items
- Retail - tracking store trolleys in supermarkets, active shelves
- Warehouses - Real-time inventory by automated registration of items in a warehouse or store-room

- Livestock - implanted RFID tags in animals for tracking and linking the animal to food, location. Applicable to farming as well as exotic breeds in zoos
- Timing - sports event timing to track athletes as they start a race and pass the finish line

Company	Applications supported
activeRF	Current revenue from a product lauched with Tesco for tracking trolleys in stores and preventing "walk-out" theft. Their active tags can also be used in public attractions, healthcare, tracking containers and shipping assets etc.
ActiveWave	The active tags can be used for asset and inventory control, container, pallet tracking, hospitals, parking lots, ID badges etc
Analytica-India	REALTIME uses dual infrared(IR) and radio frequency(RF) technology to monitor the precise location of people (e.g patients,staff and visitors) and/or equipment (e.g IV pumps,laptops,files etc.) and automatically record events associated with their location. It accurately registers the essential management and business information
AVANTE International Technology, Inc.	The LEADS-TRAKKER is a solution to all your trade show needs. Based on patented RFID technology, LEADS-TRAKKER boasts a 100% read-rate right through your badge or clothes. There are no hidden costs or fees. LEADS-TRAKKER comes with a scanner to read our RFID badges, a PDA to download your hot leads onto, and a printer to print your leads. All for one low price! The qualifying questions are customizeable to fit the exhibitors needs and appear on the pda. No more sorting through undistiguishable leads
AXCESS Inc.	Provide tags and a software system for asset and personnel tracing with readers deployed in doorways and exit points.
Bartizan	Lead verification at trade shows using RFID powered badges. Also have a range of magnetic readable cards for ID verification, age verification etc.
Checkpoint Systems	Company has working library systems for tracking books, and software packages for access control and ID management

Crosspoint	Mainly identification systems and access control into office buildings, hotels etc.
DAG Systems	DAG System is a unique electronic timing system aimed to make popular sports management easier and more high-performance (foot races, cross-country skiing, cycling sports, triathlons, etc. The system can also be used for access control.
Escort Memory Systems	The world's first RFID post office application Italian Post. Numerous high-temperature paint oven applications where RFID tags are subjected to temperature in excess of 200°C. The first application that involved embedding an RFID tag permanently inside a pallet Arca Systems, Sweden. Automotive applications with industry leaders like Ford, Toyota, Mercedes, and GM.The first application involving placing an RFID label inside skiing/snowboarding equipment. First company to embed RFID tags into wooden doors
eXI Wireless	Company focused on security products for security of assets and people and tracking of people in hospitals and other institutions
Idesco	Together with its system integrator network Idesco delivers RFID products worldwide for instance to access control, factory automation, ticketing, hazardous environments, logistics, maintenance and asset marking
inLogic	Have applications for people tracking at events and museums
Open Tag Systems	Their RFID wristband is offered with software for applications in the Heathcare industry - tracking patients, Entertainment and sporting/amusement parks for tracking guests, and law enforcement applications
Rafsec	Sell transponders that are suitable for labels, indentification tags, and also a range of wooden pallet tags.
SkandSoft Technologies	
xTag	Sell a post-natal ward baby tracking solution where alarms are raised if a baby is removed from the range of the antenna. Also have personnel tracking, building entry solutions etc based on their long range tags.

Appendix 7 : Active RFID VS Passive RFID, Barcode System and Magnetic Strip

Variables	ACTIVE RFID	PASSIVE RFID	BARCODE	MAGNETIC STRIP
Distance	More than 3 feet and some tag may transmit signal several kilometers away	less than 3 feet	Up to 1 meter	Less than 1 cm
Propagation	Beyond line of sight and the signal can propagate through obstacles	Line of sight	Line of sight	Line of sight
Power supply	Yes	No	No	No

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