RFID REAL TIME TRACKER

By

JETSARAPHORN WAE-ESOR

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

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Technology Programme
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in partial fulfilment of the requirement for the
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(Information Communication Technology)

Approved by,

_____
(Mr. Izzatdin Abdul Aziz)

UNIVERSITI TEKNOLOGI PETRONAS
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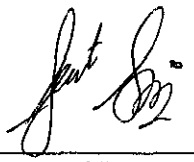
January 2008

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.



JETSARAPHORN WAE-ESOR

EXECUTIVE SUMMARY

The author has successfully completed Dissertation on RFID Real Time Tracker. A brief introduction of Radio Frequency Identification (RFID) is introduced including objectives, problem statement, scope of study, methodology and finding based on the research on RFID techniques. The purpose of this Dissertation is mainly to allow supervisor and examiners to evaluate her work on RFID Real Time Tracker based on the report which explain in writing about the contents of the project and its significance, like the problem statement, objective, scope, literature review, methodology used, results, conclusions and recommendations. Gain experience with applying the RFID knowledge and also to use the RFID concepts to solve in students tracking in real time. This Dissertation can be divided into five (5) chapters: Introduction, Literature review/Theory, Methodology/project work, Results and Discussion, lastly with Conclusion and Recommendation. In these the author learnt how to carry out simple support tasks which enhanced the author Professional Knowledge and Soft Skill Improvement.

RFID Real Time Tracker is a system that applies the advantages of RFID technology to track the students that entering building 1 in real time which can help the security guard to solve the problem of stealing cases that always happen in UTP. From the research work from FYP I – II, the author divided methodology used into 5 stages: Design system, Software Development (Interface), Hardware Testing (Hyper Terminal), Hardware and Software Integration and Model Development. In order to make sure that system is working, testing is needed. The finding can prove that system is really work as objective desired.

ACKNOWLEDGEMENT

In this opportunity, the author would like to gratefully acknowledge Mr. Izzatdin Abdul Aziz for his guidance which helps in giving some idea on RFID Real Time Tracker. The opportunity that was given by him to carry out this project was priceless as the author managed to learn a lot of new things in developing RFID system. This project has helped the author to learn more about RFID techniques in a correct way by doing some research on a particular technique related to RFID.

Captain Lakbir Bin Sandar, who has persistently and determinedly assisted her along the progress of the project. The author would like to thank the referee previous author of the relevant topic

Last but not least her parents, her siblings for their moral supports and understandings as well as all those who directly or indirectly helped her on this system "RFID Real Time Tracker".

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ABBREVIATIONS

Auto-ID (Automatic Identification)

CMOS (Complimentary Metal Oxide Semiconductor)

EJS (Enterprise Jewelry Software)

EPC (Electronic Product Code)

ETSI (European Telecommunications Standardization Institute)

HF (High Frequency)

IDB (Information Database)

ISM (Industry, Scientific, and Medical)

LF (Low Frequency)

MIT (Massachusetts Institute of Technology)

OCR (Optical Character Recognition)

PML (Physical Markup Language)

RFID (Radio Frequency IDentification)

RO (Read Only), R/W (Read/Write)

RMM (Reader Management Module)

UHF (Ultra High Frequency)

VLR (Visitor Location Register)

CHAPTER 1
INTRODUCTION

Radio Frequency Identification (RFID) is one of several automatic identification sensor-based technologies consisting of three key elements: RFID tags (transponders, typically miniaturized chips); RFID readers (transceivers); and a data collection, distribution, and management system that has the ability to identify or scan information with increased speed and accuracy. RFID technology is actively being deployed to control manufacturing processes, track assets, enable financial transactions, pay tolls and gas, as well as to allow secure building access and other applications. The developments of standards, technological advancements and end-user mandates have spurred the growth of RFID into retail and consumer good applications. RFID is poised for growth worldwide, as businesses and governments implement RFID applications to facilitate global commerce and spur innovation and competitiveness.

This project is to design and built a system that can track student movement for building access control with the real time by using RFID technology. This system consist of software development, database system and hardware implementation. This system using RFID tags to identify the movement of UTP students who entered building 1 of Universiti Teknologi PETRONAS. Database system stored the information of students such as Name, Matrix number, Course, Address and Email. Then the information of students will be display on the computer screen which including as well time in and time out. Thus, from this valuable information the UTP security guard can straight away know who are entering building1 in which area (location), and real time entering and exiting (both time in-time out). This system can help out security guard to not wasting their time by looking around new building for long period of time and can view the history of students who has entered building 1 in each day and specific time.

1.1 Problem Statement

"It is difficult to identify the stealing cases that happened in the past as we do not have any system that can track all students that entering new academic building in real time"

(Captain Bin Lakbir Sandar, Sep 12, 2007)

From the real life situation, it is difficult for UTP Security to track all students that enter the new building. Because of security department does not have any system that can record all students' movement and it is difficult to identify when some stolen happen.

1.2 Solution – RFID Real Time Tracker

The RFID Real Time tracking is a system developed using the RFID technology. In this system, RFID reader is placed at the main entrance of demonstration door. When the students passes through, the RFID reader will automatically scan the tags at certain range depends on the tags and reader specifications that used. The reader will detect the RFID tag and link it to database. Then, database system will automatically update the data and compare unique ID from tag with information that has been stored in database. Then the information of students will displayed the result on the main menu if the tag ID is matching with information in database as shown below in figure how this system work:

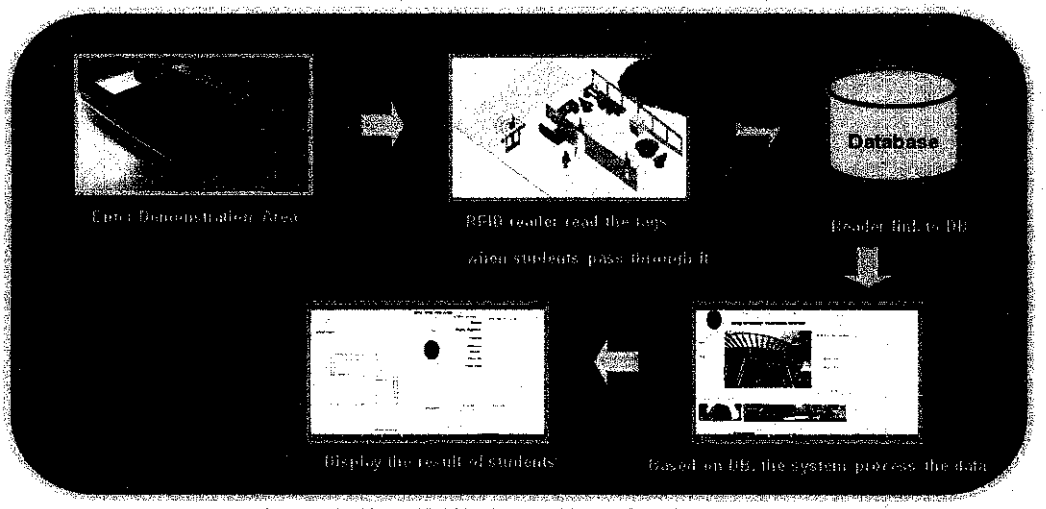


Figure 1: How RFID Real Time Tracker works.

1.3 Project Objectives

The objectives of this project are as follow:

- **To study on RFID Real Time Tracker technology.**

  The author has to do research on RFID technology, which is very interesting topic that the author should learn and know for applying this knowledge in future. Since RFID is very useful nowadays and provide the wonderful ways in which this technology can be used, until there are more standards and can be reach its end with the full potential at future time soon.

- **To provide real-time tracking of the location of students who has entered new building 1.**

  RFID Real Time Tracker can track the location of students that entering the new building 1 by using the concept of RFID techniques that used 3 basic components (RFID tag, RFID reader and Host computer) which has been described in introduction part.

1.4 Scope of project

After identify the problems faced by UTP Security Department, the author have some idea to provide more secure Building Access Control which the author has been described in the previous section. The author will develop RFID Real Time Tracker to solve the building access control problems.

For this RFID Real Time Tracker system, the author will only consider the area of building 1. This is because of everyone in UTP known this area and this area can also considered as the center of IT department. The target user for this system will be students in UTP; they have to wear their matrix card every time while entering New Academic

Building 1. At the back of their matrix card will have tag for storing personal data of each person for example Name, matrix number, course, address, and email. At anytime they enter to building 1, an antenna that allocated around building 1 will scan tag of each person then matching personal information with DB. Finally, the reader antenna converts the radio waves into digital information that can then be passed on to UTP Security Department. With RFID Real Time Tracker application, the security department will be able to monitor all students in UTP while they are entering the building 1. This will make UTP more secure at anytime.

This RFID Real Time Tracking consist two major parts, so the scope of this project are:

- Software development, this software works as an interface between RFID reader and computer. It contains result of the student information, location and most important thing is real time tracking of student when they are entering building 1.

- Develop the RFID demonstration model and implement the RFID for testing System on it.

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Reviews

There were many literatures found about the utilization of RFID technology. A few of the examples are animal tracking, toll collection, building access control, and etc. As number of literatures could be found about previous studies that have used RFID techniques as the specific purposed, these literatures would be able to help in explaining the results that are obtained by using RFID techniques as the tool for security approach.

The RFID real-time tracking used RFID technology applies to asset tracking, specifically to the tracking of all staffs entering new building. It is an important factor in ensuring the security of the building access control goods, as well as a monitoring location of people which could be facilitated by the use of RFID real time tracker as a means of monitoring. These literatures review will discuss about main component for RFID technology, overall trends in the growth of the RFID technology as it focuses on the current state of the art, the challenges ahead and the fact on benefits and limitations of RFID. It will give a detailed analysis of the current research in RFID's that has been driving the development of this technology.

Radio frequency identification (RFID) is a generic term for technologies that use radio waves to automatically identify objects. There are several methods of identification, but the most common is to store a serial number that identifies the object and perhaps other information, on a microchip that is attached to an antenna (the chip and antenna together are commonly called RFID-chip or 'tag'). The antenna enables the RFID tag to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it. [1]

Figure below shown the structure of an RFID components and how each components work.

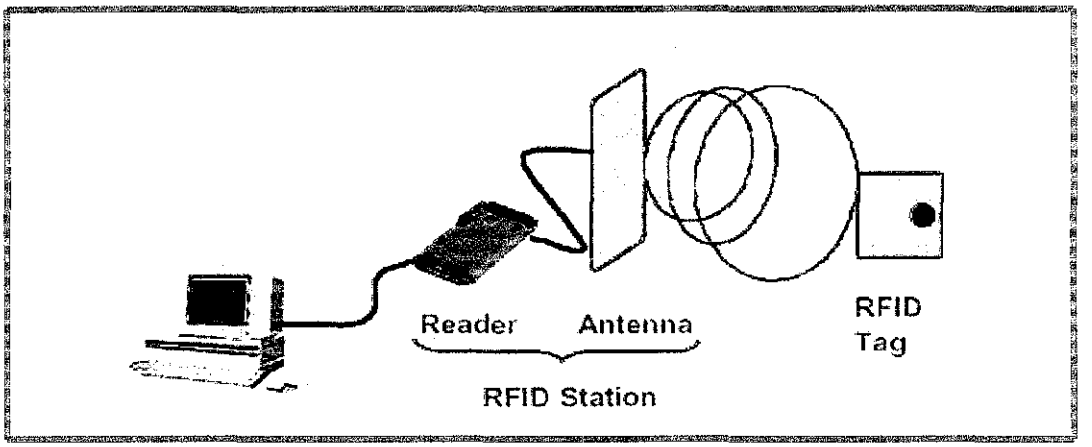


Figure 2: Structure of RFID Components. [1]

RFID is a suite of technologies that includes "tags" which get applied to items that need to be tracked, "readers" that scan the tags nearby for their data, and a series of integration technologies that link the readers back to central databases and systems that track the data being scanned.

An RFID system typically consists of a radio-enabled device that communicates with or "interrogates" a tag or label, which is embedded with a single chip processor and an antenna. The "interrogator" or RFID reader may be a fixed antenna or it may be portable, like a bar code scanner. The tag itself is an extension of the bar code labels you see everywhere today, but with more intelligence. The advantage of these more intelligent systems is that, unlike barcode tracking systems, an RFID system can read the information on a tag without requiring line of sight or a particular orientation. This means that RFID systems can be largely automated, reducing the need for manual scanning.

In the back end of the system, a host computer stores all collected data within a database. Since RFID tags can also carry data, tags can serve as data transfer agents, synchronizing disparate information systems. Tags may carry a product's history or genealogy, and may interact and communicate with manufacturing production systems for increased automation and process error proofing. The tags can either be Read Only (RO) or Read/Write (R/W) capable.

2.1.1 RFID Tag

RFID tag is usually attached to the object to be identified and carries information in an electronic microchip. RFID tag is one of the basic elements in RFID techniques which can be further broken down into two categories:

- **Active RFID Tags** are battery powered. They broadcast a signal to the reader and can transmit over the greatest distances (100+ meters). Typically they can cost £5–£20 or more and are used to track high value goods like vehicles and large containers of goods. [6]
- **Passive RFID Tags** do not contain a battery. Instead, they draw their power from the radio wave transmitted by the reader. The tag will briefly converse with the reader for verification and the exchange of data. As a result, passive tags can transmit information over shorter distances (typically 3 meters or less) than active tags. They have a smaller memory capacity and are considerably lower in cost (less than £1), making them ideal for tracking lower cost items. [6] [7] [8]

There are two basic types of chips available on RFID tags:

- **Read-only chips** are programmed with unique information stored on them during the manufacturing process, often referred to as a 'number plate' application. The information on read-only chips can not be changed. [7]
- **Read-Write chips**, the user can add information to the tag or write over existing information when the tag is within range of the reader. Read-Write chips are more expensive that Read-only chips. Another method used is something called a "WORM" chip (Write Once Read Many). It can be written once and then becomes Read-only afterwards. [7] [11]

The table below shown RFID tags types and other RFID classifications.

RFID - ACTIVE VS. PASSIVE	ACTIVE RFID	PASSIVE RFID
Tag Power Supply	Internal to tag	Energy transferred from reader via RF
RFID Tag Battery	Yes	No
Availability of RFID Tag Power	Continuous	Only within field of reader
Communication	Long Range (300+ feet), Networking of tags & readers	Short Range (< 9 feet), no communication between tags or readers
Multi-Tag Collection	Collect 1000s of tags from readers, millions of square feet	Collect hundreds of tags within 9 feet from single reader
Data Storage	Large read/write data storage directly on tag	Small read/write data storage directly on RFID tag

Table 1: RFID Tags Types. [7]

2.1.2 RFID Reader Components

RFID reader which detects tags and performs read/write operations on RFID tags. Normally readers are connected with an additional interface to forward tag information to another system, like a PC or robot control system. [12]

For more understanding, see in **Figure: 3 RFID Reader components.**

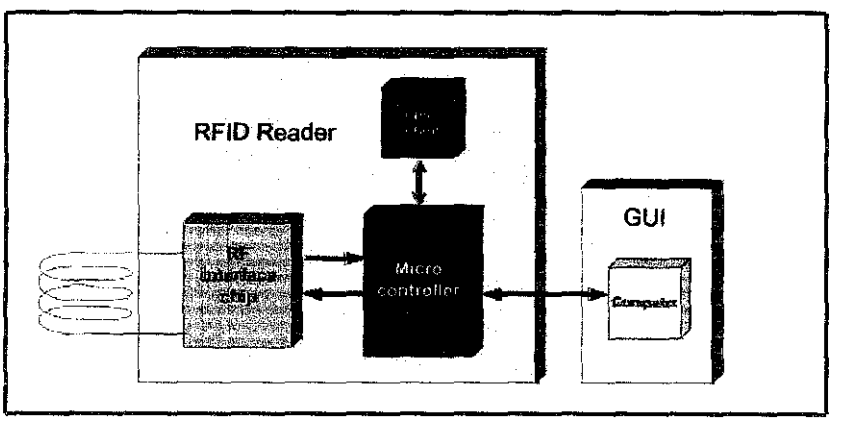


Figure 3: RFID Reader Components. [12]

The RFID reader provides the connectivity between individual tags via an antenna then transmitted unique information into micro controller to control the flow of all data and then compare with management system (Host Computer), which stored unique information.

Available in a variety of form factors, it is typically small enough to be mounted on a counter, tripod, or wall. Depending on the application and operating conditions, there may be a multiplicity of readers to fully service a specific area. [12]

2.1.3 Frequency

There are several versions of RFID that operates at different radio frequencies. The choice of frequency is dependent on the requirements and read environment. It is not a technology in which 'one size fits all' applications. RFID uses radio waves that are generally between the frequencies of 30 KHz and 5.8 GHz.

RFID systems are also distinguished by their frequency ranges. Low-frequency (30 KHz to 500 KHz) systems have short reading ranges and lower system costs. They are most commonly used in security access, asset tracking, and animal identification applications. High-frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) systems, offering long read ranges (greater than 90 feet) and high reading speeds, are used for such applications as railroad car tracking and automated toll collection. However, the higher performance of high-frequency RFID systems incurs higher system costs.

Classes of RFID frequency types include the following:

- **Low Frequency (LF)**

Frequencies between 100 KHz and 500 KHz are considered low, and RFID systems commonly use the 125 KHz to 134 KHz frequency range. A typical LF RFID system operates at 125 KHz or 134.2 KHz. RFID systems operating at LF generally use passive tags, have low data-transfer rates from the tag to the reader, and are especially good if the operating environment contains metals, liquids, dirt, snow, or mud (a very important characteristic of LF systems). Active LF tags are also available. Because of the maturity of this type of tag, LF tag systems probably have the largest installed base. The LF range is accepted worldwide. [8]

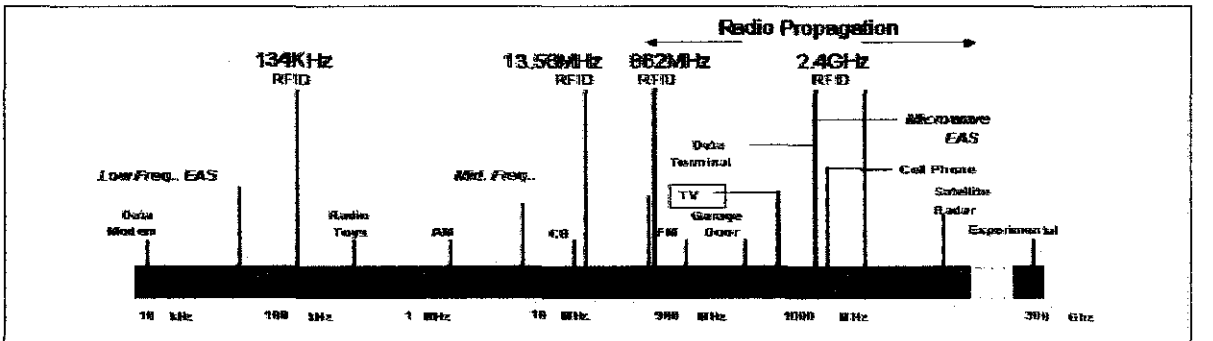
- **High Frequency (HF)**

HF ranges from 3 MHz to 30 MHz; with 13.56 MHz being the typical frequency used for HF RFID systems. A typical HF RFID system uses passive tags, has a slow data-transfer rate from the tag to the reader, and offers fair performance in the presence of metals and liquids. HF systems are also widely used, especially in hospitals (where it does not interfere with the existing equipment). The HF frequency range is accepted worldwide. [8] [9]

- **Ultra High Frequency (UHF)**

UHF ranges from 850 MHz to 5.8 GHz. A typical active UHF RFID system operates at 900 MHz and 3.5 GHz. A UHF system can therefore use both active and passive tags and has a fast data-transfer rate between the tag and the reader, but performs poorly in the presence of metals and liquids. However, the UHF range is *not* accepted worldwide. [9] [13]

The frequency of an RFID system defines the relationship between the tag and reader, and impacts both the transmission range and speed. Some related statistics about tags of different frequencies are as follows: [14] [15] [16]



Frequency Band	Characteristics	Typical Applications
Low **100-500 kHz**	Short to medium read range Inexpensive low reading speed high atmospheric noise	Access control Animal identification Inventory control Car immobiliser marine navigational
High Frequency **3-30 MHz**	Short to medium read range potentially inexpensive medium reading speed affected by solar flux	Access control Smart cards amateur radio
[illegible]	Long read range High reading speed Line of sight propagation Expensive	Railway car monitoring Toll collection systems WLAN Satellite links

Table 2: Frequency bands and applications. [14][15][16]

RFID technologies are grouped under the more generic Automatic Identification (Auto-ID) technologies. RFID is often positioned as next generation bar coding because of its obvious advantages over barcodes. The real benefits of RFID can be summarized as follows:

- Line of sight not required
- Durability
- Range
- Data volume
- Multiple read–Speed
- Read/Write–Update

Rather than using light to collect or read a number from a bar code, radio waves are used to read a number from the RFID tag. RFID therefore does not need line-of-sight to operate. Using radio means that the tag no longer has to be visible on the object to which it is attached; the tag can be hidden inside the item or box that is to be identified and still be read. This minimizes or eliminates the need for a person to have to present the reader to the tag, as it can now be fixed to a wall, for example. As the item is passed by the reader it will be read automatically, thus giving a potentially large saving in labor costs or substantial increase in the throughput of scanned items. [5] [9]

Another feature of RFID is the ability to read many tags at the same time. It is not necessary to present each tag to the reader separately (as is required for barcodes); instead, all tags within the range of the reader can be read almost simultaneously as they pass the reader. Again, there is a huge savings potential in not having to manually present the reader to each item to be identified. [5] [7]

Furthermore, data can also be written to the tag, a feature that is not possible with barcodes. The table below showed the advantages of RFID over Bar codes.

Capability \ Technology	Bar Code	RFID	RFID Benefit Example
Line of sight requirement	Required	Not required	No need to orientate scanned items
Number of items that can be scanned	One	Multiple	Very fast inventory scan
Automation & Accuracy	Manual read errors & prone to mis-scanning	Fully automated and highly accurate	Error free inventory count
Identification	Only series or type	Unique item level	Targeted Recall
Data storage	Limited codes	Up to several kB data	Real time data access in any location

Table 3: Comparison of RFID with Bar codes. [5]

2.2 Current State of the Art:

The RFID is the state of the art in the aspect that information contained in the tag, such as the location and status of the goods, has the potential of being made available worldwide to manufacturers, distributors, and retailers simultaneously. In fact, it has become the motivation for retailers such as Wal-Mart, as well as for the U.S. Department of Defense to mandate the use of RFID by their top suppliers beginning in 2005. [17]

Going back less than a year, numerous research and innovations have been proposed to the TFID and its problems. In August of 2004, the Zuma RFID design was proposed and created. Such a chip includes user memory and has the capability to perform field writes, allowing a way to personalize the information-bearing content of RFID tags while reducing die area. In addition, this design has a 256-bit block non-volatile memory. It offers extremely low power; relatively fast write times, 100,000 cycles write endurance, and 10 year retention of data. The range performance is typically 11 meters for reads, and 8 meters for writes. However, the bandwidth requirements discourage the use of this design outside of the United States. [11]

Another proposed architecture focuses on the network used by RFID tags for effective communication. This architecture, proposed in 2004 by Texas University, uses every physical object identified by an RFID tag to communicate over a standard LAN network. It focuses more so on the readers than on the tags, where the readers are continually picking up the tags' information. Such readers are to be managed by a Reader Management Module (RMM), and for every tag the capture the electronic product code (EPC) of the tag read, the EPC of the reader that scanned the tag, and the reading timestamp. These readers are then connected to the Savants, which are distributed data routers, using a LAN connection. The Savants are organized in a tree like structure and each leaf node is called the Edge Savant, while each internal node is called the Internal Savant. Useful association is written in Physical Markup Language (PML), and a file using this language contains both static and dynamic data pertaining to an object and is stored in a server called the PML server. Such a server would reside at a level above the Savants. Several such servers can then communicate via a secure intra-network. [12]

The static data collected includes the EPC class-level manufacturer data, the EPC Serial Level Manufacturer's data, and the transaction documents, and it would be stored in a database called the Information Database (IDB). The dynamic data would include mobility data such as tracking and location, and it would be stored in mobility management registers. Finally, a dynamically changing Visitor Location Register (VLR) cache would be located at corresponding PML servers to keep information about a visiting object. This means that the RFID readers would sense the objects as they enter or leave their radio field and would accordingly notify the corresponding Savant who in turn would generate a notification message to the PML server. Based on those messages the information in the mobility registers would be updated. [12] [17]

The IBM China Research labs propose a new solution to the security issues faced by RFID tags. The suggestion for read access control has been proposed for readers accessing a tag's ID. The idea is that the tag has to first identify whether the reader is authentic. To do this the tag sends a random number to the reader, prompting the reader to respond to the tag with a function value of the random number and its own ID. The

reader's output for each query changes, disabling unauthorized eavesdroppers from passing this authentication process. [16] [18]

"Head of BT's business continuity recommended that whenever you are concerned with tracking inventory in a place or maintaining a fleet of vehicles, there is a clear need for a fully RFID technology that will help you keep track of people, items, and equipment in real-time". [17]

"RFID makes it possible to track objects within a controlled environment, which may be a warehouse, a hospital, a high-security building, or wherever important valuable assets need to be tracked closely. Processes can be automated by including item specific information or instructions within the tag." [18]

RFID technology enables many new types of applications by allowing concurrent monitoring of multiple items, without requiring a person to "touch" each one (with a hand-held barcode scanner, for example). The kinds of applications that can take advantage of this automated identification include diverse areas such as inventory control, logistics management, surveillance, and toll collection. [18] [19]

"Corporations love the RFID advantages of being able to track every single item in their system from production all the way through to knowing that their products now sit in your living room." [21]

RFID is used for everything from tracking cows and pets to triggering equipment down oil wells. It may sound trite, but the applications are limited only by people's imagination. The most common applications are payment systems (Mobil Speedpass and toll collection systems, for instance), access control and asset tracking. Increasingly, retail/CPG and pharma companies are looking to use RFID to track goods within their supply chain, to work in process and for other applications. [20]

Use RFID technology to track the location of each car in the lot at any time. In addition, our advanced RFID technology can automatically check cars into and out of the lot in real time. [23]

Real-time Inventory Tracking using RFID integrated solution can generate an updated inventory and track the exact location of goods in real time. The system can keep track of virtually any activity of the tagged equipment or inventory. The system will identify and track the items at any point in the warehouse or any part of the building that the system is installed. [22]

2.2.1 RFID Tagging Of Animals Gone Marine (June 8th, 2007)

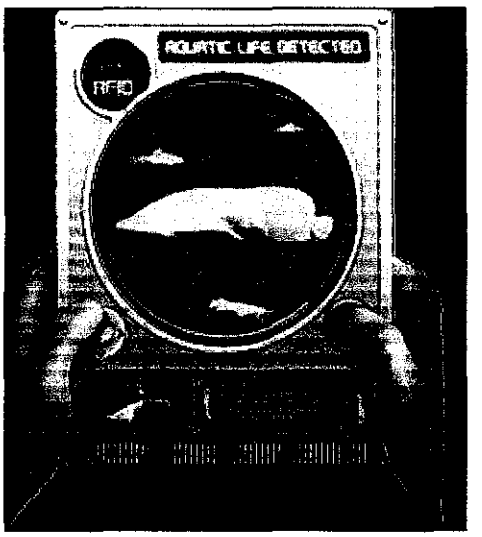


Figure 4: RFID tagging machine. [23]

We have all heard about RFID tagging of animals and pets now chipping is happening to fishes. RFID is certainly going places, recently in Singapore it has gone under water. The Singapore Underwater World recently announced the latest RFID enabled sea aquarium exhibit. Several species of fish - Arapaima, Alligator Gar, Flower Ray, Pacu, Redtail Catfish, Shovelnose Catfish and Walking Catfish are implanted with RFID. In the past, visitors would have to match fish by their shape and colour to static information wall panels to figure them out. After a couple of tanks, it gets too tedious to find which is which - I know because I was there too. [23]

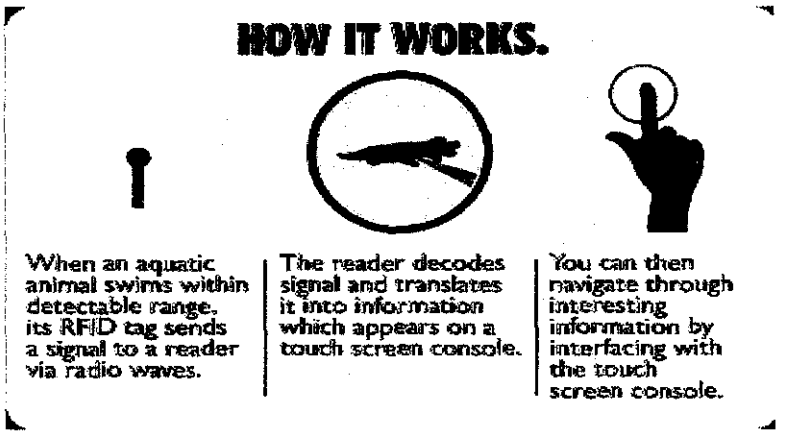


Figure 5: How RFID tagging machine work. [23]

NOW, when a fish moves within the vicinity of the RFID reader, the information about the fish runs up on the touch-screen display. And of course the visitor can interact further with the device to learn more information about the fish - it's really something! [23]

2.2.2 Jewelry Security System Using RFID (August 26th, 2006)

Enterprise Jewelry Software implements a security feature using RFID. The solution approaches the problem with appropriate theft preventive measures and recovery.

Placing antennas into each display space, jewelry items are continuously scanned real-time 24 hours. Thefts often happen at the counter when an enthusiastic sales person loses track of the items that are removed from the drawer while showing dazzling jewels to potential buyers. This is the opportune time for the attacker to strike, to conveniently drop off an extra item in his pocket. [26]

Using RFID scanners built into every shelf, the EJS system will pick up if an unusual number of jewelry items are removed from the display. The system immediately alerts the store manager who tunes in to the activity and responds accordingly. EJS can be integrated with panning camera systems to observe any suspicious activity in the store.

This sharply contrasts a jewelry RFID system using handheld readers. A cheaper alternative, however the semi automated solution cannot implement the security feature described above. Missing items detected using a handheld RFID solution is often too late for item recovery. [26]

The latest state of the art in RFID technology for RFID technology allows shippers to arm the device using a encrypted code. The RFID then transmits its location and arrival time, and it notifies officials of any unauthorized security breaches. This device also detects changes in its field, and functions on 2.4 GHz technology with a range of 30 meters for reading. The latest additions include additional RFID device attachments that can sense temperature, radiation, chemicals, etc. [24]

2.3 "Hard" Problems

There are several challenges faced by the RFID, which need to be overcome to ensure uniform and effective RFID use.

2.3.1 MHz Problem

One such "hard" problem is that the RFID's rely heavily on either dedicated or unlicensed industrial, scientific, and medical (ISM) bands. This is a problem because the requirements around the world vary for these bands, hence inhibiting attempts to deploy these tags in the area of global trade. For instance, in the United States the FCC provides unlicensed spectrum in the 902-928 MHz band. In Europe there is a limiting range of 869.4 – 869.65 MHz. The Japanese have a temporary allowance of 950 – 956 MHz, and the regulations for RFID in China and Korea are in transition with a considered spectrum of 433 MHz for active and 900 MHz for passive tags. This means that no RFID technology will operate at the same frequency with equal performance anywhere in the world. Attempts to solve this problem look at designing frequency readers, but this adds to the cost, communication latency, and performance difference of the tags. Hence, there remains the need for a data management infrastructure to coordinate the transmission of data between different networks that are using different standards. [21][23][25]

2.3.2 Capacitance Problem

RFID chips that are implemented using complimentary metal oxide semiconductor (CMOS) technology suffer from power variations. The tag's power varies from minimum to maximum over a timeframe of three decades, creating challenging situations for power supply predictability. Furthermore, many used materials produce high levels of turboelectric charge, and more of this charge can be produced in manufacturing environments. In an attempt to circumvent this, current methods degrade the RF performance.

Proximity of the RFID tags to water, metals, and certain types of plastics can detune the tags. This is because such materials form a parasitic capacitance with the RF circuits, diminishing their capability to collect and to reflect energy. This is why each RFID tag installation needs to be customized to its specific environment. For instance tags that are used near metals should use a patch antenna, and tags that are used near water or moisture should use dielectric spacers to increase the coupling distance. Also, RFID tags are relatively easy to jam using energy at the right frequency, and can be disrupted by being repeatedly interrogated, wearing the battery down. Lastly, personalizing each tag requires some form of non-volatile storage. [21][23][28]

2.3.3 Cost Problem

Financially, it is not worth it to produce RFID's aimed at the supply chain exceeding 1 mm squared. This is because the bulk of the cost of RFID's is in the testing phase. Test costs alone can even be comparable to the product's entire applied cost. [26]

2.3.4 Health Problem

Another challenge faced by RFID manufacturers is the debate over their effect on human health. In 1995 the European Telecommunications Standardization Institute (ETSI) sub-committee published the pre-standard ENV50166-2 advising that an antenna that is

within 8 inches of the body should not exceed 10 watts per square meter in emissions when averaged over 6 minute intervals. The FCC follows these recommendations for North America. [31]

2.3.5 Security Problem

Some additional challenges include the fact that RFID's must be physically recognized by any legitimate user. This means that they must be worldwide usable and hence accepted by any government's regulatory agency. Furthermore, tags must be writable and lockable by intermediate and end users, yet they must provide a secure forward link to avoid eavesdropping, traffic analysis, spoofing, and denial of service. This is partly solved by encryption. Tags should also have the ability to be put to sleep while the product is in transit, denying access to readers that lack a legitimate need to know, requesting a password. Finally, there is a debate as to whether a tag should be disabled completely or partially when its ownership changes. [21][22][27]

2.3.6 Privacy Problem

The issue of privacy invasion is yet another challenge faced by RFID's. This issue is relevant to tagging of cargo as well as to tagging of products for individual customers. The argument is that if an TFID tag would remain active after a purchase it would allow tracking of customers' movements. This reasoning is a result of lack of understanding of the technology. However, relating to delivered cargo this issue is a valid concern. For instance a warehouse's inventory that is labeled with unprotected tags may be monitored by competitors' unauthorized readers. Encryption does not help much here because items can still be tracked by their fixed encryption code. [28][29][30]

2.4 RFID Benefits and Limitations

RFID is not a new technology, but it was not widely deployed and used until 1990s. [33] Businesses across various industry sectors, for example, Wal-Mart, and US Department of Defense, also began to adopt RFID in their enterprise information systems. This enthusiasm is driven by the benefits brought by RFID system, which include:

- ***Efficiency***:

  Data capturing can be done with less or without labor involved, data collection speed is greatly improved as multiple tags can be identified almost simultaneously.

- ***Flexibility***:

  There are not many restrictions on tag placements.

- ***Improved data accuracy level***:

  With RFID system, objects can be tracked on the item level.

- ***Cost savings***:

  Despite all these benefits, RFID is not much more expensive than traditional data collection methods like the barcode system. Normally, a passive tag costs several cents, and its price will be even cheaper in near future.

However, RFID system also has its limitations. The 2 main undesired effects are false negative reads, where RFID tags are not read at all, and false positive reads, where RFID tags are detected when they are not in the interrogation range of the reader. [32] These failures can be caused by collisions on the air interface, tag detuning, tag misalignment, metal and water in the vicinity of the RFID system. [34]

The significant advantage of all types of RFID systems is the noncontact, non-line-of-sight nature of the technology. Tags can be read through a variety of substances such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging

conditions, where barcodes or other optically read technologies would be useless. RFID tags can also be read in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. The read/write capability of an active RFID system is also a significant advantage in interactive applications such as work-in-process or maintenance tracking. Though it is a costlier technology (compared with barcode), RFID has become indispensable for a wide range of automated data collection and identification applications that would not be possible otherwise.

To conclude, having examined the current state of the art , the "hard" problems and benefits and limitations regarding the use of RFID, they are non-the-less effective and low cost, and their benefits outweigh the problems, hence they are a good solution for RFID real time tracker and building access control in term of security.

CHAPTER 3
METHODOLOGY

The purpose of this project is to design and built a system that can track student's movement in area of building 1 by using RFID technology. This objective statement can be decomposed into two major parts which is the construction of the software for RFID Real Time Tracker including database record and interface. While the other part is to develop the demonstrate model and implement the system. In developing the whole system, it requires Visual Basic 6.0 programming language, Microsoft Access and Adobe Photoshop CS2. This chapter will discuss on the method that will be used to achieve the objectives of the project.

Here, the author provides the methodology used in this system "RFID Real Time Tracker".

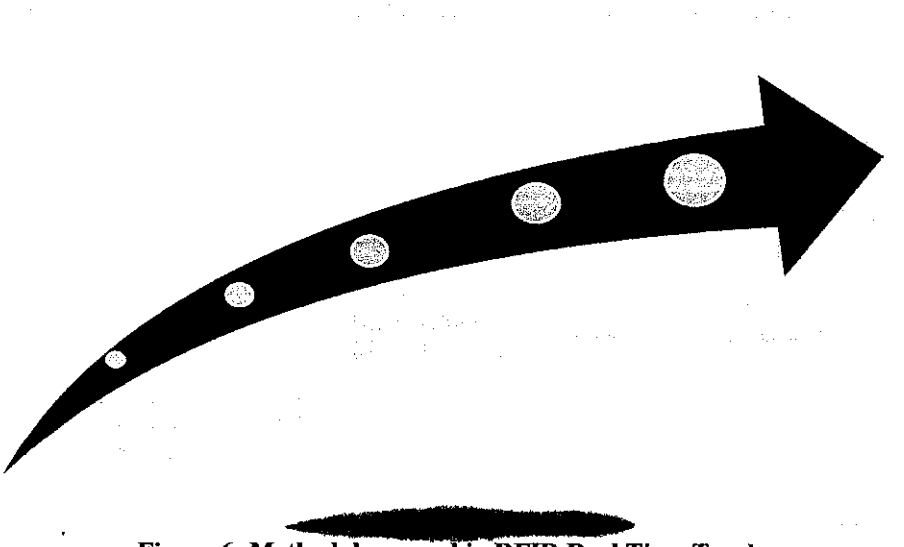


Figure 6: Methodology used in RFID Real Time Tracker.

From the figure above, they are 5 stages methodology used in this system which the author would like to explain below one by one.

3.1 Design system

This is the first stage, design system which the author has to design overall of the system such as what is the function that this system should provide which have to design based on the objectives and problem statement. The author also has to design what is the frequency used, tag type and demonstration area for testing this system. From all factors mentioned, the authors design to demonstrate at building 1 but because of this area is very large and need to have a powerful reader. Therefore, the author designs to build model which represent building 1 for testing this system. High frequency is chosen as well as passive tags are needed to complete this project.

3.2 Software development (Interface created by VB 6.0)

Visual Basic was designed to be easy to learn and use. The language not only allows programmers to easily create simple GUI applications, but also has the flexibility to develop fairly complex applications as well. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions of those components, and writing additional lines of code for more functionality.

Since default attributes and actions are defined for the components, a simple program can be created without the programmer having to write many lines of code. Performance problems were experienced by earlier versions, but with faster computers and native code compilation this has become less of an issue.

Forms are created using drag and drop techniques. A tool is used to place controls (e.g., text boxes, buttons, etc.) on the form (window). Controls have attributes and event handlers associated with them. Default values are provided when the control is created, but may be changed by the programmer. Many attribute values can be modified during run time based on user actions or changes in the environment, providing a dynamic application.

For example, code can be inserted into the form resize event handler to reposition a control so that it remains centered on the form, expands to fill up the form, etc. By inserting code into the event handler for a key press in a text box, the program can automatically translate the case of the text being entered, or even prevent certain characters from being inserted.

For example, a drop-down combination box will automatically display its list and allow the user to select any element. An event handler is called when an item is selected, which can then execute additional code created by the programmer to perform some action based on which element was selected, such as populating a related list.

Unlike many other programming languages, Visual Basic is generally not case sensitive, although it will transform keywords into a standard case configuration and force the case of variable names to conform to the case of the entry within the symbol table entry. String comparisons are case sensitive by default, but can be made case insensitive if so desired.

3.3 Hardware Testing (Hyper Terminal)

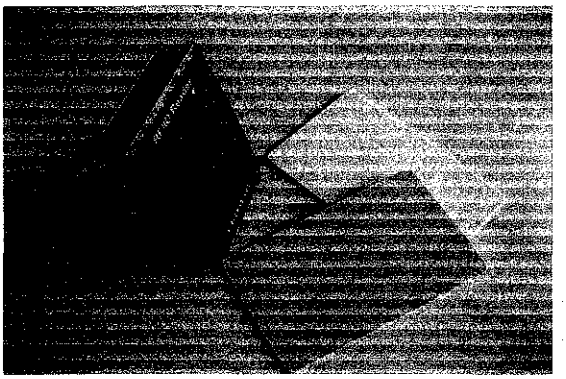


Figure 7: RFID Reader & RFID Tag.

The RFID reader that used in this project is model Mifare Card Reader MF7.The MF7 is a very high performance proximity reader featuring medium range and small dimensions. It is the best choice for system integrators because of its wide range of power inputs (between 5V to 18V DC). The Three-In-One interface, RS232, MSR ABA TK2 and

Wiegand allowing it to integrate with a variety of applications (**Please refer to Appendix 9 for more information on this reader**). The tag that used in this project is CFR01 that is ISO standard 0.8 mm thickness with random ID number.

3.4 Hardware and Software Integration

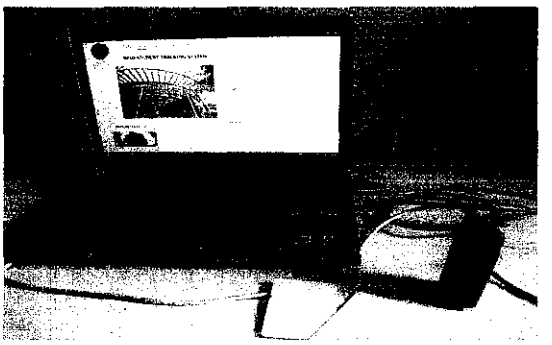


Figure 8: RFID Reader, RFID Tag and Host computer.

In this part it is actually focus on source code to make these two components work. Refer to **Appendix 10:** source code.

3.5 Model Development

From the figure below, this is a model that use for demonstrate this system "RFID Real Time Tracker" which can be divided into 2 areas in order to have more understanding of the project and how RFID reader read the tag, basically how this system works. And the objective of the model is to show how the RFID Technology for RFID Real Time Tracker works clearly.

Figure 9: Model for Demonstrate Area 1 and Area 2.

The model for this system had been built to implement the system. This model is actually similar as building 1: Information Technology that has 2 rooms, each room has one entrance and exit door (area 1 will be entrance door and area 2 will be exit door).

The limitation of this system is actually the number of reader, only one reader being use in this system this is because of the price of reader is very high and the author capable to afford to buy only one reader which will use for 2 areas. Since this project has only one reader so that the author decide to place the reader at the entrance door of model. Assume that area 1 has 1 reader which will track time in of students. Area 2 has another 1 reader which will track time out of students.

3.6 Summary

Those are the methodology that considered during built the project. From the basic fundamental of RFID technology in terms of technical specification, theory, appropriate software and design. All those terms are really important to make sure that the system works well. A good understanding of fundamentals in RFID technology or software could help to troubleshoot if any errors occur during the developing process.

The Mifare Card Reader MF7 was used in this system as a RFID reader while the tag CFR01 works as RFID tag. After established the connection between the RFID reader and tag, it can be used with the software. Visual Basic 6.0 works as an interface for the system and Microsoft Access as software that keep all the data of the system.

CHAPTER 4
RESULTS and DISCUSSIONS

4.1 System Results

After the author has implemented all the section mentioned above; The final system can be illustrated as Figure 10.

Figure 10: RFID for Real Time Tracker.

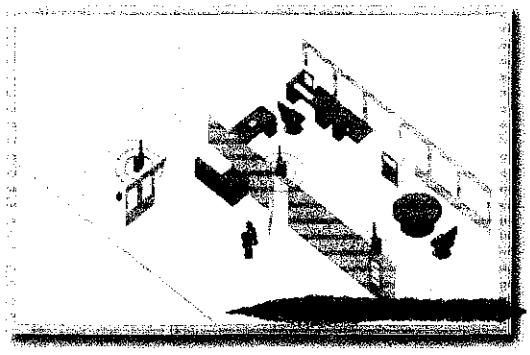


Figure 11: RFID simulation system.

For the concerns that security guards face each day, RFID technology brings solutions that magnetic stripe or barcode technology simply cannot deliver as effectively. The RFID tag is assigned and attached to student's matrix card. Every time staffs with the RFID tag enter to the building 1, RFID reader will read information from tag and transmitted to host computer. The mentioned concept is similar with the **Figure 11:** RFID simulation system.

Every step of the system and how it works is shown and discussed, and every detail displayed.

4.1.1 Main Menu Form

This system starts with the main menu page which is the overview of all function that consists in this system. There are five functions available to access; those are Administration, RFID Real Time Tracking, History Area 1, History Area 2 and Log Out. Each function was built to give smooth tracking experience to security in building access control.

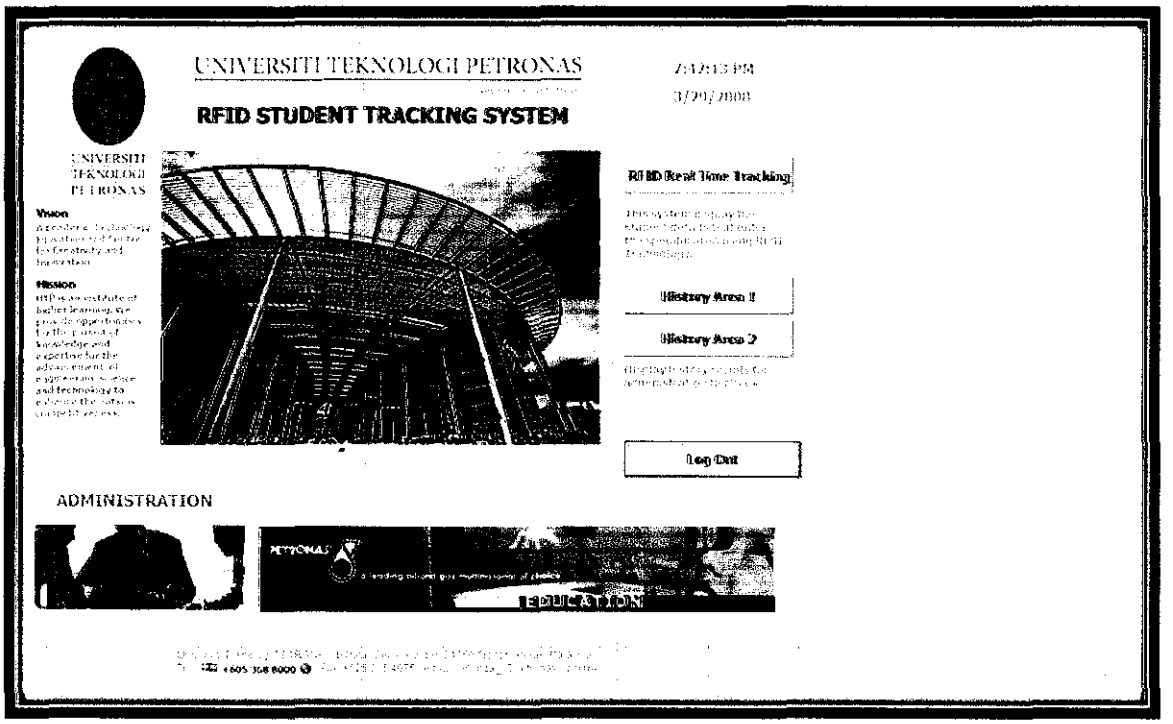


Figure 12: Main Menu Form.

4.1.2 Administration

This function is mainly for security guard to add new users or student detail by fill in student information into the form that has been created as shown below.

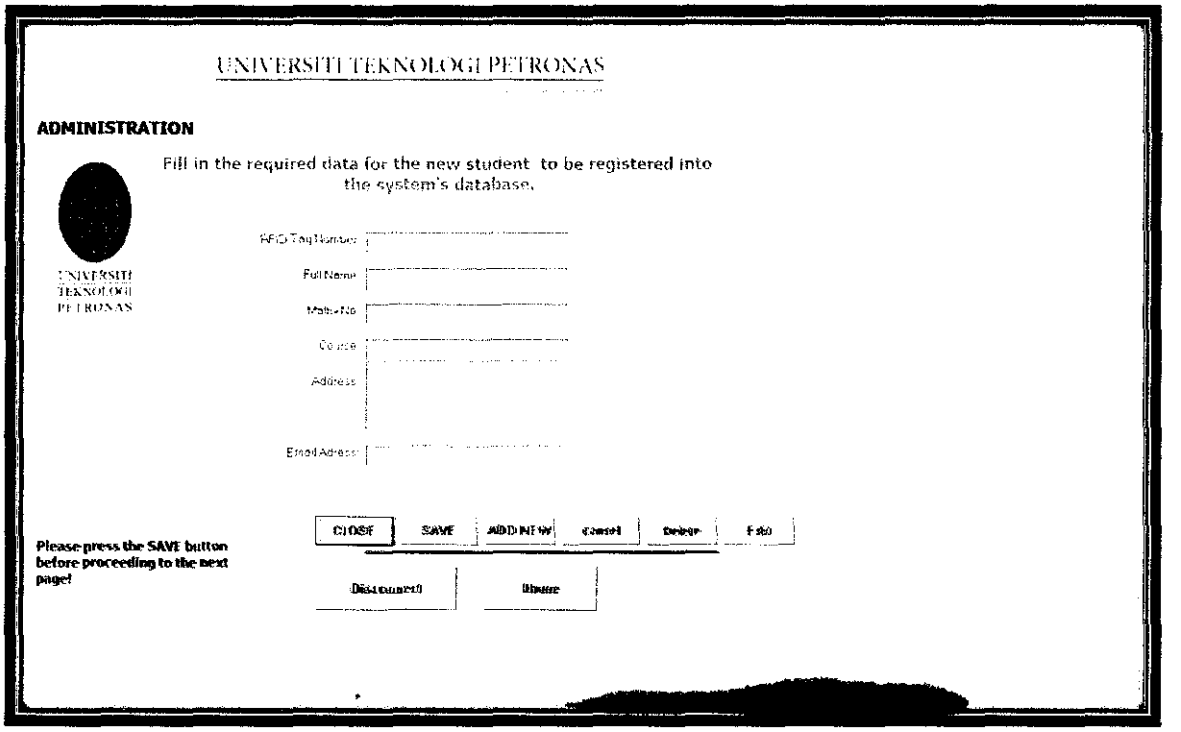


Figure 13: Administration Page.

As the first step, security guard click "ADD NEW" to add new student to be registered into the system's database. Next, check the rfid tag ID number by using reader to read that particular ID number of that tag. This step the rfid tag number will appear in first blank that provided then security can fill in student information. After fill in all information click "SAVE" then continue with disconnect button to disconnect all communication port that might be effect the connection between host computer and database system.

4.1.3 RFID Real Time Tracking

RFID Real Time Tracking is the main function of this project. It displayed the student ID number as well as student details which are Name, Matrix Number, Course, Address, Email, Time in, Time out, History of Area 1 and History of Area 2.

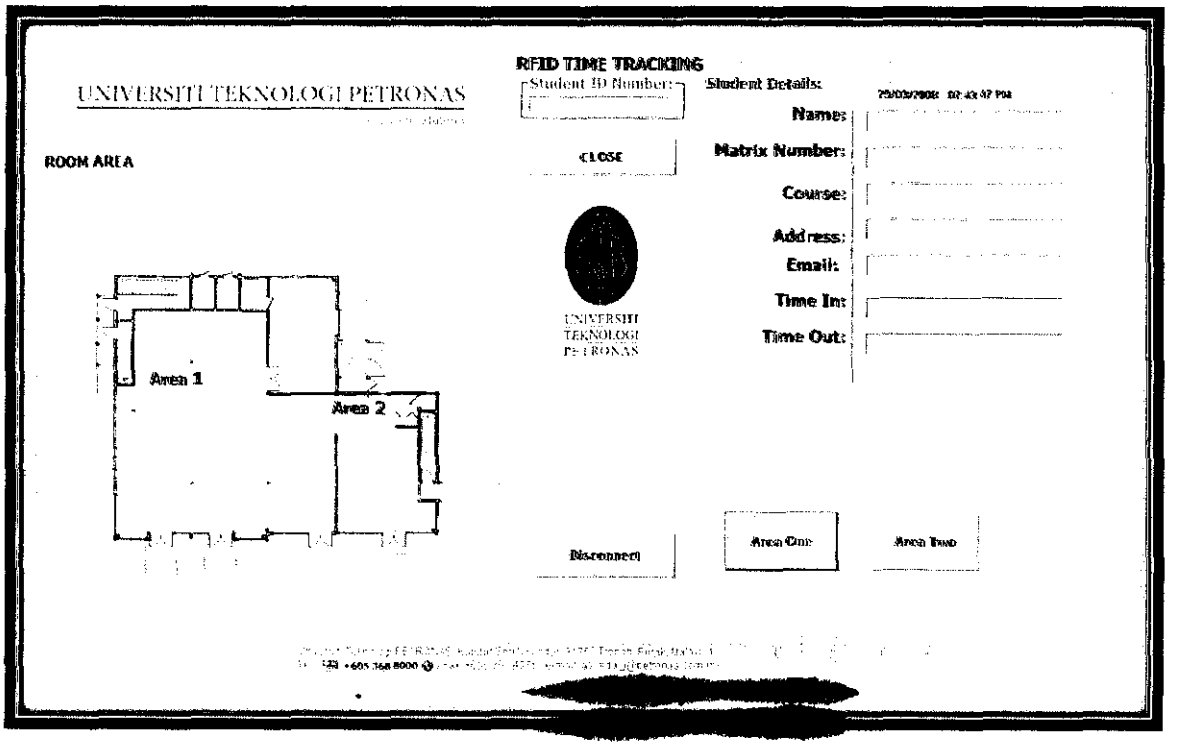


Figure 14: RFID Real Time Tracking Page.

Since the author has mentioned earlier that this system has only 1 RFID reader, so time that show in this page will based on real time tracking from the system. First tag will consider as time in which can be declare that student is in Area 1. For time out, it will represent that student is out from Area 2 since this system have only one entrance door (Area 1) and one exit door (Area 2).

4.1.4 History Area 1 and History Area 2

Security Guard can direct see the history of students who has entered in Area 1 and Area 2 in each day which will record or keep track name of [redacted]nts as well as time in - time out and the date in area 1 and area 2.

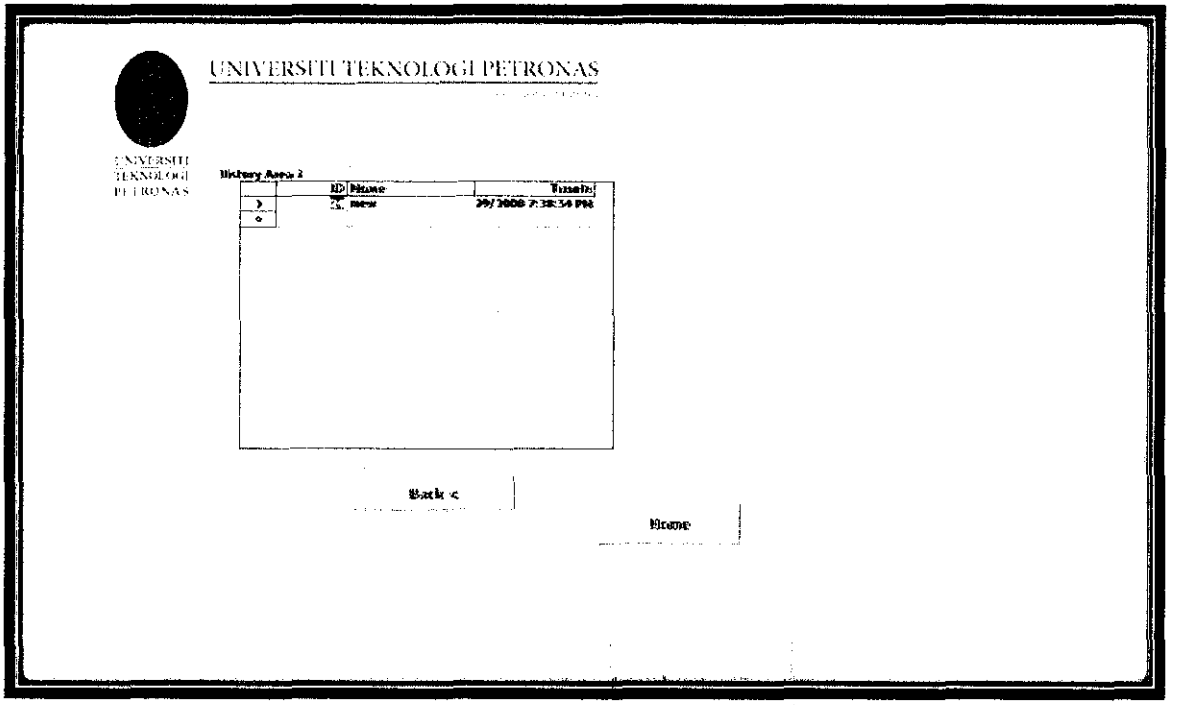


Figure 15: History Area Page.

4.1.5 Log out

Lastly, Security Guards have to log out form [redacted]e Tracker system.

After RFID reader detected a tag the results for each student will display. Those results can help security guard to save their time in keeping track all students information that entered building 1 and when anything happen in each day, security guard can refer to history in each area so that they can see whether who has entered each area on which day.

4.2 Testing Results

Testing is any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results. Although crucial to software quality and widely deployed by programmers and testers, testing still remains an art, due to limited understanding of the principles of software. The difficulty in testing stems from the complexity of software. The purpose of testing can be quality assurance, verification and validation, or reliability estimation. The [redacted]itions that require that an application be tested more than once.

So, the author has come out with different type of testing which will use to test this RFID Real Time Tracker, started with:

4.2.1 Aesthetics Testing

Aesthetics testing involves testing of the User Interface and focusing on the beauty, the product's looks rather than the products functionality alone. It is a part of Usability testing but often gets relegated to the back burner due to focus on attributes such as the ease of use and the user's ability to quickly accomplish tasks.

Aesthetics testing covers the various elements of the UI including display styles, fonts, colors, messages, icons, etc. The product also tends to look and feel like an output of a well designed and professional endeavor. Considering the subjective nature of beauty and aesthetics, it helps to consult with a representative sample of potential users and folks such as professional UI designers, human-computer interaction experts, graphic artists, and also try to conform to commonly accept and user expected interface design guidelines. [30]

This Aesthetics testing, the author comes out with the evaluation form to get feedback from overall about interface and design of her system. Below are pie charts that show result from 8 security guards in UTP who is actually will be real user for this system. There are 4 questions asked in evaluation form which are:

1) What do you think about this interface?

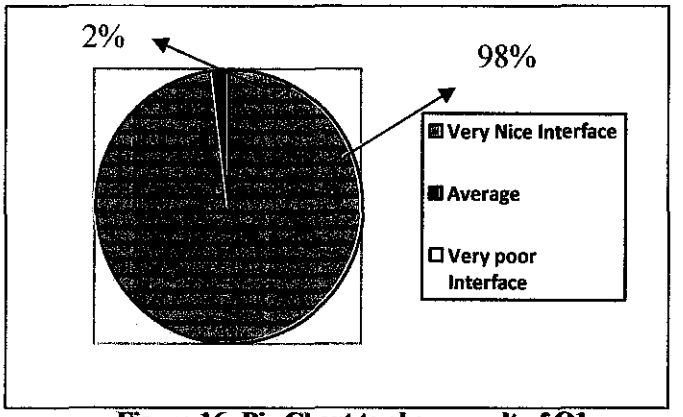


Figure 16: Pie Chart to show result of Q1.

The finding in this question shown that **98%** of overall 8 users very grateful in the interface and state that interface very nice and easy to use. 2% mention that interface look average, it is too simple and do not have much function.

2) What do you think about color used in this system?

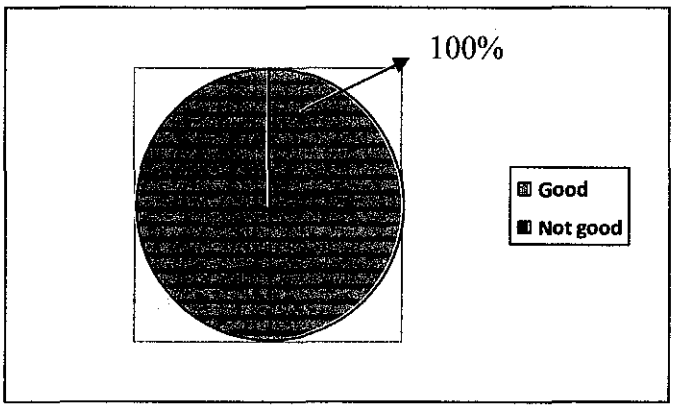


Figure 17: Pie Chart to show result of Q2.

100% state that color used in this interface is really nice and match with university corporate colors which are dark blue, gold and gray. It is look clean by overall.

3) What do you think about font used in this system?

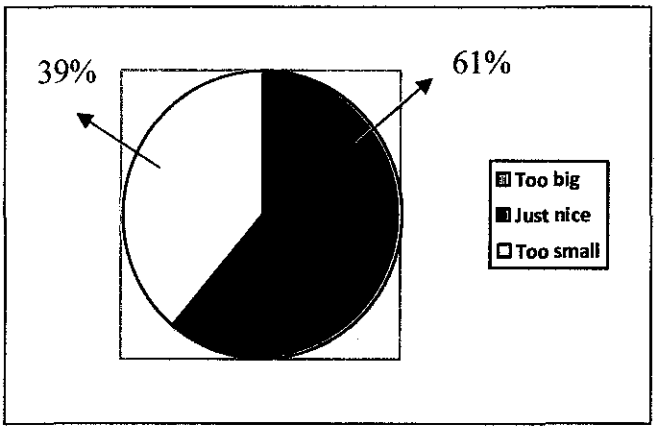


Figure 18: Pie Chart to show result of Q3.

Finding show that 61% comment that font size is just nice, not too big and not too small. Others 39% state that font size is too small, difficult to read because the majority of security is senior level (age > 45 years old)

4) All functions in this system are easy to use or not?

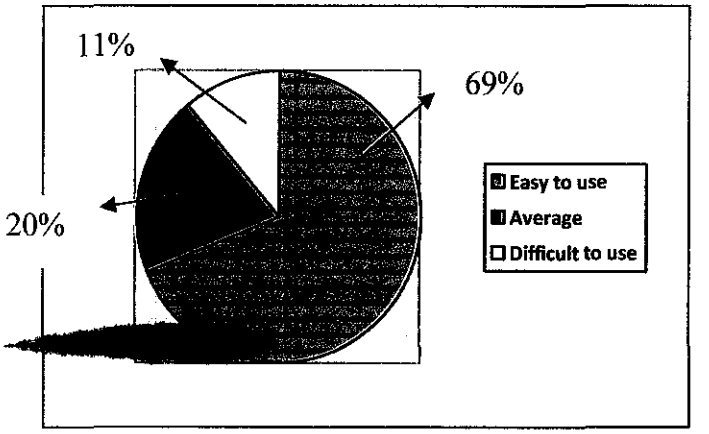


Figure 19: Pie Chart to show result of Q4.

69 % state that this system is very easy to use and do not have much function to make users get confuse sine each page in the system already guide users by writing the instruction. 11% from finding show that this system is difficult for them and 20% state that this system is average, not easy and not difficult.

4.2.2 Integration Testing

Integration testing the separate modules will be tested together to find weaknesses and bugs in the system. In this testing, the author tries to test each function one by one by setting the conditions as follow:

After set up the hyper terminal for RFID reader, the author also has to test whether all components can work well with others components or not. Some time hardware works but software does not. So, in this testing should test as well the com port of the host computer because different computer use different com port. For example, this host computer that the author uses in this experiment use com port 5 while others computer may use com port 1.

4.2.3 Reliability Testing

Reliability is a measure of the continuous delivery of correct service without failure for a specified time in a specific environment.

As this system is mainly focus on real time tracking so that the author tries to test this system by external clock which set exactly same time as show in the computer screen. The author use can conclude that the real time tracked by system is exactly the same with what is shown from external clock as well. Meaning that this system can achieve the objective of this system. Not only real time that this system can be capture, it is also capturing location area 1 and area 2 as well.

The second testing is that the author tries to store 1 tag with her information while another tag does not register any information into database. The author test by passing the tag through reader, found that system show pop up menu which state that "**No current record**". Figure below show the mentioned pop up menu.

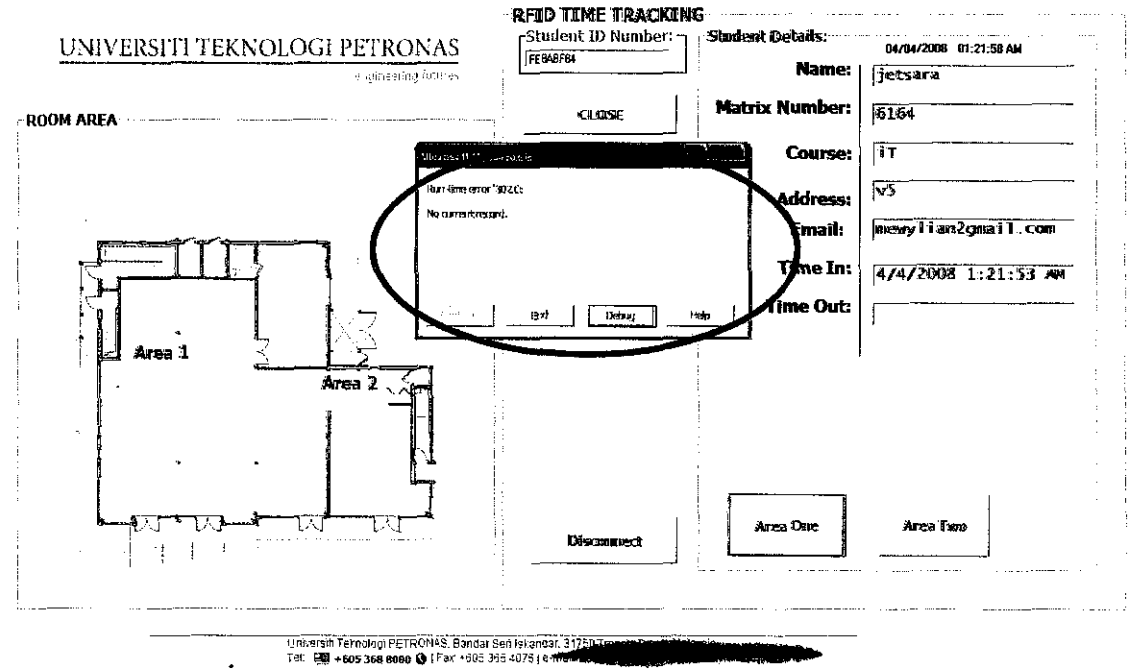


Figure 20: Pop up menu.

Therefore, this system is reliable enough sine it is can capture all error data by sending pop up menu to computer screen and can make users understand what should do next.

4.2.4 Acceptance Testing

The goal of acceptance testing is to verify that the user requirements have been achieved. After this system have been complete the author set up the meeting with 3 persons from security guard department to comment on this system, they are Siti Rohana Bt Awan, Mohd Noor hazman B Majid and Rahaizam B Hashim. They very satisfies with this system and they also gave some comment on this system.

- System sebegini bagus untuk kita pengetahuan pelajar yang ada serta tempat building 1
- Sangat sesuai untuk kakitangan pk gad

Siti Rohana Bt Awan

- Overall bagus!

Mohd Noor hazman B Majid

- Very nice and look clean

Rahaizam B Hashim

From those evidences, can conclude that this system is accepted by users since the result of testing really fine and meet the users' requirement which is can track students in real time.

4.3 Discussion

In this section, the author would like to discuss more deep in the project which will be discuss below:

4.3.1 System Overview

To design and built The RFID Technology for this system, the main element is RFID tags and RFID reader. These two elements must work each other to make sure all the data or information can be detect and it's accurate. Besides that, software developments also a part in this project. In order to manage and process the valuable information and send to the program to display result. So, overall overview of this project includes hardware implementation and software development. All this elements need each other to make sure this project can achieve the objectives.

The database system in the personal computer is created using Microsoft Access, so all the data can be access from that system. It is include number of students in UTP. This database system is link to the Visual Basic 6.0 for data manipulated in GUI (Guide User Interface). This program will receive the information from the RFID reader then do the matching methods for showing the exactly students detail from the data that have been stored in Database.

First, the connection between RFID reader and computer can be identifying using hyper terminal program that provides in Windows operating system. Named the new connection and choose the available communication port that can be use. Then, setting the port in terms of bits per second, data bits, parity, stop bits and flow control. These are the parameter that requires establishing the connection. Each RFID readers do not have same configuration, it depends on which types of model that used. Those setting can be finding at the datasheet of the reader. For more information please refer to **Appendix 9:** Start up.

The unique ID of RFID tag can be detected at the hyper terminal once the reader detects it; it means that the connection is successful. After that, connect the RFID reader with the interface that been built. To connect it in Visual Basic 6.0, used the MSComm that provided. Turn the setting in hyper terminal into coding types.

Once it finished, test the software with the reader. This personal computer or host is connected through USB (Universal Serial Bus) or serial port. So, the communication between RFID reader and interface are using that port. If the personal computer does not have serial port, use the serial converter to connect to USB port.

Then, when the reader detects the tag, the interface will process the information that received. It will compare all those data with database that it had. Once verify it and complete the process, the results will display on the computer screen for users or security guards.

Overall view of the system is to design the GUI for RFID Real Time Tracker and determined the connection between RFID reader with the host. It used Visual Basic 6.0 as interface and Microsoft Access to develop database. Then, Adobe Photoshop CS2 to design pictures that makes the interface good looking and attractive to use.

4.3.2 RFID Real Time Tracker - System Development

The RFID Technology for this system is developed to display the student's movement in real time tracking. It is developed using Visual Basic 6.0 and Microsoft Access.

This project consists of interfacing the GUI with RFID reader and keep all the process in the program is accurate. Serial port is the connection between RFID reader and GUI. In order to receive data from RFID reader, the MSComm control in the Visual Basic 6.0 is required. The MSComm control provides serial communications for the application by allowing the transmission and reception of data through serial port.

Here, the author had come out with some of the diagrams; Use case diagram, Sequence diagram and RFID Architecture for more understanding how system work.

The **Use Case Diagram** describes the system's behavior under various conditions as it responds to a request from one of the stakeholders, called the primary actor. The primary actor initiates an interaction with the system to accomplish some goal.

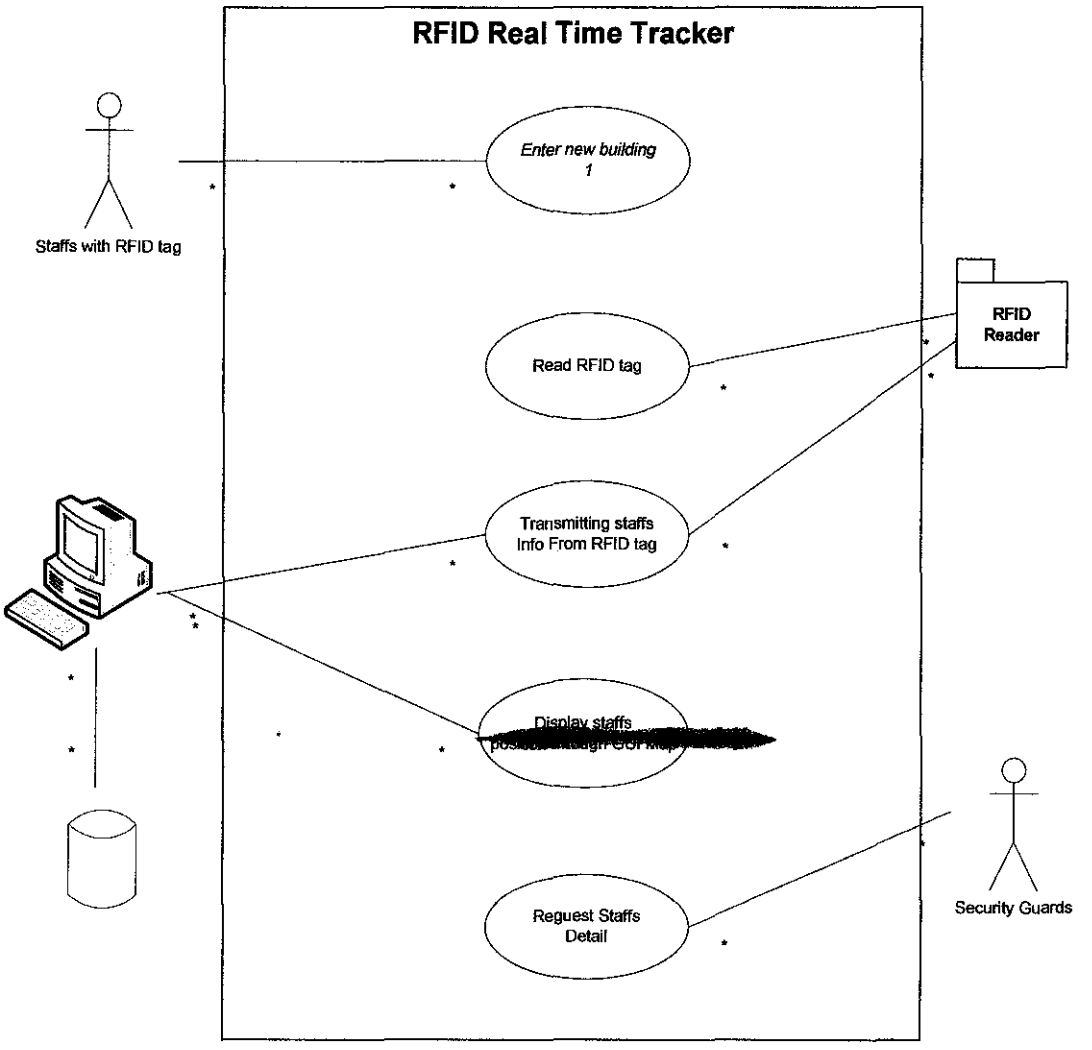


Figure 21: Use-Case Diagram.

The **Sequence Diagram** shows the interactions among the various classes in RFID Real Time Tracker system. It focuses on time-dependency events with the earliest operations represented by stimuli starting from the top.

- **RFID Reader Sequence Diagram**

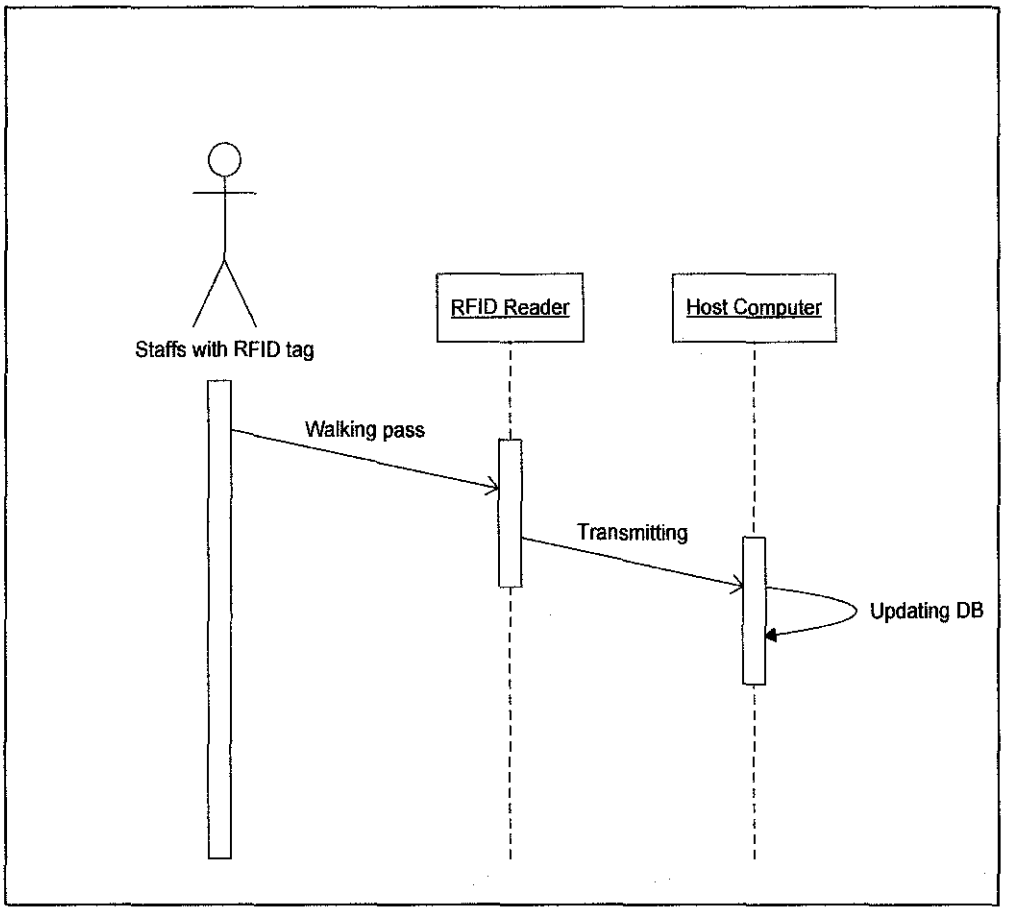


Figure 22: RFID Reader Sequence Diagram.

Firstly the Students with RFID tag entered to the building 1 and walk pass RFID Reader, RFID Reader will read the students information from the tag then transmitted to Host Computer which connected to Database.

- **Display Sequence Diagram**

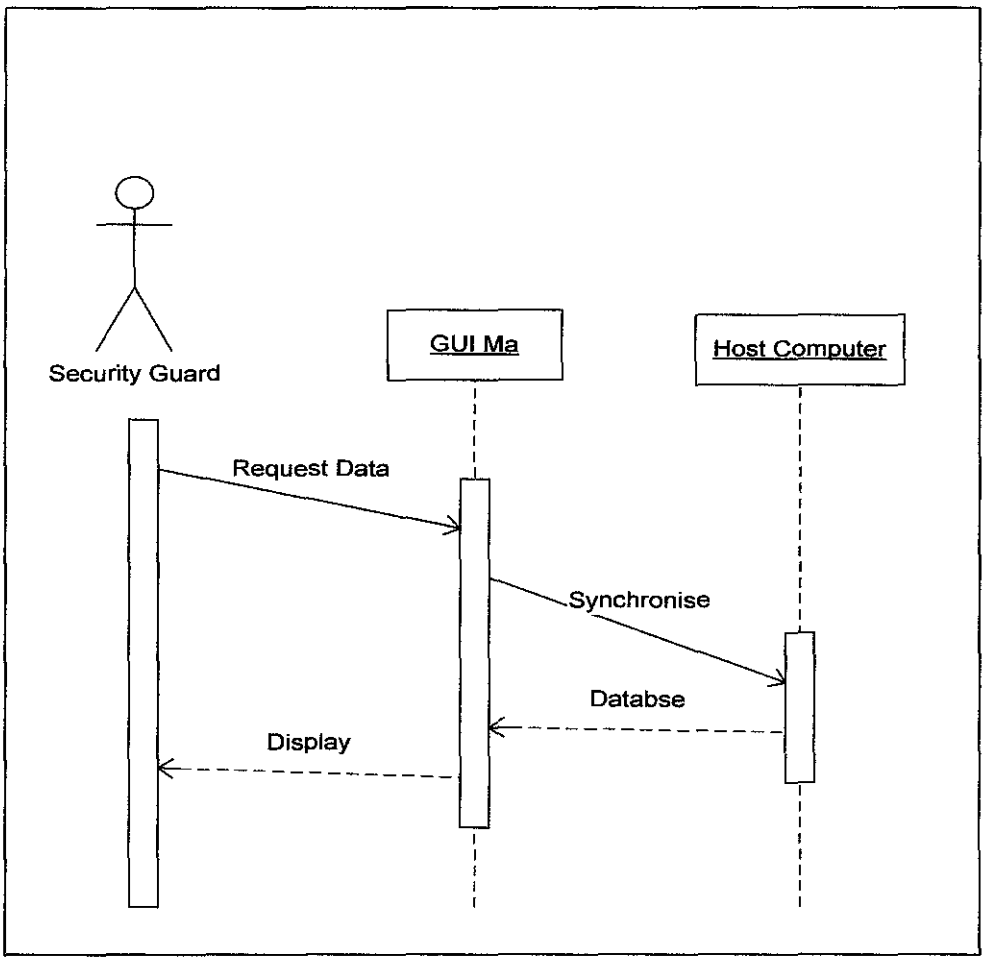


Figure 23: Display Sequence Diagram.

The Security Guards can request detail of students which will display in computer screen then it will synchronize data stored in database from host computer. Finally, student's information will display on computer screen.

In this project, one serial port is used to establish the connection. Each MSComm control used corresponds to one serial port. But it used two USB port if used it with computer laptop. One for power supply and the other one for data transfer. Because of the computer laptop do not have serial port, the USB serial converter is used in this project.

The settings property at communication port is allowed to specify the baud rate, parity, data bits and stop bits. Baud rate for this project's reader is set at 9600 and the parity setting is for data validation. It is commonly not used, and set to "N". The data bits setting specify the number of bits that represents a chunk of data, while the stop bits indicate when a chunk of data has been received. Those are setting at 8 and 1.

Data communication and which port to open must be specified when use it. It is important to specify it to support the settings and prevent the error occur during connection. How to open and close the port are declared using Boolean value, True or False. PortOpen property is used to establish the connection in Visual Basic 6.0 and setting the value True or False will instruct the port to open or close.

When a port is opened, the input from RFID reader can be received and store in receive buffer. This buffer is created once the connection establish. It is used for store and retrieves data. So, the GUI can get the input and process it to display the results.

In this system developed, it must be able to keep update the database of the system. To keep the all of the information, Visual Data Manager is used. It's the database that provided by Visual Basic 6.0. It easier to use and the database is saved in Microsoft Access format.

There are three tables had been built in this project, the table name is history Area1, history Area2, and student information. Each table has their own function and database. To open the database table manually, open Visual Basic and click Add-Ins top of the windows and click Visual Data Manager.

All the information is retrieve from this database, this Visual Data Manager is slightly different from ADO Data Control (ADODC) because it used only coding to open or edit it automatically. While ADODC use link settings and configuration to make it work with interface.

Since the development of RFID Real Time Tracker is an iterative process. So, as a first step of conducting this system will be design system which have to consider from all information that have been collected for example what is the problem statement that security guard are facing now, how can this system solve the problem, how this RFID technology works and also where is demonstration area and who will be testing it. All these information come out into consideration and finally we should try it out.

For the first idea, the author plan to conduct this system at in front of building 1 area which has shown below:

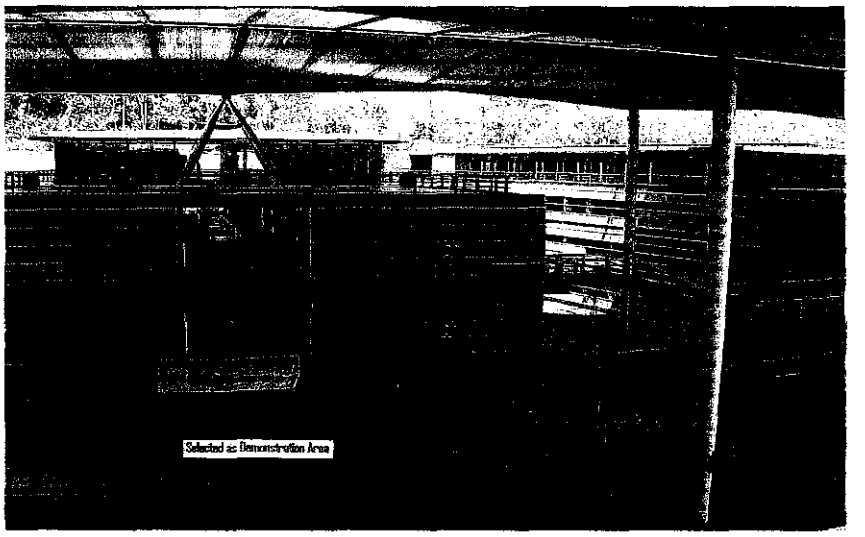


Figure 24: Demonstration Area (Previous).

Based on the information that the author has after conducted the interview session with Captain Lakhbir Bin sandar, he told the author that in each building will have it own camera to record movement of all staffs entering new building which places at the end of each level near elevator. And only one place that do not have camera is in front area which shown in **Figure 24: Demonstration Area (Previous).**

After the author discussed with her supervisor, Mr. Izzatdin. He suggests that the demonstration area should be in room because in front place (previous demonstration area) actually it has nothing to track, better demonstrate 2 rooms (room area1 and room area2). Thus, the author decided to change demonstration area as rooms because it has lots of computers and worth computer equipments.

The author arrange to put reader at the door entrance for area 1 and reader will read the information from tag then display into computer screen in the form format. The form will show picture of both area 1 and area 2 in left side of the form. Student details, record of students who entered in both area 1 and 2 together with time in-time out which displayed in the right side of the form. The result will display after reader read unique number from tag and it will link to database which stored student details. If the detail of student match with the unique number stored in database it will display result.

After understand the objectives, identify project scope, design system and all requirements are discover. Therefore, the author comes out with project time line which including work plan from FYP I to FYP II (Gantt chart). See in **Figure 25:** Project Time Line for RFID Real Time Tracker.

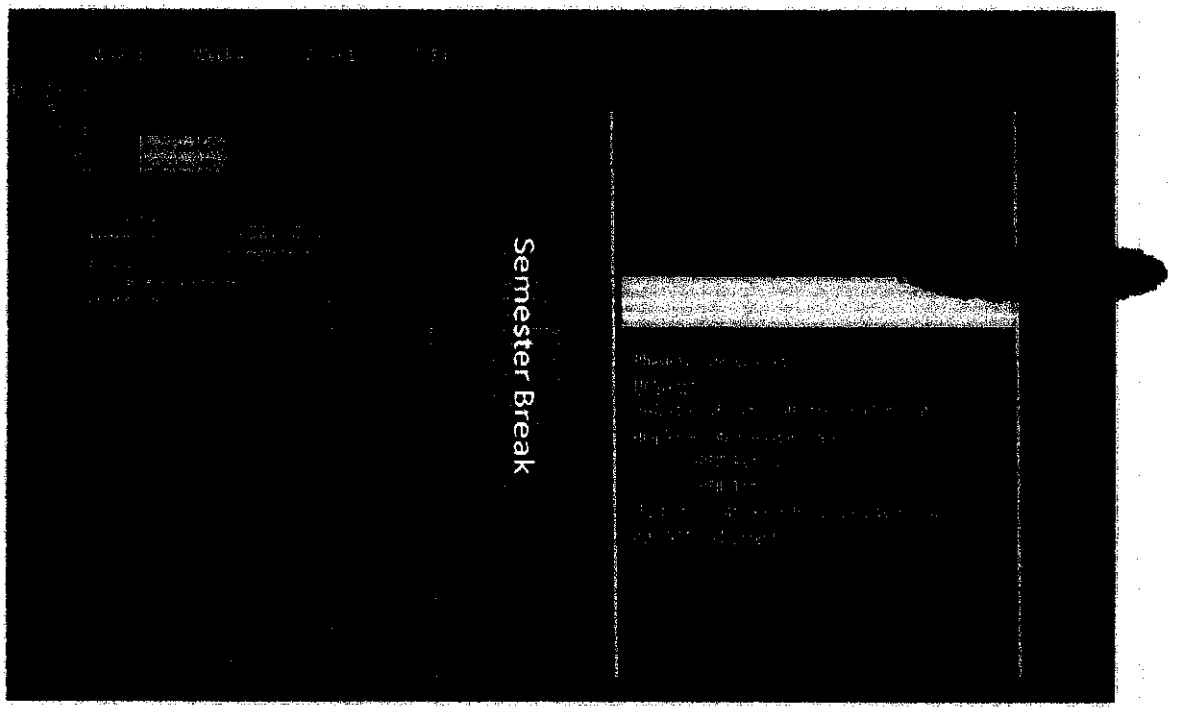


Figure 25: Project Time Line for RFID Real Time Tracker.

Many important references were obtained from the journal that been published by the RFID technology website. The journals describe the RFID performances including RFID categories. After collecting journals, interpretations of the journal contents need to carry out in favor of to select the useful information. Below the author would like to discuss from her understanding about the project scope.

- **Why Implementing RFID Real Time Tracker?**

Since RFID technology has a wide variety of advantages in tracking the real time location of object or people. Based on the problem statement mentioned by Captain Lakbir Bin Sandar, head of security department in UTP, it is difficult to monitor students movement that has entered to new building since we have imbalance number of security guard incomparison with number of students that keep increasing semester by semester and when anything happen it really difficult to keep track all history. This is the reason why the author has chosen RFID technology to adapt in this application and solve it.

- **Scope of demonstration area?**

The author has chosen area of building 1 to be the demonstration area since building 1 is a building for IT, lots of IT equipments are placed and its easy to steal because normally all equipments are in small size but expensive.

- **What type of the RFID tag will be used?**

The author decided to choose RFID Passive tag, because passive tag can help well in this kind of building access control. Lastly, it can be reusable when the owner of that tag quit UTP in the future time so that security guard can just use the same RFID tag and change only the information details of new staffs because it can reusable.

- **How many tags will reader read/write at one time?**

Actually the reader will be able to read how many tag at a time is depend on RF (Radio Frequency) types. They are many types of RF which can be shown in the table below:

LOW FREQUENCY	~ 125 KHz	1 tag at a time
HIGH FREQUENCY	13.56 MHz	50 tags at a time
ULTRA HIGH FREQUENCY (UHF)*	860 - 960 MHz	up to 100 tags at a time
MICROWAVE FREQUENCY**	2.45 GHz	Various tags

Table 4: Radio Frequency types and fun[illegible]5] [16]

In this project, the author use High Frequency which can be read 50 tags at a time. It is could be enough and suitable for this project.

- **What is possible location for the RFID tag?**

As the concept of this project have been described in previous section. The system utilizes RFID tags on matrix card of all UTP students to identify and track them through RFID readers that relay real-time information to a host computer. The Figure below shown example of RFID tag attached in student matrix card.

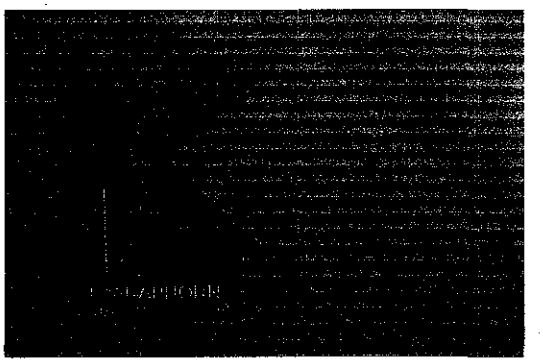


Figure 26: Student matrix card with passive RFID tag.

- **What are possible locations for the reader?**

It is actually depends on how long reader can read or range of reader that can be read. In this project, the author had chosen High Frequency, which can be read in range of 2 cm and it will place at the door entrance of the model.

CHAPTER 5
CONCLUSIONS and RECOMMENDATIONS

5.1 Conclusions

As a conclusion, a RFID Technology for RFID Real Time Tracker had been developed. This project has been successfully completed; the project is functioning and performing as desired. Great satisfaction was achieved as much knowledge had been applied to improve the project in term of hardware and software.

The final result proves that by using the RFID technology, the system of helping Security Department for smoother their work experience can be done and become easier. This system can help security guard control and keep track for all students movement in specific area which is building 1 (Model) which is brings a lot of convenience for them.

5.2 Future Works

In this project, there is little limitation although the system is successfully built. Therefore, enhancement can be made for the future works.

In this system, only one reader is used for all application. For a better performance, the system is suggested so that one reader for each application. It is because to avoid sharing one communication port at the same time which is will affect the connection between reader and computer. Besides, the computers have insufficient communication port to connect with readers and other hardware such as microcontroller. The reader in this application used two communication ports while the computers only have two. So the connection with other hardware is limited.

The RFID reader and tag in this project were bought from vendors. Therefore, it makes the project costly. For future work, the RFID reader or tag can be designed and it will definitely cut the project cost.

Nevertheless, what will happen if this project has 2 readers, one at entrance door and another one at exit door? And the range of both readers are interfere between each other, what will be the solution if a tag come into between these 2 reader ? Which reader will read the particular tag?

5.3 Recommendations

However, there are still many aspects and areas in the utilization of RFID techniques as some network installation and programming part that must be studied to a greater extent in upcoming. Here, some of the studies that could be conducted in the future would be recommended. These studies would greatly help to elevate the potential of utilizing RFID as the heavy techniques can be adsorbent in the future.

- **The study of RFID adsorption of other components.**

By conducting this study, the adsorption characteristics for other components with the RFID would also be able to be determined. From the research work only could not be guarantee that can complete all work since have to conduct and brainstorming with an experience person who ever conduct this kind of techniques.

- **A more detailed on RFID equipments and prices.**

More details on RFID equipment and its price can easier continuous adsorption need to be conducted apart form those done in this study. Apart from confirming the observations made in this study, more detailed experiments could also be done by utilizing other types of concept. A more detailed on RFID equipment and its price could also confirm and also explain the observations made during this study.

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APPENDIXES

Appendix 1: The Origins of RFID

The first disturbing fact is that RFID is not a new technology. It was first used over sixty years ago by Britain to identify aircraft in World War II and was part of the refinement of radar. It was during the 1960s that RFID was first considered as a solution for the commercial world. The first commercial applications involving RFID followed during the 70s and 80s. These commercial applications were concerned with identifying some asset inside a single location. They were based on proprietary infrastructures.

The third era of RFID started in 1998, when researchers at the Massachusetts Institute of Technology (MIT) Auto-ID Center began to research new ways to track and identify objects as they moved between physical locations. This research, which has a global outlook, centered on radio frequency technology and how information that is held on tags can be effectively scanned and shared with business partners in near real time.

To do this we needed standards. The work of the Auto-ID Center focused on:

- Reducing the cost of manufacturing RFID tags.
- Optimizing data networks for storing and delivering larger amounts of data.
- Developing open standards.

It became apparent that the ideas being proposed, combined with other ongoing technological and standardization activities worldwide, would help to reduce the costs of RFID tagging. By 2003, the Center had over 100 sponsors from four continents. Its final task was to conduct a large field trial with 40 participating companies in 10 US cities. Today, the work of the Auto-ID Center has helped to make RFID economically viable for pallet and carton-level tagging. The technology is also becoming more affordable for high-value items. The Auto-ID Center officially closed on October 26, 2003, transferring all its technology to EPCglobal.

Appendix 2: So Why Now?

That's good, but why is everyone talking about RFID now? Well, after 15 years of testing, trials, and live specialized use, a number of converging factors have increased the attention and momentum behind RFID. Figure 28: from Deloitte Consulting, summarizes these factors best.

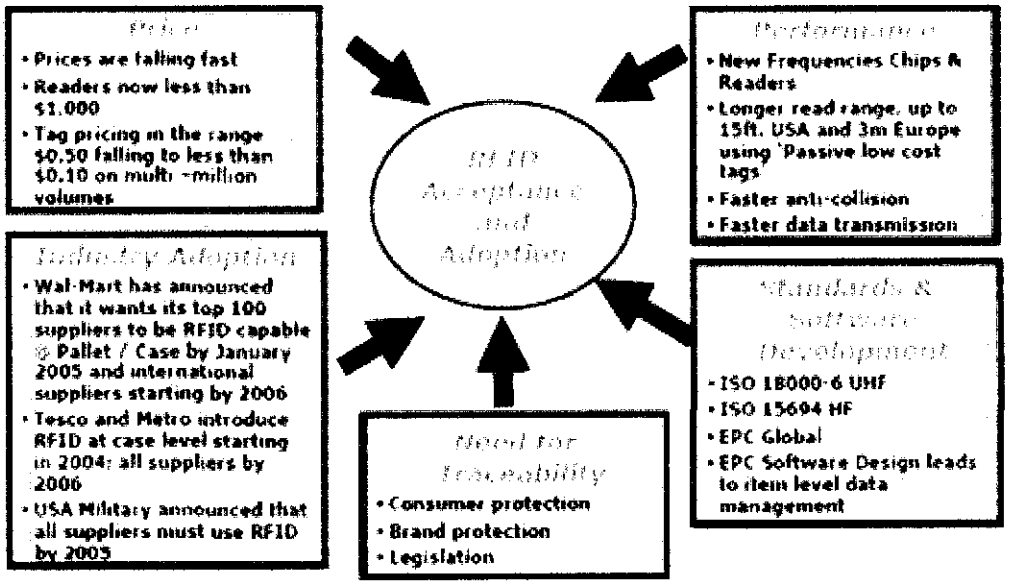


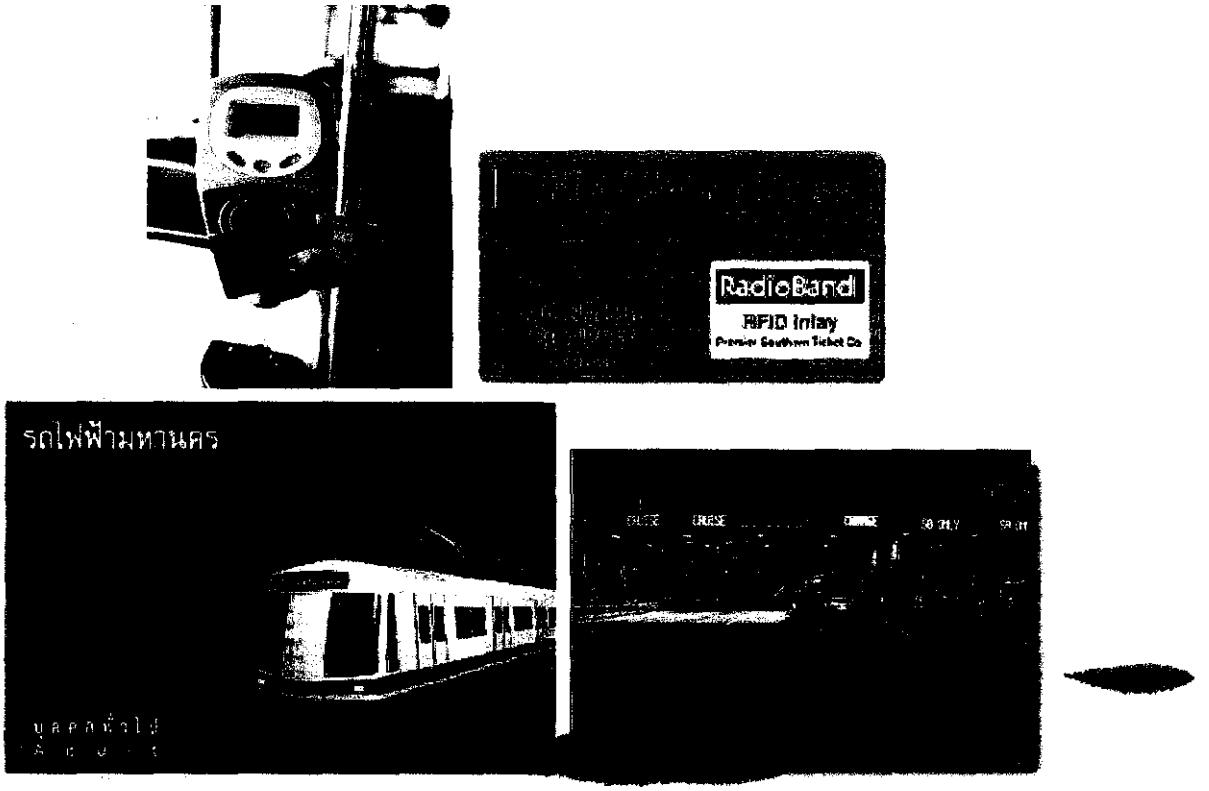
Figure 28: Why RFID Now?

(Source: Deloitte Consulting: Lawrence Huntley, RFID [redacted] Forum June 2004, Deloitte)

Appendix 3: Photographs Taken of Animal Tagging

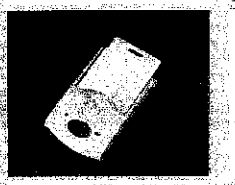
(Source: Animal tagging: David Luis, RFID – advantages, RFID Journal August 2006)

Appendix 4: Member card/e-Ticket



(Source: Watcharakorn Noothong, Thailand IC Design Incubator National Electronics and Computer Technology Center (NECTEC))

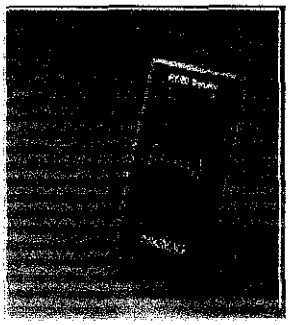
Appendix 5: RFID Readers - 13.56MHz

Model	Product Name	Product Image	Price
223001	13.56 MHz High Frequency (HF) PDA CF RFID Reader Writer		Contact us for more information
223002	13.56 MHz. High Frequency (HF) SD Interface RFID Reader		Contact us for more information
223003	13.56 MHz. RFID UTE Handheld Reader / Writer		Contact us for more information
223004	13.56 MHz. RFID HF Paddle Reader w/ Bluetooth		Contact us for more information
233002	13.56 MHz. High Frequency (HF) Fixed RFID Reader Writer Mifare		Contact us for more information
233003	13.56 MHz. High Frequency (HF) Fixed RFID Reader Writer		Contact us for more information
233004	13.56 MHz. High Frequency (HF) Reader RFID Writer with Antenna		Contact us for more information

Appendix 6: RFID Tags - 13.6MH

Model	Product Name	Product Image	Price
113001	13.56 MHz. High Frequency (HF) ICODE RFID Tag		Contact us for more information
113002	13.56 MHz. High Frequency (HF) Square Paper RFID Tag		Contact us for more information
113003	13.56 MHz. High Frequency (HF) Rectangle Paper RFID Tag		Contact us for more information
113004	13.56 MHz. High Frequency (HF) Round Paper RFID Tag		Contact us for more information
113005	13.56 MHz. RFID HF Laminated Mini PVC Tag		Contact us for more information
113006	13.56 MHz. RFID HF Jewellery Tag		Contact us for more information
113007	13.56 MHz. ISO Dual Frequency (125 kHz.& 13.56 MHz.) RFID Card		Contact us for more information
113008	13.56 MHz. High Frequency (HF) ISO MF 1 S50 Thin RFID Card		Contact us for more information

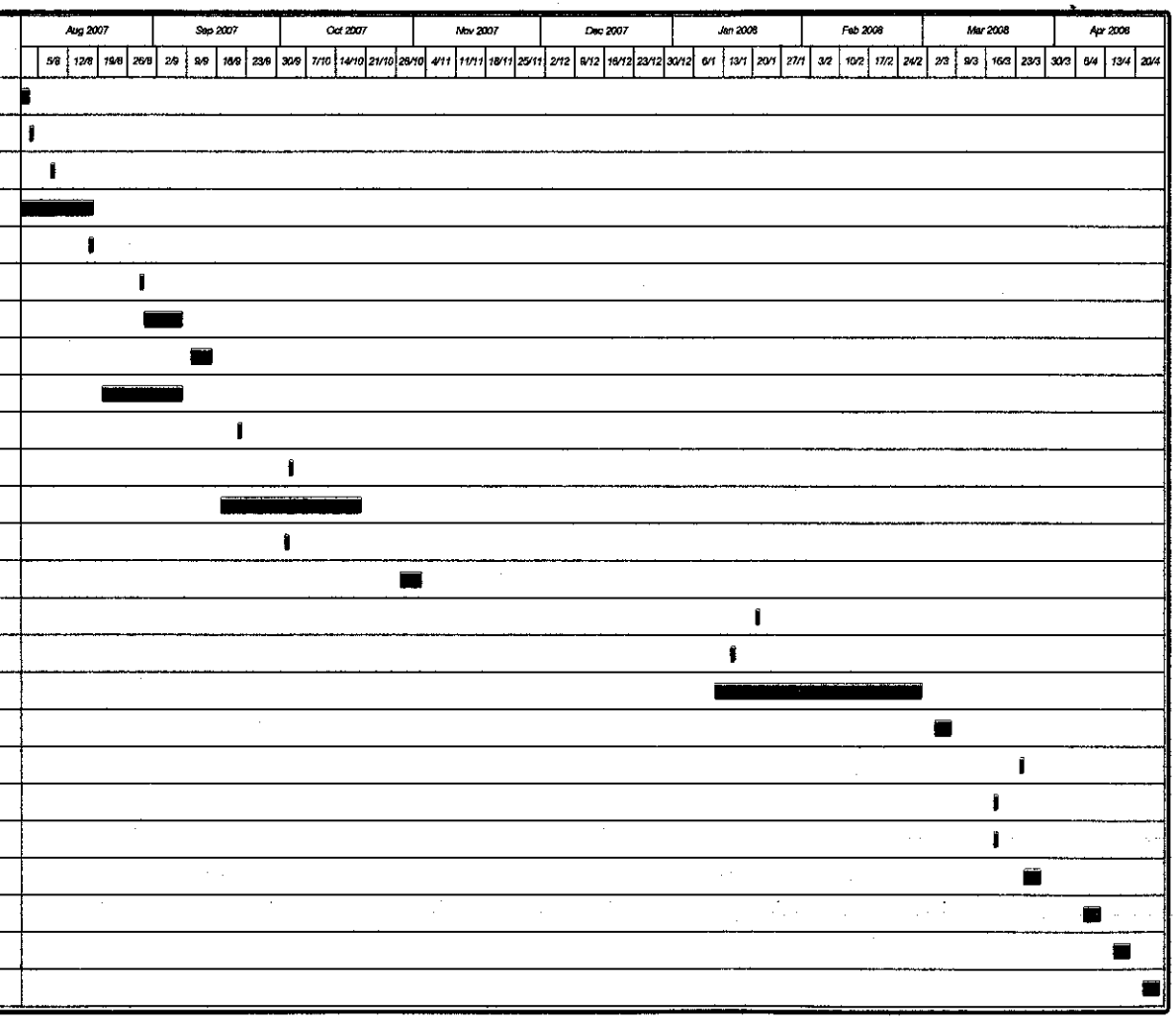
Appendix 7: MIFARE CARD READER MF7



Power Requirements	5 ~ 18 Volts regulated DC at 150mA Typical with a 12V supply ※ A linear regulator is recommended
Interface	Wiegand 26 bits MSR ABA Track 2 RS232 **or Special Customized Specification**
Card type	**Mifare MF1** standard cards for 1024 / 4096 bytes and **Mifare UltraLight** cards of EEPROM size 512 bits for ISO 14443A
Maximum reading distance	Up to 50 mm at 5V ~ 18V with **Mifare** card in ideal conditions
Frequency	13.56 MHz standard
Transponder	Read only (For Unique Serial Number / Unique Identifier)
Audio / Visual Indication	**Internal LED and Buzzer**
Dimensions	83 (L) x 47 (W) x 16(D) mm
Operating temperature	-10 ~ +60°C
Housing material	ABS

Appendix 8: Timeline of overall tasks

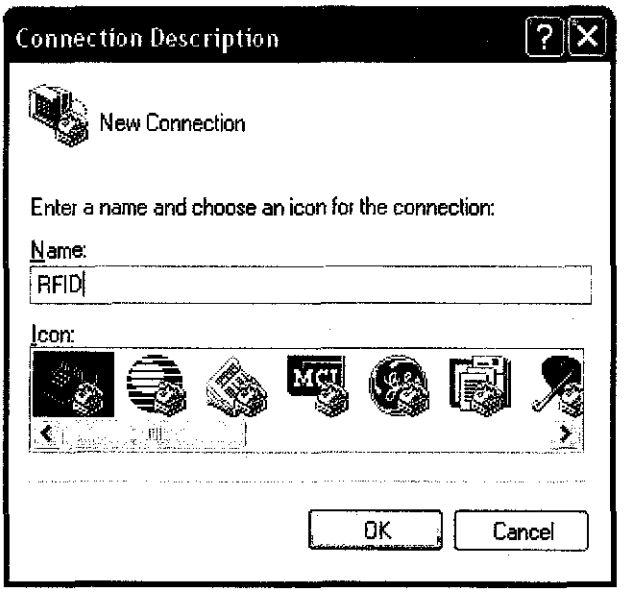
ID	Task Name	Start	Finish	Duration
1	Selection of Project Topic	8/1/2007	8/2/2007	.4w
2	Submission Project Proposal	8/3/2007	8/3/2007	.2w
3	Proposal Approve by RC	8/8/2007	8/8/2007	.2w
4	Preliminary Research Work	8/1/2007	8/17/2007	2.6w
5	Submission of Preliminary Report	8/17/2007	8/17/2007	.2w
6	Seminar 1 (optional)	8/29/2007	8/29/2007	.2w
7	Data Collection	8/30/2007	9/7/2007	1.4w
8	MID – SEMESTER BREAK	9/10/2007	9/14/2007	1w
9	Project Work	8/20/2007	9/7/2007	3w
10	Submission Progress Report	9/21/2007	9/21/2007	.2w
11	Seminar 2 (compulsory)	10/3/2007	10/3/2007	.2w
12	Project Work Continues	9/17/2007	10/19/2007	5w
13	Submission Interim Report Final Draft	10/2/2007	10/2/2007	.2w
14	Oral Presentation (FYP I)	10/29/2007	11/2/2007	1w
15	Project Work Continues	1/21/2008	1/21/2008	.2w
16	Submission of Progress Report 1	1/15/2008	1/15/2008	.2w
17	Project Work Continues	1/11/2008	2/29/2008	7.2w
18	MID-SEMESTER BREAK	3/4/2008	3/7/2008	.8w
19	Submission of Progress Report 2	3/24/2008	3/24/2008	.2w
20	Seminar (compulsory)	3/18/2008	3/18/2008	.2w
21	Project Work Continues	3/18/2008	3/18/2008	.2w
22	Poster Exhibition	3/25/2008	3/28/2008	.8w
23	Submission of Dissertation (soft bound)	4/8/2008	4/11/2008	.8w
24	Oral Presentation (FYP II)	4/15/2008	4/18/2008	.8w
25	Submission of Project Dissertation (hard bound)	4/22/2008	4/25/2008	.8w



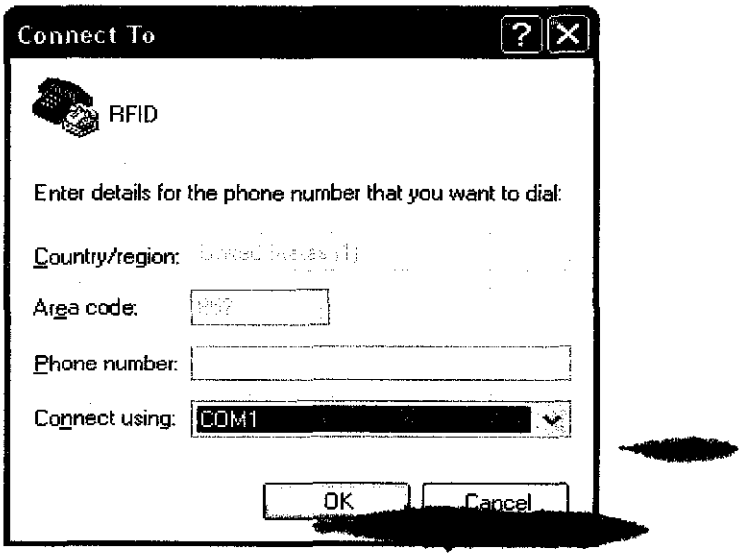
Appendix 9: Startup

Plug the receiver to the PC com port. No power is required.
Place a transmitter around 1 meter away from the receiver.

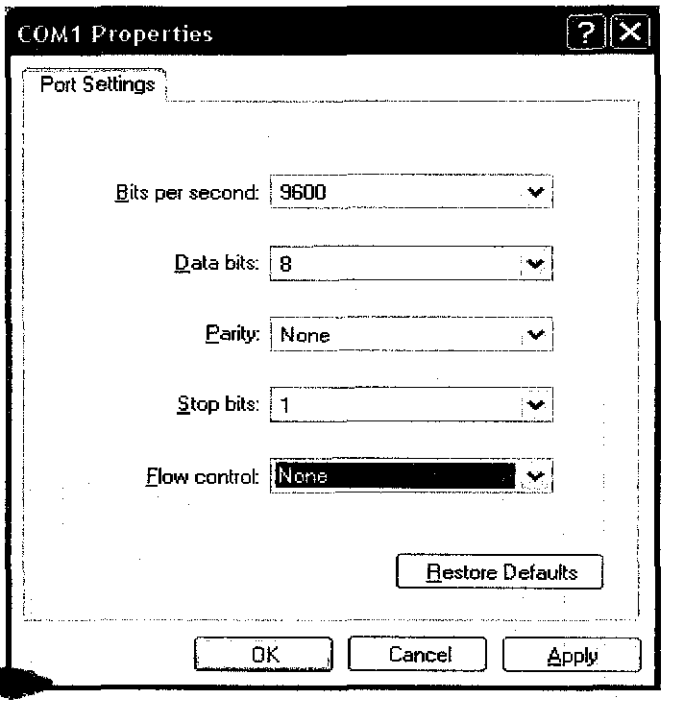
From Start manual, select Programs > Accessories > Communications > HyperTerminal



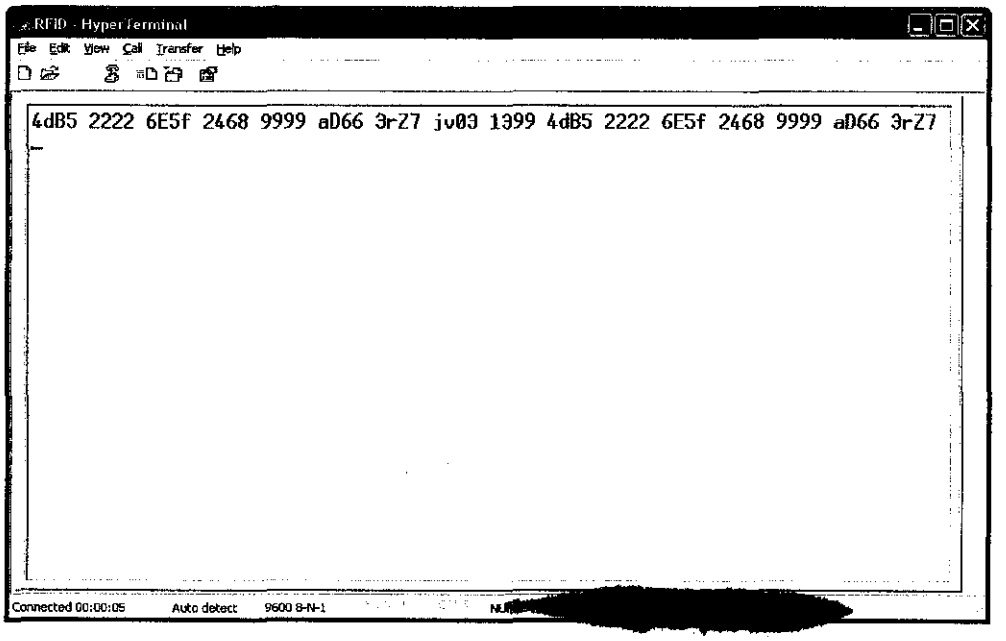
Enter a connection name, e.g. RFID



Select the com port name (Connect using) where you connected the receiver. In this project, select the comport 5 for connecting the receiver.



Bits per second MUST be 9600, Data bits MUST be 8, Parity MUST be None, Stop bits MUST be 1 and Flow control MUST be None.



You should see the 4 characters codes and the same code will keep on coming up for every 2.5 seconds (not exactly 2.5 seconds, it is an intended design) if the transmitters are in range.

Appendix 10: Source Code

Form 1: Interface

```
Private Sub cmdHistory1_Click()
Form5.Show
Form6.Hide
End Sub

Private Sub cmdHistory2_Click()
Form6.Show
Form1.Hide
End Sub

Private Sub Image4_Click()
Form1.Hide
Form4.Show
End Sub

Private Sub Logout_Click()
Form1.Hide
End Sub

Private Sub rfiddtct_Click()
Form1.Hide
Form3.Show
End Sub

Private Sub Timer1_Timer()
Label2.Caption = Time
Label3.Caption = Date
End Sub

Private Sub trackin_Click()
Form1.Hide
Form2.Show
End Sub
```

Form 3: RFID Real Time Tracking

```
Option Explicit
Dim ws As Workspace
Dim db As Database
Dim rs As Recordset
Dim ws1 As Workspace
Dim db1 As Database
Dim rs1 As Recordset
Dim chckCard As Recordset
Dim dbEnter As Database
Dim confirm
Public Aline As String
Public flagIn As Boolean

Private Sub btnExit_Click()
Set dbEnter = OpenDatabase(App.Path & "\student.mdb")
Set chckCard = dbEnter.OpenRecordset("SELECT * FROM student_info WHERE RFID LIKE '" & Aline & "'")
txtRFID.Text = ""
txtName.Text = ""
txtMatrik.Text = ""
txtCourse.Text = ""
txtName.Text = ""
txtAddress.Text = ""
txtTimeIn.Text = ""
txtTimeOut.Text = ""

Set chckCard = dbEnter.OpenRecordset("student", dbOpenTable)

End Sub
Private Sub btnAreaOne_Click()
Form5.Show
End Sub

Private Sub btnAreaTwo_Click()
Form6.Show
End Sub

Private Sub cmdCancel_Click()
Form3.Hide
Form1.Show
End Sub

Private Sub cmdDisconnect_Click()
If MSComm1.PortOpen = True Then
   MSComm1.PortOpen = False
   'cmdConnect.Enabled = True
   cmdDisconnect.Enabled = False
   'cbCommPort.Enabled = True
End If
End Sub

Private Sub Form_Load()

'frmTopup.Top = mdiAdmin.ScaleHeight / 19
'frmTopup.Left = mdiAdmin.ScaleWidth / 3

txtName.Enabled = False
txtRFID.Enabled = False
txtCourse.Enabled = False
txtEmail.Enabled = False
txtAddress.Enabled = False
txtMatrik.Enabled = False
txtTimeIn.Enabled = False
txtTimeOut.Enabled = False
```

```
On Error GoTo err_exit
With MSComm1

If .PortOpen = False Then
   .CommPort = "9"
   .Settings = "9600,n,8,1"
   .RTSEnable = True
   .RThreshold = 1
   .InputLen = 1
   .PortOpen = True
End If

End With

Exit Sub
err_exit:
MsgBox "Unable to open Comm Port. The Comm Port is either doesn't exist or is being used by other application.", _
        vbCritical, "Comm Port Error"

End Sub

Private Sub Pass()

Set ws = DBEngine.Workspaces(0)
Set db = ws.OpenDatabase(App.Path & "\student.mdb")
Set rs = db.OpenRecordset("hist_area1", dbOpenTable)

Set ws1 = DBEngine.Workspaces(0)
Set db1 = ws.OpenDatabase(App.Path & "\student.mdb")
Set rs1 = db.OpenRecordset("hist_area2", dbOpenTable)

Set dbEnter = OpenDatabase(App.Path & "\student.mdb")
Set chckCard = dbEnter.OpenRecordset("SELECT * FROM student_info WHERE RFID LIKE '" & Aline & "'")

Call lvelDetect

End Sub

Private Sub MSComm1_OnComm()
Dim Achar As String

Achar = MSComm1.Input
If Not Achar = Chr$(2) Then
   If Not Achar = vbCr Then
      If Not Achar = vbLf Then
         If Achar = Chr$(3) Then
            Call Pass
            Aline = ""
         Else

          Aline = Aline & Achar
         End If
      End If
   End If
End If

End Sub

Private Sub Updates()
txtRFID.Enabled = True
txtRFID.Text = chckCard("RFID")

txtName.Enabled = True
txtName.Text = chckCard("Name")

txtCourse.Enabled = True
txtCourse.Text = chckCard("Course")
```

```
txtMatrik.Enabled = True
txtMatrik.Text = chckCard("Matrik")

txtEmail.Enabled = True
txtEmail.Text = chckCard("Email")

txtAddress.Enabled = True
txtAddress.Text = chckCard("Address")

txtTimeIn.Enabled = True
txtTimeIn.Text = Now()

Call Edit

End Sub

Private Sub Timer1_Timer()
lblTime.Caption = " " & Format(Now, "dd/mm/yyyy") & "   " & _
                  Format(Now, "hh:mm:ss AM/PM")
End Sub

Public Function Edit()

chckCard.Edit

chckCard("TimeIn") = Now()
chckCard("lvlDetect") = 1
chckCard("AreaOne") = 1
chckCard("AreaTwo") = 0

chckCard.Update

rs.AddNew
rs("Name") = txtName.Text
rs("TimeIn") = Now()
rs.Update

End Function
Public Function edit2()

chckCard.Edit

chckCard("TimeOut") = Now()
chckCard("lvlDetect") = 0
chckCard("AreaOne") = 0
chckCard("AreaTwo") = 1

chckCard.Update

rs1.AddNew
rs1("Name") = txtName.Text
rs1("TimeIn") = Now()
rs1.Update

End Function


Private Sub lvelDetect()

If chckCard("lvlDetect") = 0 Then
   Call Updates
ElseIf chckCard("lvlDetect") = 1 Then
   Call Updates2
```

```
End If
End Sub
Private Sub Updates2()

txtRFID.Enabled = True
txtRFID.Text = chckCard("RFID")

txtName.Enabled = True
txtName.Text = chckCard("Name")
txtCourse.Enabled = True
txtCourse.Text = chckCard("Course")

txtMatrik.Enabled = True
txtMatrik.Text = chckCard("Matrik")

txtEmail.Enabled = True
txtEmail.Text = chckCard("Email")

txtAddress.Enabled = True
txtAddress.Text = chckCard("Address")

txtTimeIn.Enabled = True
txtTimeIn.Text = chckCard("TimeIn")

txtTimeOut.Enabled = True
txtTimeOut.Text = Now()

Call edit2

End Sub
```

Form 4: Add new information form

```
Option Explicit

Dim ws As Workspace
Dim db As Database
Dim rs As Recordset
Dim rs1 As Recordset
Dim max As Long
Dim i As Long
Dim errormsg
Dim dbadd As Boolean
Dim dbedit As Boolean
Public Aline As String

Public Function add()

If txtRFID.Text = vbNullString Or _
txtName.Text = vbNullString Or _
txtMatrik.Text = vbNullString Or _
txtCourse.Text = vbNullString Or _
txtAddress.Text = vbNullString Or _
txtEmail.Text = vbNullString Then
errormsg = MsgBox("All Fields Must Contain Data", vbCritical, "Error")
   Exit Function

End If
```

```
rs.AddNew
rs("Name") = txtName.Text
rs("RFID") = txtRFID.Text
rs("Matrik") = txtMatrik.Text
rs("Course") = txtCourse.Text
rs("Address") = txtAddress.Text
rs("Email") = txtEmail.Text

rs.Update
txtRFID.Text = vbNullString
txtRFID.Enabled = False
txtName.Text = vbNullString
txtName.Enabled = False
txtMatrik.Text = vbNullString
txtMatrik.Enabled = False
txtEmail.Text = vbNullString
txtEmail.Enabled = False
txtAddress.Text = vbNullString
txtAddress.Enabled = False
txtCourse.Text = vbNullString
txtCourse.Enabled = False
'txtSearch.Text = vbNullString
btnSave.Enabled = False
btnCancel.Enabled = False
btnNew.Enabled = True
btnClose.Enabled = True
btnEdit.Enabled = True
btnDelete.Enabled = True
'list

End Function

Private Sub btnCancel_Click()
txtRFID.Text = vbNullString
txtRFID.Enabled = False
txtName.Text = vbNullString
txtName.Enabled = False
txtMatrik.Text = vbNullString
txtMatrik.Enabled = False
txtEmail.Text = vbNullString
txtEmail.Enabled = False
txtAddress.Text = vbNullString
txtAddress.Enabled = False
txtCourse.Text = vbNullString
txtCourse.Enabled = False

btnSave.Enabled = False
btnCancel.Enabled = False
btnNew.Enabled = True
btnClose.Enabled = True
btnEdit.Enabled = True
btnDelete.Enabled = True

Set rs = db.OpenRecordset("student_info", dbOpenTable)

'list
End Sub

Private Sub btnDelete_Click()

errormsg = MsgBox("Are You Sure You Want To Delete This Record", vbYesNo, "Delete Record")

If errormsg = vbYes Then

rs.Delete
Set rs = db.OpenRecordset("student", dbOpenTable)
```

```
txtMatrik.Enabled = False
txtEmail.Text = vbNullString
txtEmail.Enabled = False

txtAddress.Text = vbNullString
txtAddress.Enabled = False
txtCourse.Text = vbNullString
txtCourse.Enabled = False
btnSave.Enabled = False
btnCancel.Enabled = False
btnNew.Enabled = True
btnClose.Enabled = True
btnEdit.Enabled = True
btnDelete.Enabled = True
Else
Exit Sub
End If
End Sub
Private Sub cmdDisconnect_Click()
If MSComm1.PortOpen = True Then
   MSComm1.PortOpen = False
   'cmdConnect.Enabled = True
   cmdDisconnect.Enabled = False
   'cbCommPort.Enabled = True
End If
End Sub
Private Sub cmdHome_Click()
Form4.Hide
Form1.Show
End Sub
Private Sub Form_Load()
'frmUserMng.Left = mdiAdmin.ScaleWidth / 3

Set ws = DBEngine.Workspaces(0)
Set db = ws.OpenDatabase(App.Path & "\student.mdb")
Set rs = db.OpenRecordset("student_info", dbOpenTable)

txtName.Enabled = False
txtRFID.Enabled = False
txtCourse.Enabled = False
txtEmail.Enabled = False
txtAddress.Enabled = False
txtMatrik.Enabled = False
'list

On Error GoTo err_exit
With MSComm1

If .PortOpen = False Then
   .CommPort = "9"
   .Settings = "9600,n,8,1"
   .RTSEnable = True
   .RThreshold = 1
   .InputLen = 1
   .PortOpen = True
End If
End With

Exit Sub
err_exit:
MsgBox "Unable to open Comm Port. The Comm Port is either doesn't exist or is being used by other application.", _
        vbCritical, "Comm Port Error"
```

```
End Sub
Private Sub btnEdit_Click()

txtName.Enabled = True
txtRFID.Enabled = True
txtEmail.Enabled = True
txtMatrik.Enabled = True
txtAddress.Enabled = True
txtCourse.Enabled = True
btnNew.Enabled = False
btnDelete.Enabled = False
btnEdit.Enabled = False
btnClose.Enabled = False
btnSave.Enabled = True
btnCancel.Enabled = True

dbedit = True

End Sub


Public Function Edit()

If txtRFID.Text = vbNullString Or _
txtName.Text = vbNullString Or _
txtMatrik.Text = vbNullString Or _
txtCourse.Text = vbNullString Or _
txtAddress.Text = vbNullString Or _
txtEmail.Text = vbNullString Then
   errormsg = MsgBox("All Fields Must Contain Data", vbCritical, "Error")
   Exit Function
End If

rs.Edit

rs("Name") = txtName.Text
rs("RFID") = txtRFID.Text
rs("Matrik") = txtMatrik.Text
rs("Course") = txtCourse.Text
rs("Address") = txtAddress.Text
rs("Email") = txtEmail.Text

rs.Update

txtRFID.Text = vbNullString
txtRFID.Enabled = False
txtName.Text = vbNullString
txtName.Enabled = False
txtMatrik.Text = vbNullString
txtMatrik.Enabled = False
txtEmail.Text = vbNullString
txtEmail.Enabled = False
txtAddress.Text = vbNullString
txtAddress.Enabled = False
txtCourse.Text = vbNullString
txtCourse.Enabled = False
'txtSearch.Text = vbNullString
btnSave.Enabled = False
btnCancel.Enabled = False
btnNew.Enabled = True
btnClose.Enabled = True
btnEdit.Enabled = True
btnDelete.Enabled = True

Set rs = db.OpenRecordset("student", dbOpenTable)
List
End Function

Private Sub btnClose_Click()
If MSComm1.PortOpen = True Then
   MSComm1.PortOpen = False
End If
```

```
'Unload Me
'frmUserMng.Hide
Form4.Hide
Form1.Show
End
End Sub
Private Sub btnNew_Click()
txtRFID.Text = vbNullString
txtMatrik.Text = vbNullString
txtAddress.Text = vbNullString
txtEmail.Text = vbNullString
txtName.Text = vbNullString
txtCourse.Text = vbNullString


txtName.Enabled = True
txtAddress.Enabled = True
txtRFID.Enabled = False
txtEmail.Enabled = True
txtCourse.Enabled = True
txtMatrik.Enabled = True
btnNew.Enabled = False
btnDelete.Enabled = False
btnEdit.Enabled = False
btnClose.Enabled = False
btnSave.Enabled = True
btnCancel.Enabled = True

dbadd = True
End Sub
Private Sub btnSave_Click()

If dbadd = True Then
   Call add
Else
  If dbedit = True Then
    Call Edit
End If
End If
End Sub

Private Sub MSComm1_OnComm()
Dim Achar As String

Achar = MSComm1.Input
If Not Achar = Chr$(2) Then
   If Not Achar = vbCr Then
      If Not Achar = vbLf Then
         If Achar = Chr$(3) Then
            txtRFID = Aline
            'Call Pass
            'Aline = ""
         Else
            Aline = Aline & Achar
         End If
      End If
   End If
End If

End Sub
```

Form 5: History Area 1

```
Private Sub cmdClose_Click()
Form5.Hide
Form3.Show
End Sub

Private Sub cmdHome_Click()
Form1.Show
Form5.Hide
End Sub

Private Sub DBGrid1_DblClick()
CommonDialog1.ShowOpen
DBGrid1.Columns(3) = CommonDialog1.FileTitle
rs.Refresh
End Sub
Private Sub Form_Load()
rs.DatabaseName = App.Path & "\student.mdb"
rs.RecordSource = "hist_area1"
rs.Refresh

End Sub
```

Form 6: History Area 2

```
Private Sub cmdClose_Click()
Form6.Hide
Form3.Show
End Sub

Private Sub cmdHome_Click()
Form6.Hide
Form1.Show
End Sub

Private Sub DBGrid1_DblClick()
CommonDialog1.ShowOpen
DBGrid1.Columns(3) = CommonDialog1.FileTitle
rs3.Refresh
End Sub

Private Sub Form_Load()
rs3.DatabaseName = App.Path & "\student.mdb"
rs3.RecordSource = "hist_area2"
rs3.Refresh

End Sub
```