RFID BASED SECURITY SYSTEM FOR VEHICLE

NORZIKRI BIN SAIRI

Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Automotive Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2010

ABSTRACT

Lacking of security in the car lead the higher number of reported stolen car. By using RFID as additional security might be reduce the number of stolen vehicle. The system will act as second key to vehicle when the owner wants to start or turn on their vehicle. The objective of this system is to act as additional passive safety for the vehicle. The main components of the system are PIC, RFID reader and tag. All of the components will be assembled according to the design. Then, the PIC will be programmed suit to the application which is to make the PIC send a high signal to the LED. This LED will be modified to the relay to make it possible to the real world application. When the tag is place on the reader, the reader will read and send the data to PIC. The PIC will analyze the data which the serial number of that card and then compare with the number at the PIC itself. If the ID is correct, the user can start their car but if the wrong ID, they cannot start the engine. The result shows that the LED is on when the correct tag is put on the RFID reader. As conclusion, this system can be proposed in the automotive industry as a one solution of vehicle theft.

ABSTRAK

Kekurangan sistem sekuriti pada kenderaan menjurus kepada jumlah laporan kecurian kereta yang lebih tinggi. Dengan menggunakan RFID sebagai keselamatan tambahan boleh mengurangkan jumlah kecurian kenderaan. Sistem ini akan bertindak sebagai kunci kedua untuk kenderaan ketika pemilik kenderaan ingin memulakan atau menghidupkan kenderaan mereka. Tujuan utama sistem ini adalah untuk bertindak sebagai keselamatan pasif tambahan untuk kenderaan. Komponen utama sistem ini adalah PIC, pembaca RFID dan tag. Semua komponen yang terlibat akan disambungkan seperti dalam rekaan. Kemudian, PIC akan diprogramkan untuk aplikasi yang membuatkan PIC menghantar isyarat tinggi untuk LED. LED ini akan diubahsuai kepada penggunaan geganti untuk membolehkannya digunakan di dalam industri. Ketika tag RFID diletakkan ditempat pembaca RFID, pembaca akan membaca dan menghantar data ke PIC. PIC kemudiannya akan menganalisa data yakni nombor siri kad itu dan kemudian membandingkannya dengan nombor siri di dalam PIC itu sendiri. Jika ID benar, pengguna boleh mula kereta mereka tetapi jika ID yang salah, mereka tidak dapat menghidupkan kenderaan tersebut. Keputusan projek menunjukkan bahawa LED menyala apabila tag yang betul diletakkan pada pembaca RFID. Sebagai kesimpulan, sistem ini boleh dicadangkan dalam industri otomotif sebagai salah satu penyelesaian kecurian kenderaan.

TABLE OF CONTENTS

EXAMINER'S DECLARATION		ii
SUPERVISOR'S DECLARATION		iii
STUDENT'S DECLARATION		iv
DEDICATION		v
ACKNOWLEDGEMENT		vi
ABSTRACT		vii
ABSTRAK		viii
TABLE OF CONTENTS		ix
LIST OF TABLES		xi
LIST OF FIGURES		xii
LIST OF SYMBOLS		xiv
LIST OF ABBREVIATIONS		xv
CHAPTER 1	**INTRODUCTION**	
1.1	Project Background	1
1.2	Problem Statement	3
1.3	Project Objective	3
1.4	Scope of Project	3
CHAPTER 2	**LITERATURE REVIEW**	
2.1	Introduction	5
2.2	History of RFID	5
2.3	RFID component system	7
	2.3.1 RFID tags	7
	2.3.1.1 Passive	7
	2.3.1.2 Semi – Passive	8
	2.3.1.3 Active Tags	8
	2.3.2 RFID reader	10
	2.3.3 Antenna	11
	2.3.4 Parameter Requirement	12
	2.3.4.1 Optimal Placing	12
	2.3.4.2 Optimal Design	12
	2.3.4.3 Speed of reading	13
	2.3.4.4 Security/Safety	13
	2.3.4.5 Pricing	13
	2.3.4.6 Programming	13

CHAPTER 3 METHODOLOGY

3.1 Introduction 14

3.2 Design Cycle 14

3.3 Flow Chart 15

3.4 Proposed RFID Block Diagram 17

3.5 Actual Block Diagram 18

3.6 Schematic Diagram 19

3.6.1 Hardware Implementation 19

3.6.1.1 RFID Reader and tags 21
3.6.1.2 PIC 22
3.6.1.3 Liquid Crystal Display (LCD) 24
3.6.1.4 Other Electronic Part 25

3.5.2 Software Implementation 27

3.7 Work Flow Chart 29

CHAPTER 4 RESULT AND DISCUSSION

4.1 Introduction 31

4.2 Hardware Test 31

4.3 Adaptation 35

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion 38

5.2 Recommendations 38

5.2.1 Using writable RFID tag 39
5.2.2 Integrate the system with GPS or GSM system 39
5.2.3 Using an active RFID as a marker for vehicle 39

REFERENCES 40

APPENDIX A1 41

APPENDIX A2 42

APPENDIX B1 43

LIST OF TABLES

Table no.	Title	Page
2.1	RFID class frequency	6
2.2	Comparison between tags type	9
3.1	Specification of PIC16F876A	23
3.2	Pin connection for LCD	25

LIST OF FIGURES

Figure no.	Title	Page
1.1	Number of car lost for several years.	2
2.1	Example of passive tag	8
2.2	Example of semi-passive tag	8
2.3	Example of active tag (miniature)	9
2.4	RFID reader (USB connector)	10
2.5	Examples of (a) tag antenna and (b) reader antenna	11
2.6	Examples of active reader antenna	12
3.1	Design cycle of product	14
3.2	Flow chart for this project	16
3.3	Proposed block diagram	17
3.4	Actual block diagram	18
3.5	Proposed schematic diagram for car starting system	18
3.6	Schematic diagram for the project	20
3.7	RFID reader	21
3.8	RFID tags (keychains and cards)	22
3.9	PIC16F876A functional block diagram	23
3.10	LCD display	24
3.11	Schematic diagram for power supply	26
3.12	Schematic diagram for LED as output	26
3.13	User interface of MPLAB	27
3.14	User interface of WinPIC800	28
3.15	Work flow chart of the system	29
4.1	Assembled circuit.	32

4.2	First user, Dr. Yusnita	33
4.3	Second user, Cik Mimi	33
4.4	Instruction after verifying the user (correct ID)	34
4.5	Invalid ID	35
4.6	Proposed schematic diagram for car starting system	36
4.7	Schematic diagram for relay function	36
4.8	Testing of modification by using relay	37

LIST OF SYMBOLS

MHz	Mega Hertz
kHz	Kilo Hertz
m	meter
GHz	Giga Hertz
mA	miliampere

LIST OF ABBREVIATIONS

RFID	Radio Frequency Identification
IC	Integrated Circuit
RF	Radio Frequency
EPC	Electronic Product Code
CMOS	Complementary metal–oxide–semiconductor
ID	Identification
EEPROM	Electrically Erasable Programmable Read-Only Memory
EM	Electromagnetic
RS 232/485	Recommended Standard 232/485
USB	Universal Serial Bus
HF	High Frequency
ASIC	Application-Specific Integrated Circuit
PIC	Programmable Interface Controller
LF	Low Frequency
EMC	Electromagnetic Compatible
SRAM	Static Random Access Memory
I/O	Input/output
USART	Universal asynchronous receiver/transmitter
LCD	Liquid Crystal Display
RAM	Random Access Memory
AC	Alternative Current
DC	Direct Current
LED	Light Emitting Diode

GPS	Global Positioning System
GSM	Global System for Mobile Communication

CHAPTER 1

INTRODUCTION

1.1 Project Background

Every year, the number of car had been stolen increasing. The latest number of stolen is 74856 (Musliza, 2009). This is very serious problem to the owner of the car beside the insurance party.

This thing happens because of certain factor such as lack of security system, user negligence, and others. Because of the high demand of the some care and their part, the thief will choose the car depend on low security, high demand, more profit and easy to transport or disassemble. Basically the thief will start the car or drive the car (if already on) and the car will be hide at some place that only known among the member in the syndicate.

Hence, by using radio frequency identification, RFID in security, car theft will be decreased except the car is stealing by tow truck or forced by the thief.

The conventional security still does not reduce the statistic of stolen vehicle. Every year, the number of car lost is increasing as shown below.

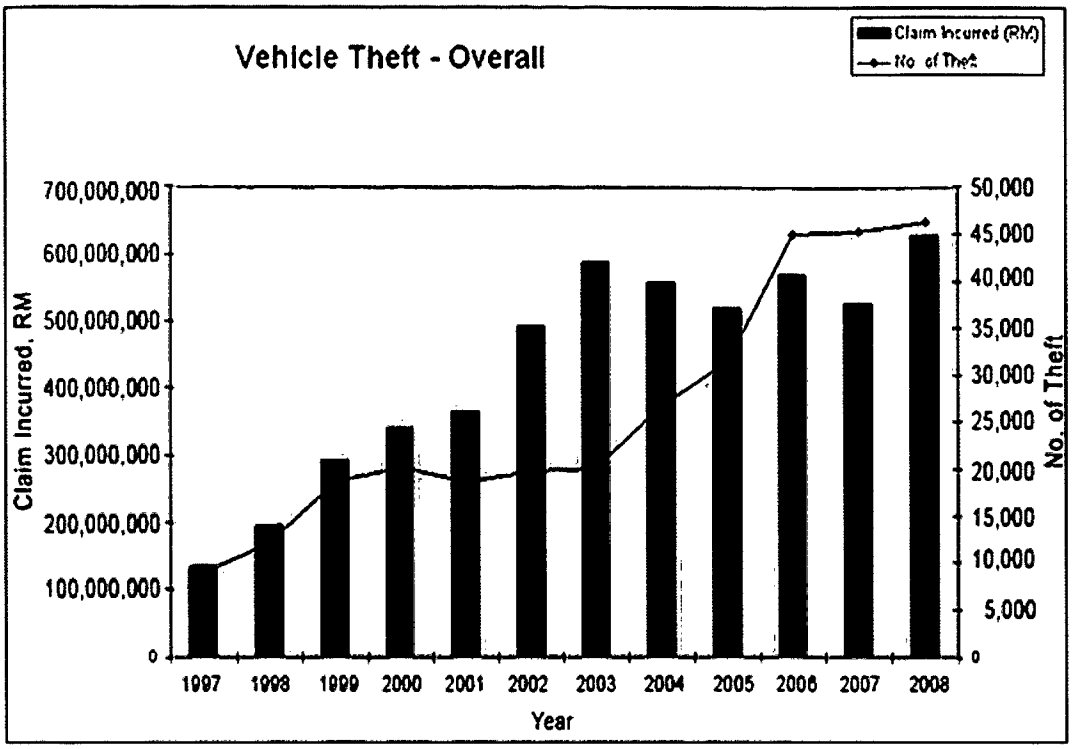


Figure 1.1: number of car lost for several years.

Source: PIAM (2009)

The total cost in insurance claim increasing because of the value of the car that insured, besides the total demand of the stolen car itself. This is the main cause why the total insurance claim is around approximately 6 billion for ten years ago (PIAM, 2009).

The purpose of this project might be able to solve some the stolen car case. Basically, users in Malaysia are lack in securing their car. Hence, by doing this project and then try to propose to the manufacturer, maybe the number of car lost can decrease in time.

This project will be use the RFID as the key to open the car and as a switch to turn on the engine. To open the car's lock, simply flashing the card at the reader and the locking system will unlock the lock for the door. The logic for the door locking system is

OR logic because user still can open via their keys. Second stage of system is when user wants to turn on the car. At their keys, there is a RFID chip embedded inside the key. When the key is around and place to the lock, RFID readers will read the tags and validate with the system. Once the validating is done, the engine can be on if the correct ID but cannot on if the key has a wrong ID. The system at the key is AND Logic. The keys and the tag must be correct in order to start the car.

1.2 Problem Statement

In order to complete this project, several problems might be occurred when completing some task. Some of the problems are:

i. There is certain problem in order to get best design of the security system
ii. The development for the project might be long and take time
iii. The controller might be failed when in test.
iv. The coding for the programmable integrated chip, PIC might be failed

1.3 Project objective

There are several objectives to achieve in this project. The objectives are:

i. To understanding the basic concept of RFID system and their function
ii. To design a car security system by using RFID
iii. To ensure the security system is practical, economical and attainable

1.4 Scope of Project

This project will be separated to three different stages. This project is dividing into different stages because it can be a guidance to do the project accordingly and follow the schedule. The stages are:

First stage : design the suitable system for the security of the vehicle

Second stage : assemble all the part which is RFID reader, PIC microcontroller and others

Third stage : test phase which the system will be tested and the result will be analyzed and the improvement will be done.

This security system is limited to car only. Other vehicle will be taken in consideration to apply the system. This is because the car is the major percentage of the total lost for insurance company compare to other vehicle.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will give a brief information about the findings on several topic which is considers important to this research.

Overall the RFID Society of Malaysia sees huge potential for application of the technology in manufacturing, road tax, the national identity card, other identification and security cards, in secure car parking, ticketing and payment systems, as well as for tracking the movement of children in shopping malls.

2.2 HISTORY OF RFID

Radio Frequency Identification, RFID is a system in which the identification data of objects is stored in IC chips, then placed on, or embedded in objects, which then transmit data into the system, via wireless communication. The birth of RFID is in October 1948 after publication of paper by Harry Stockman – "Communications by Means of Reflected Power". Some kind of popular system back that time is Identification Friend or Foe. It was one of the first applications of RFID technology (Paret, 2005).

At 1970s, universities, government laboratories and companies were actively engaged in development of practical applications of RFID such as animal tracking, toll gating, and factory automation and so on. During 1980s, there is a mass deployment of

RFID technology where US interested on transportation and access control while Europe interest on animal tagging, industrial applications and toll roads.

Advances in microelectronics, embedded software and microwave-circuit integration are opening door to a new wireless system and expanding the application field for RFID.

The operation of RFID is dependable; when a tag senses wireless Radio Frequency (RF) waves from the reader, the control circuit in the tag transfers the energy of the wireless waves into internal power. The tag has a built-in, RF launch module and control circuit, which transmits back the Electronic Product Code (EPC), including commodity code, type, and date of manufacture with the built-in RF wireless wave. The RF of the tag signal will transmit stored data, on another frequency, in order to avoid interference of weak signals. The frequencies commonly used in RFID systems are introduced below:

Table 2.1: RFID class frequency

Frequency	Description
125–134 kHz	this is the low frequency application which allows the detection of RFID tags in a range of less than 0.5 m
13.56 MHz	this frequency allows the detection of RFID tags for a distance of up to 1.5 m. Applications within this bandwidth are for access and security
433–956 MHz	The frequency bandwidth is characterized as ultra-high frequencies. The frequencies at a range of 433 to 864 allow the detection of RFID tags for a distance of up to 100 m while the frequencies at a range of 865 to 956 MHz allow the detection of RFID tags for a distance which varies from 0.5 to 5 m. Applications within this bandwidth are for logistics.
2.45 GHz	This frequency enables an RFID reader to detect a tag from a distance of 10 m and is characterized as microwave frequency.

Source: Lehpamer (2008)

2.3 RFID component system

Basically, RFID contain most three different parts which is tag/transponder, receiver/ transmitter and computer subsystem. The detail of this part will discuss in next topic.

2.3.1 RFID tags

RFID tags are divided to three types which are passive, semi-passive and active.

2.3.1.1 Passive

No internal supply is needed. The electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the CMOS integrated circuit in the tag to power up and transmits a response. The antenna has to be designed to both collect powers from incoming signal and also to transmit the outbound backscatter signal. The response of the RFID tag is not just an ID number the tag can contain nonvolatile EEPROM for storing data. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Read-only tags most often operate as a license plate into a database, in the same way as linear barcodes reference a database containing modifiable product-specific information. The tradeoff is that they have shorter read ranges than active tags and require a higher-powered reader.

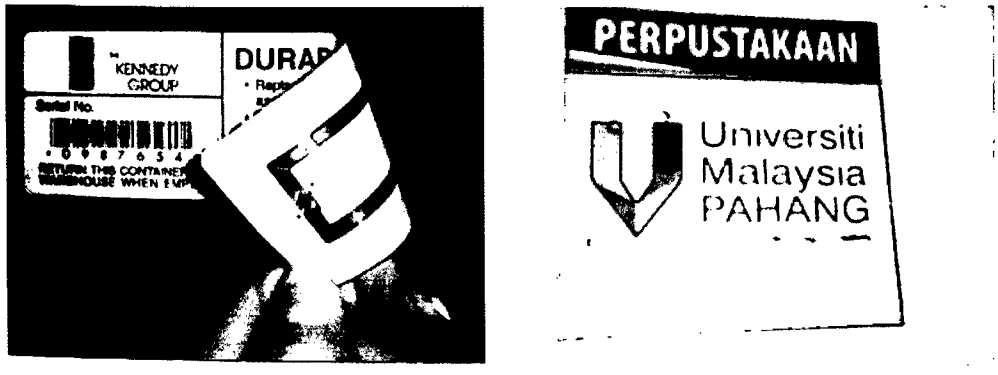


Figure 2.1: Examples of passive tag

2.3.1.2 Semi Passive

Similar to passive tag except for the addition of a small battery. This battery allows the tag IC to be constantly powered which removes the need of an aerial to be designed to collect power from the incoming signal. As semi passive tag is pre-energized, they can be read more reliably in this more difficult environment.

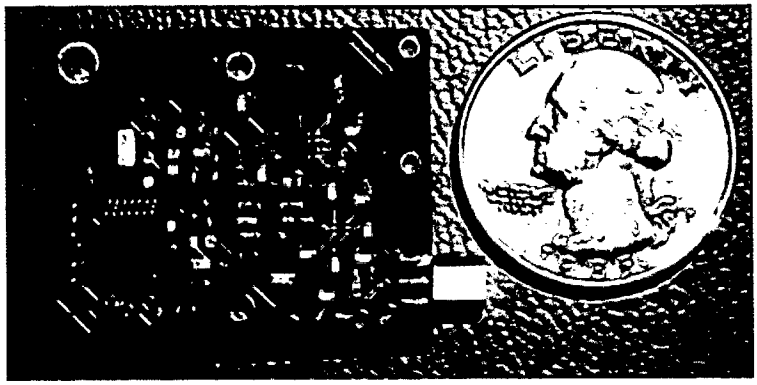


Figure 2.2: Example of semi-passive tag

Source: http://alumni.media.mit.edu/~matt/research.html (2007)

2.3.1.3 Active Tag

Active tag has their own internal power source which is used to power any ICs that generate the outgoing signal. They are more reliable (fewer errors) due to the ability for active tag to conduct a session with a reader. Because of their onboard power supply also transmit at higher power level than passive tags, allowing them to be more effective in "RF challenged" environments such as water, metal or at longer distances. A battery can live up to 10 years and have practical ranges of hundreds of meters. The tradeoff is greater size, greater cost, and a limited operational life (which may yield a maximum of 10 years, depending upon operating temperatures and battery type).

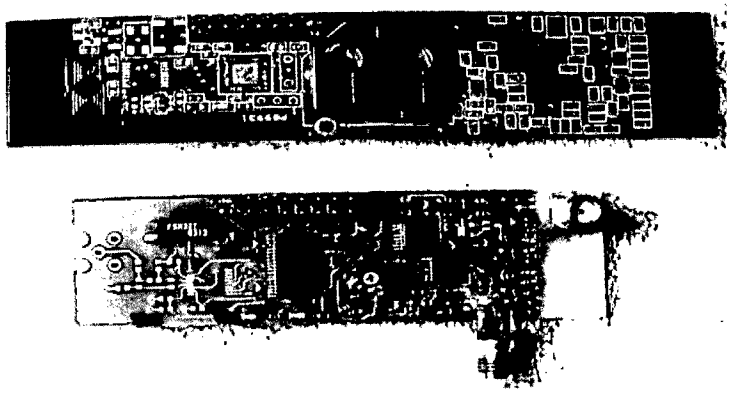


Figure 2.3: Examples of active tag (miniature)

Source: www.diytrade.com/china/4/products/2627378/RFID_active_Tag.html (2007)

Table 2.2: Comparison between tags type

Passive	Semi-passive	Active
No need a power. Get power from EM field	Power supply from small battery	Power supply from small battery
Close range/ proximity.	Higher range from passive but lower than active.	High because tag itself transmit the signal.
Antenna induce the energizing signal, the chip powered and send back modulated signal RF.	Same as passive but the chip is powered by battery.	Wake up tags system – sleep until activated by coded message from reader. Awake tag or beacon system – response to reader without coded message being required to switch the tag from sleep.
Slow	Moderate	Fast
Cheaper	Less expensive	Expensive
Small	Big	Big

2.3.2 RFID reader

RFID reader is the device to transmit and receive radio frequency signals, receive command from a host computer; passes data back to the host computer and as an interface to transfer data. A reader typically contains a radio frequency module which

is transmitter and receiver, a control unit and a coupling element to the transponder. In addition, many readers are fitted with an additional interface such as RS 232, RS 485 or USB to enable them to forward the data received to another system such as computer or robot control system.

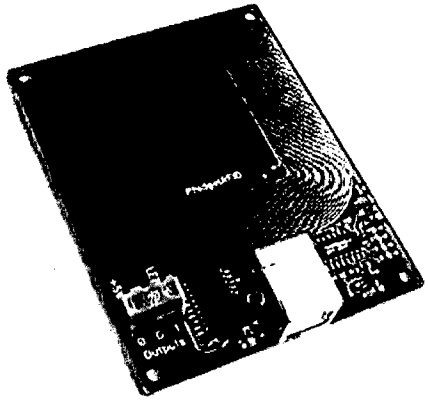


Figure 2.4: RFID reader (USB connector)

Source: Phidget (2007)

In all systems, the readers can be reduced to two fundamentals functional blocks which is the control systems and the HF interface, consisting of a transmitter and a receiver. The entire system is controlled by an external application via control commands. HF interface is shielded against undesired spurious emissions by tinplate housing. The control system comprises an ASIC module and microcontroller.

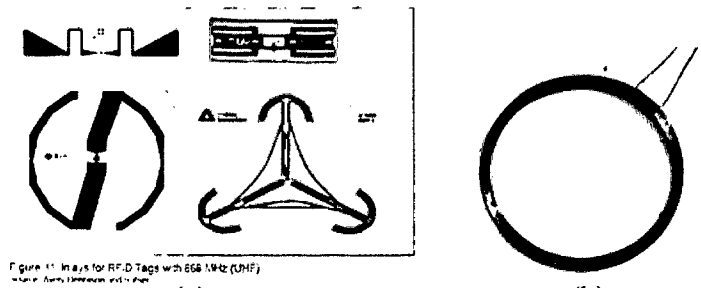
RFID readers usually come in four different types which is handheld, vehicle-mount, post-mount, and hybrid. The first three readers are dedicated to readings passive or active tags while the fourth types has the active/passive mode that allowing it to switch from the passive to active mode and vice versa. Both handheld and hybrid readers are more expensive compared to vehicle mount-mount and post-mount.

2.3.3 Antenna

The purpose of an antenna is to transmit RF from reader to tags and also received the RF signal from tag. The antenna is so important because the communication cannot happen without the proper antenna.

In order to get a better idea and performance, some of the design must be considered such as orientation of the antenna which is simple, one single antenna and complex which has more than one antenna. Next is gain. For a small gain, the communication will happen in the close range but if the antenna has a high gain, the communication can be happen at far range. Besides that, the shape and size are important to make the antenna is small but capable to communicate with high range.

Then, others consideration is the positioning of the antenna. This is important because RFID use electromagnetic to send the signal and the position is the key to make sure that the communication between tag and reader happen.



(a) (b)

Figure 2.5: Examples of (a) tag antenna and (b) reader antenna

Source: http://www.tootoo.com/d-rp14442623-RFID_Antenna/ (2007)

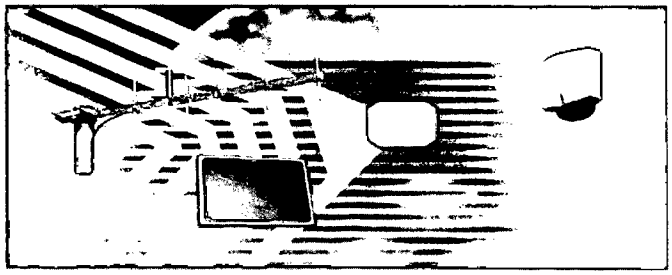


Figure 2.6: Examples of active reader antenna

Source: http://komoeyay.blogspot.com/2010/04/uhf-ultra-high-frequency-rfid-readers.html (2010)

2.4 Parameters requirement

This project will involve some parameter that needs to look when design and develop the project. The parameters are:

(a) Optimal placing
(b) Optimal design
(c) Speed of reading
(d) Security/safety
(e) Pricing
(f) Programming

2.4.1 Optimal placing

The location of the reader is the key point of the system. The suitable place will be search and the environment of the location must be taken care in order to maximize the performance of the RFID system.

2.4.2 Optimal design

The design of the system is important in order to make the product is success. Besides that, the design must be follow the rules and regulation that made by agencies or government in order to eliminate some causes or effect to the user.

2.4.3 Speed of reading

This is important as the RFID need time to read the tag, hence it is important to find the maximum and minimum and also the average mean time of RFID receiver read the tag.

2.4.4 Security/safety

In order to make the system can reduce the number of car lost; the security of the system is must be highest at all. Any slight problem in security can make a loophole to theft to bypass the security system.

2.4.5 Pricing

It is possible to make the system less expensive compare to other system. Because of the user are lack to spend the money to buy the security system, hence the price of this must be cheap enough and the manufacturer can install it into the car as standard part.

2.4.6 Programming

This is very hard because the programming is the heart of the system. The programming is secret enough in order to avoid the hackers to hack the system and change the code.