Degree Program in Information Technology

Bachelor's Thesis

Installation and Simulation of a Simple Parking Lot Management System

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Mr. ArtoToppinen, Principal Lecturer	

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Abstract

Thepurpose of this final project was to simulate a simple automatic management system of a parking lot. This simple parking lot management system includes a wireless security camera, RFID device, a computer and management software installed on the computer.

In this final project, firstly the theories of the IP security camera system and RFID system were studied.The applications of these two technologies in the parking lot management were taken a closer look at. Then these two systemswere built up and run them to make videos and record the information of RFID tags. Finally the wireless camera's longest range of transmission and the reading speed of Siemens Simatic RFID system were tested.

The results of this final project are four tables of testing data about the wireless camera's transmission ranges and Simatic RFID system's reading speed in different situations, analyzing the advantages and disadvantages of them.

Keywords

Parking lot, IP wireless security camera, RFID, Siemens Simatic RF manager.

Confidentiality

Public

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Abstract

Työn tarkoituksena oli simuloida yksinkertaista automaattista pysäköintipaikkajärjestelmää. Järjestelmä sisältää langattoman valvontakameran, RFID tunnistusjärjestelmän, tietokoneen ja järjestelmän hallintaohjelmiston. Pysäköintipaikkajärjestelmään kuuluu valvontakamera ja RFID tunnistusjärjestelmä. Tietokone ohjaa molempia järjestelmiä ja tallettaa luetut tiedot.

Päättötyön päämäärinä oli tutkia IP-valvontakameran toimintaa, kuinka rakentaa sen tietojärjestelmä ja käyttää järjestelmää valvontavideon tuottamiseen. Samoin tutkittiin RFID-järjestelmää, kuinka Siemens RFID-järjestelmä konfiguroitiin ja kuinka sillä luetaan RFID-tagit. Työssä testattiin langattoman kameran toimintasädettä ja myös RFID-järjestelmän tagin luentanopeutta.

Työssä esitetään tutkimuksen tulokset ja arvioidaan miten tarkasteltuja tekniikoita voidaan käyttää pysäköintipaikkajärjestelmän ohjaukseen.

Avainsanat

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As regards my final project, firstly I would like to thank my supervisor, Mr. ArtoToppinen. Before I completed this final project, he gave me all lab devices including an IP wireless camera, a wireless router, and Siemens Simatic RF devices. He also recommended some websites about Siemens Simatic to me. They were very helpful for my final project. Secondly, I would like to express myappreciation to Mr.Mohanmed I, Mursal. He gave me somesuggestions about the RFID part of my final project and taught me how to use the Simatic RF configuration software to scan RFID tags. I never forget the words he said “The best way is the simplest way.”

At last, thanks to my school, Savonia University of Applied Science. It supplied me a good study environment and an advanced lab for my final project.

Ningyuan Chen
21 September 2011
Kuopio, Finland

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Abbreviations

RFID
Radio Frequency Identification

CCTV
Closed Circuit Television

IP
Internet Protocol

LAN
Local Area Network

WLAN
Wireless Local Area Network

COM
Component Object Model

Hz
Hertz

MB
Megabyte

GB
Gigabyte

LED
Light-emitting diode

Cmd
Command Prompt

EPC
Electronic Power Conditioner

Wi-Fi
A mechanism for wirelessly connecting electronic devices

ALE
Application Level Events
48
ANT
Ants P2P

OSD
On-Screen Display

RS232
The traditional name for a series of standards for serial binary single-ended data and Control signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment).

Router
A device that forwards data packets between telecommunications networks, creating an overlay internetwork.

Tag
A unique identifier protocol used in internet technologies

1. Introduction

After the 1950s, personal cars started to become more and more important for humans' lives. At the present age in Europe, every 100 people have about 40 cars. From 1990s, in China, this number keeps increasing all the time. According to the statistics in June 2009, Every 1000 Chinese people had 30 cars. It seems not to be a very large number but the population of China is 1.3 billion, from it can be calculated, there were about 390,000,000 cars running on China's roads. (See **Figure 1.**)And this number wasmuch larger in 2011. Because of the increasing number of cars around the world, some industries and equipment which serve cars are becoming necessary and popular. For example, gas stations, washing stations, repairing stations, and parking lots are needed.

A parking lot is a cleared area which is used to park, manage and protect vehicles when people do not need to use them. As we know cars are traffic tools which possess big bodies. It is necessary to find a wide, safe and orderly space to put them when people go to companies, markets, schools and many other places by car.

The original parking lot was managed and protected artificially, but it wasdifficult to protect cars and record the amount and identification of cars. In modern society, this situation has been changed because humans invited RFID and camera. They use these two technologies to manage and protect parking lots. In other words, it can be said that humans have created a parking lot management system.

This purpose of this final project is to simulate a simple parking lot management system.**[1]**

Figure 1.A cars' world.

A parking lot management system is an intelligent system. (See **Figure 2.**)It is used for monitoring a parking lot, mark the identification of cars' owners, manage the information of cars and record the entering and exiting circumstances of cars. These four ones are main functions of a parking lot management system.

A parking lot management system includesthree parts: a security camera system, an RFID system and a control system.

The security camera system is responsible for monitoring a parking lot. It shoots the panorama of a parking lot and situations of entering and exiting, and then saves the videos into the management computer.

Other three functions belong to the RFID system. Through the RFID barrier, the RFID system reads and saves all kinds of information of the RFID tags of drivers. For example, a car enters the parking lot at 9:00, exits at 15:00, the car's owner is Mr. Brown, this information will be recorded and saved by the RFID system when Mr. Brown and his car pass the RFID barrier.

The control system is a software in the management computer, it controls the security camera system and the RFID system and stores all information they provide.**[2]**

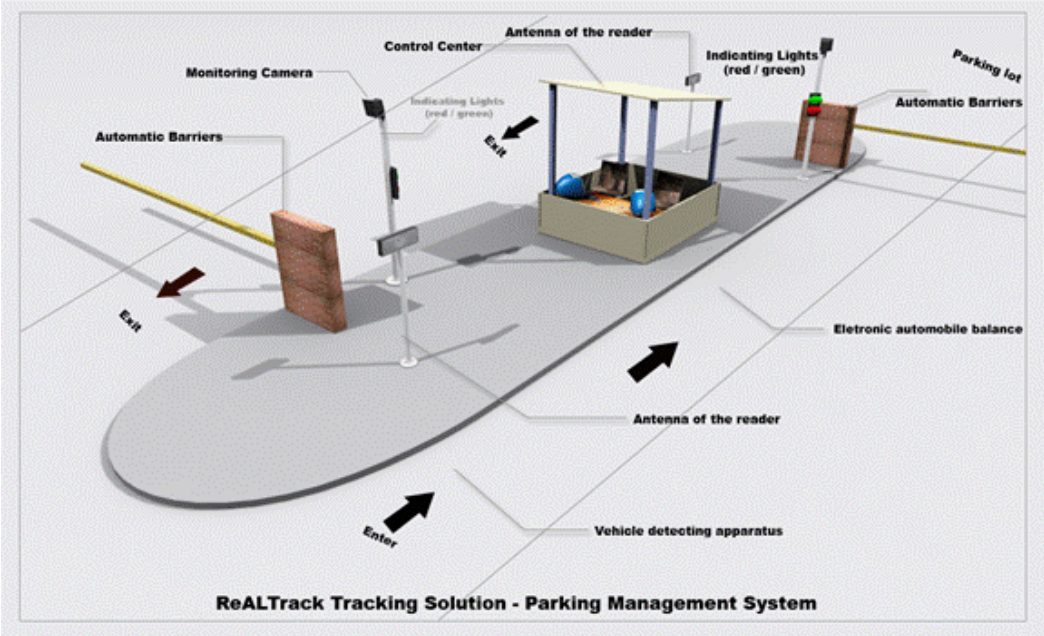

Figure 2. The schematic of a parking lot management system.**[8]**

In thisfinal project, firstly, parking lot management systemswere studied to getknowledge about IP wireless cameras and RFID.

Secondly, a simple IP wireless camera system was assembled.The system included an IP wireless camera, a laptop, a wireless router, an IP camera software and some cables. After installation had been completed, the system was runand the available distance between camera and router was tested.

Thirdly, Siemens Simatic RF660 Antennas and Reader and computer were connected in the school lab.Software named Siemens SimaticConfigurationwas used to switch on the antennas then these antennas can read different RFID tags. The software showed tags' IDs. The distance was tested and the speed of antennas was read.

Finally,the software, Siemens RF-manager, was used to simulate a simple RFID system of parking lot.

2.Security Camera System

2.1 Introducing the System

A Security Camera System which can also be called asaCCTVsystem can transmit video signals from cameras to monitors in a limited area. The security Camera System is usually used for crime prevention and prevalence, video art, industrial processes, traffic monitoring and transport safety. The first Security Camera System was created by Siemens AG of Germany in 1942. They used video tapes tosave and record the videos.(See **Figure 3.**)**[3]**

Figure 3. Security Cameras in a corner.**[9]**

In modern world, the computer's hard disk replaces with the video tape. Computer engineers have created professional software for security camera systems, besides saving videos, this software can also control and adjust direction, focal length, brightness and even color tones of the camera. It makes the Security Camera System more and more intelligent and operable.

Figure 4. All components of a modern security camera system.**[10]**

At the beginning of 21st Century, wireless technology became more and more universal. The Security Camera System introduced this technology for its development. Wireless technology helps Security camera System to run without cables and makes it more convenient.(See **Figure 4.**)

The Wireless Security Camera System is one kind of all security camera systems, It uses radio band to transmit video and audio signals from cameras to monitors. It doesnot need cables to transmit but at least one power cable. Even though some cameras have batteries to supply power, they are not popular because most security cameras need long-time and stable power supplies.

Figure 5.A wireless security camera. (Digital one)**[11]**

There are two kinds of Wireless Security Cameras: Analog Wireless Cameras and Digital Wireless Cameras. (See **Figure 5.**)Analog camera uses radio frequency to transmit signals. Its transmission distance is about 90 meters in a clear space, If the space has walls, closed doors and many big stuffs, the transmission may be stopped or hampered.(See **Figure 6.**)

There are three different frequency types of Wireless Security Cameras: 900MHz, 2.4GHz and 5.8GHz. Most wireless cameras choose 2.4GHz because it has longer range and bigger amount of transmission than 900MHz and it needs lower power than 5.8GHz.900Mhz is used on Wi-Fi because Wi-Fi is a WLAN which does nott need long range, and it will not be interfered Internet signals.

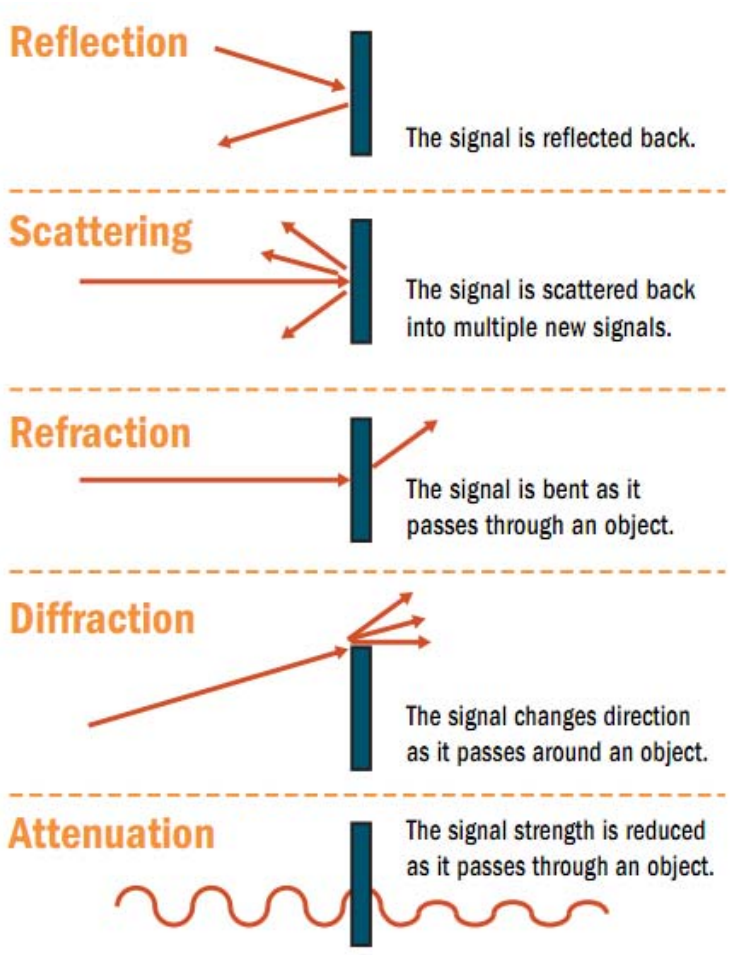

Figure 6. Range limit factors.**[12]**

Digital Wireless Cameras change analog video and audio signals to digital signals which are high-bandwidth radio frequencies. This kind of cameras have wider transmission ranges and higher quality videos. Because of the digital signals the cameras to change their focal distances and shooting directions can be controlled and commanded. **[4]**

2.2 Introducing the IP Camera and the Camera Software in the Final Project

In thisfinal project, a digital wireless security camera was used. It has WLAN connecting functions and a control software. It has an independent IP address and the IP address by a wireless router can be searched. This router connected to this computer. When it was found, the camera software can be used to connect and control it. This real-time videos transmitted from the IP camera can be seen.

Figure 7. The IP wireless camera I used in thisfinal project.

The IP wireless camera has two advantages: High speed transmission by Internet and all computers which have Internet connections can use it. The route was connected to Internet, and then used a computer with camera software connecting to the Internet to find the router IP address. The router can transmit the video signals received from the IP wireless camera to the computer by Internet. In other words, you can use every computer around the world connecting to the Internet to watch videos from the IP wireless camera, and the user can control the camera remotely if he or she has the administrator's name and password.

This camera has three wires.(See **Figure 7.)** The first one is an aerial on the back of the camera. It is in charge of sending video signals to the wireless router. The second one is a power wire; its function is connecting to power supply in order to give the camera electric power. The last one is a network cable. But the router is not a wireless router, and then connects the camera to the router by cable was connected.

Around the camera lens, there are many small lights. They are infrared lights. They can emit infrared. With their help, camera is able to shoot in the night or

dark places.

Figure 8. The Primary window of camera software

The camera software is installed from a CD. It is a only 5MB software installed into the folder" C:/windows/system32". When the user opens it, there will be a window which can show the IP address of camera. (See **Figure 8.)** Double click the IP address, it will open a Internet Explorer window, there is a login page shown in the window, type correct administrator's name and password, the controlling and setting interface will be opened.The brightness and tone of video can be controlled and adjusted. (See **Figure 9.**)

Figure 9. The Controlling and setting interface of camera software.**[13]**

In thisfinal project, the camera software has four independent screens for play real-time videos from four different cameras. But there was only one camera. The four cameras' IP addresses were shown in the primary window. (See **Figure 9.**) Double clicked different IP address and entered different camera's interface.

2.3 How to Install the System

For installing the IP wireless security camera system, it is necessary to have the following components:

- An IP wireless camera
- A computer
- A wireless router
- A network cable
- A power supply for the camera, the computer and the router
- A CD which has the camera software

Use the network wire to connect the computer and the wireless router. Put the camera in somewhere not very far from the wireless router. Connect the camera, the computer and the router to the power supply. Switch on all of them. When the operating system of computer starts to run, put the CD into CD drive of the computer. (See **Figure 10.**)

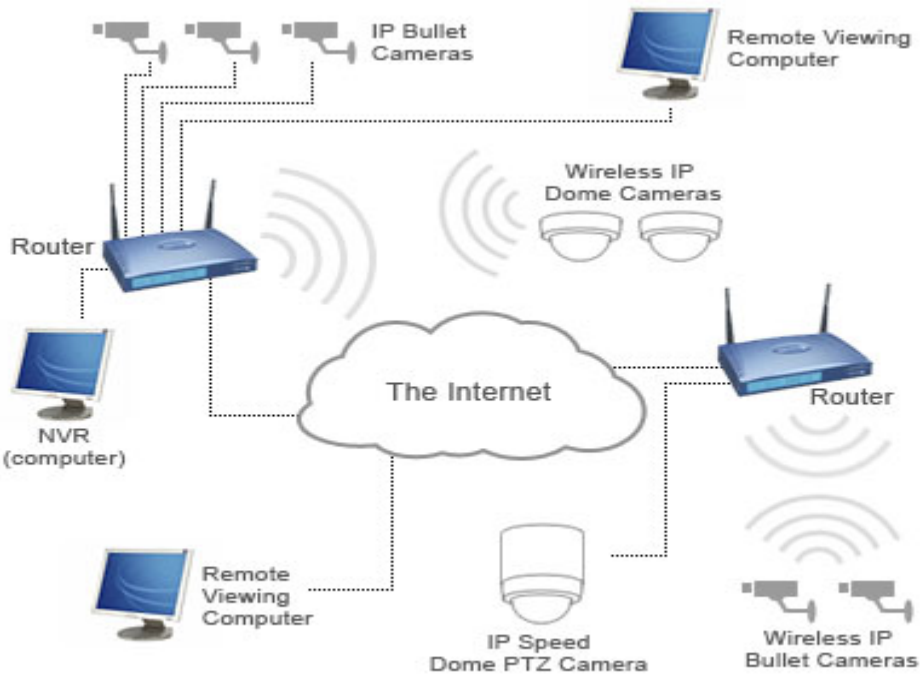

Figure 10. The schematic diagram of a wireless camera system.**[14]**

In thisfinal project, a laptop was used to install the software but when the first router was connected, the camera's IP address cannot be found in the window. It was necessary to change another router. This second one had more power than the first one so that the IP address was shown in the window when the software ran.

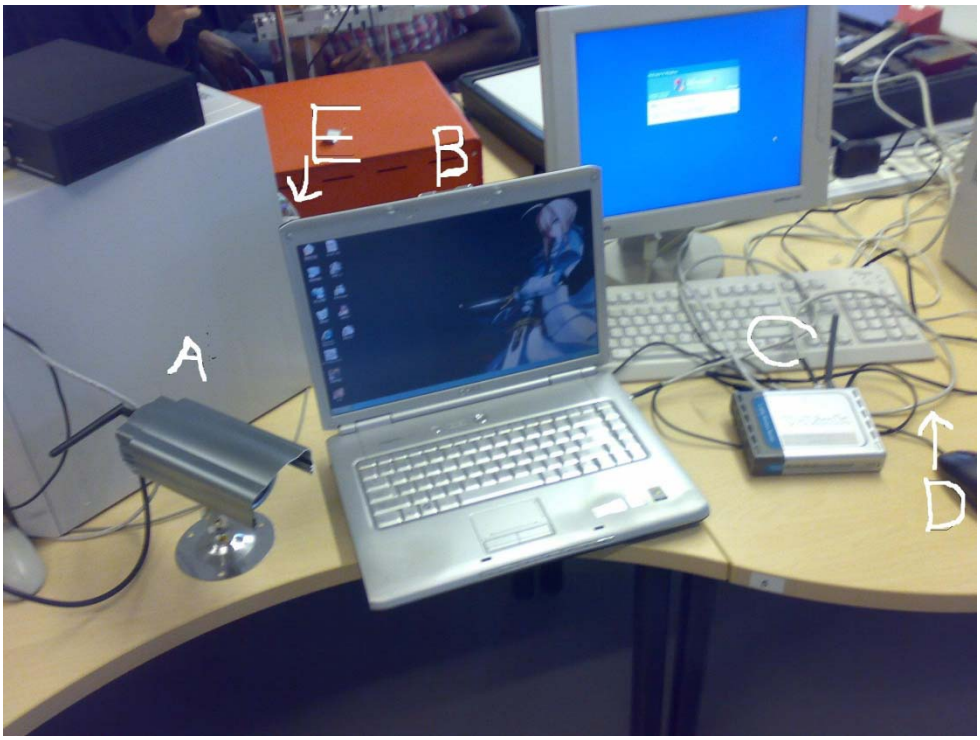

Figure 11. The view of the completed system in thisfinal project.

In **Figure 11**, A is the IP wireless camera. B is the laptop which has the camera software. C is the wireless router. (The second one.) The arrow of D points to the network cable which connected the laptop and the router. The arrow of E points to the power supply. However, there was no cable between laptop and camera, they used wireless connection.

Insert one end of the network cable into the network port of laptop,put the other end into the wireless router.

The reason why a network cable was used to connect the laptop and the camera was that the laptop does not have a wireless network driver. If the laptop has it, run the wireless network software and find the router's IP address, then click the "Connect" button. It will give same result.

When all the connections were complete, the camera would start to work. The LED light should be checked if it was working normally. The LED light is a small yellow light at the back of the camera and it will be lit.

After put the CD into the CD driver of the laptop, a dialog appears and asks if it is ready to install the camera software. Click the "Next" button to continue. (See **Figure 12.**)

Figure 12. The first dialog of installation

Then continue, the second dialog came, it told the user the installation was ready. Click the "Next" button. (See **Figure 13.)**Then it begins to install. The installation is fast. (It spends 10 seconds for installation.)

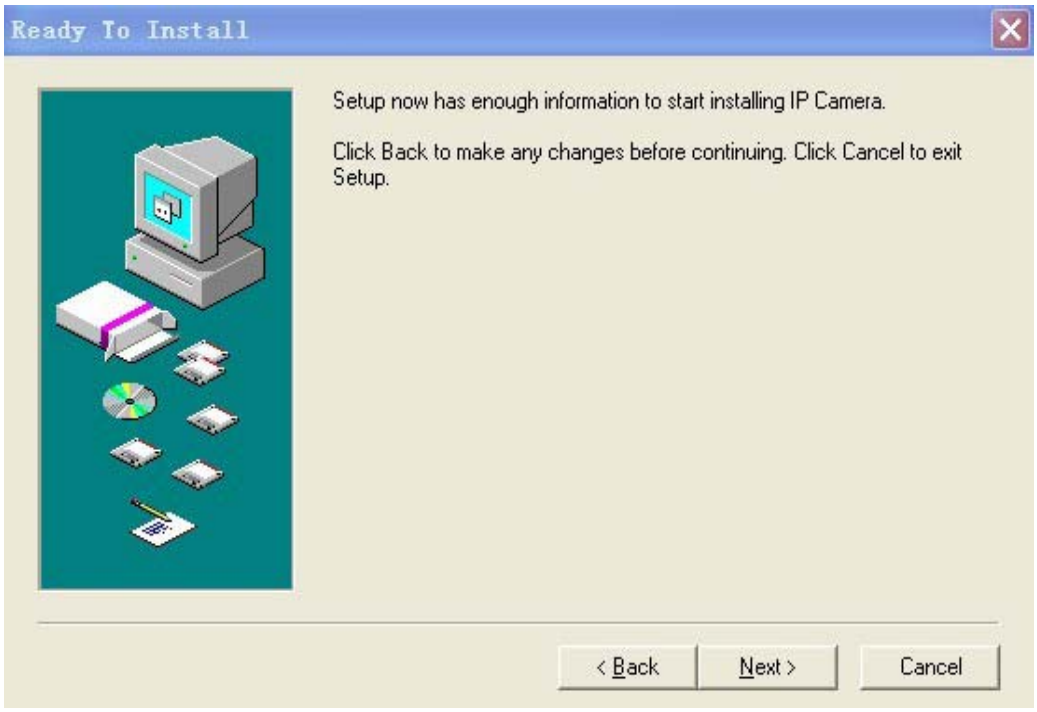

Figure 13. The second dialog of installation, click "Next", it starts to install.

2.4 How to Run and Configure the System.

When the camera softwareis installed completely, restartthe laptop. Then double click the “IP Camera Tool” icon on the desktop of the laptop.

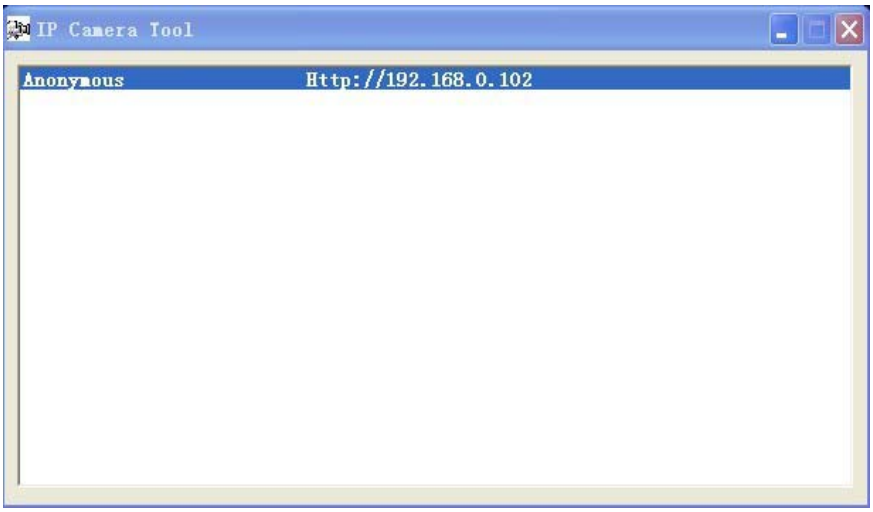

Figure 14. Thewireless camera’s IP shown in the window

The primary window appeared on the screen. An IP address was shown in the window because the camera and the router were working. (See **Figure 14.**) This was the camera’s IP address.

If the camera’s IP address is not in same network with the computer. Move the mouse arrow to the IP address and click right mouse button. The network selecting and setting dialog will be shown on the screen. The network setting can be changed to be same withthe computer.

Set up the IP address of the wireless camera according to the network of the laptop or LAN. But the camera’s address must be different from the addresses of other devices which are in a same LAN.Only the network port setting on the webpage can be changed.

In **Figure 15**, the IP address of the wireless camera is 192.168.0.102. Actually the primary address was 192.168.0.103, but it was same with the laptop in the LAN. The camera’s IP address would not be shown in the window. Click the start menu then chose “Run”. Type “cmd” to open command prompt.Type “ipconfig” in it and check the laptop’s IP address.(See **Figure 15.**)When the address had been found, run the camera software again and right click it, then changethe IP address of camera and make sure it is different with my laptop. After it is changed, the IP address of camera will be shown in the window normally.

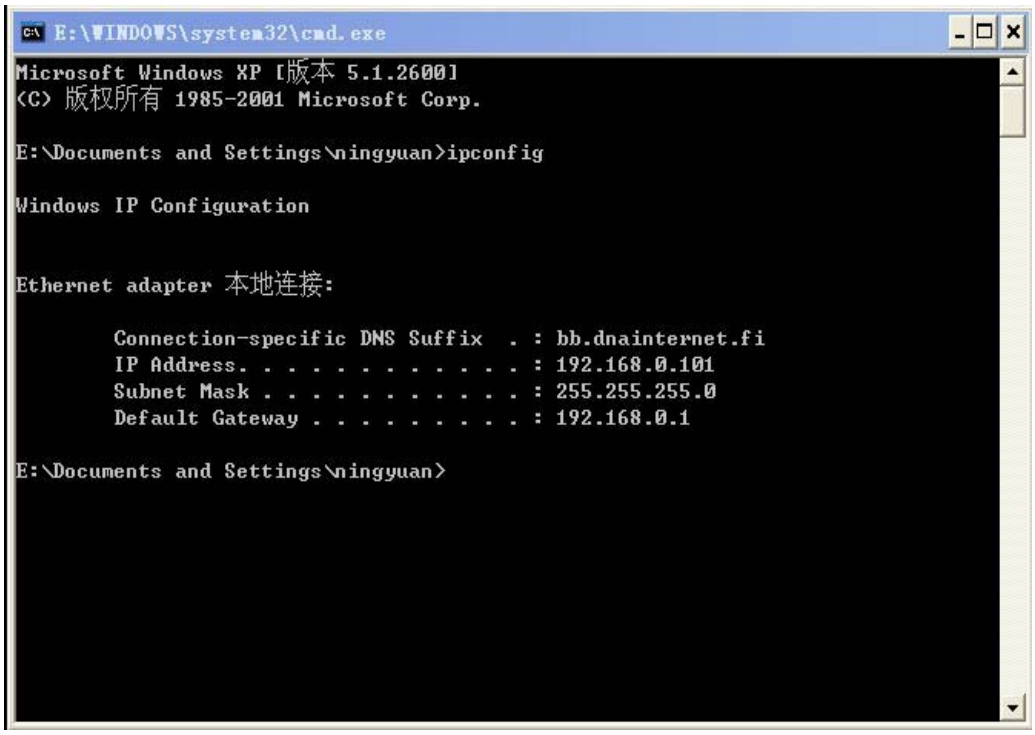

Figure 15. Check laptop's IP address in command prompt.

Double click the IP address, A webpage opens soon. (See **Figure 16.**)

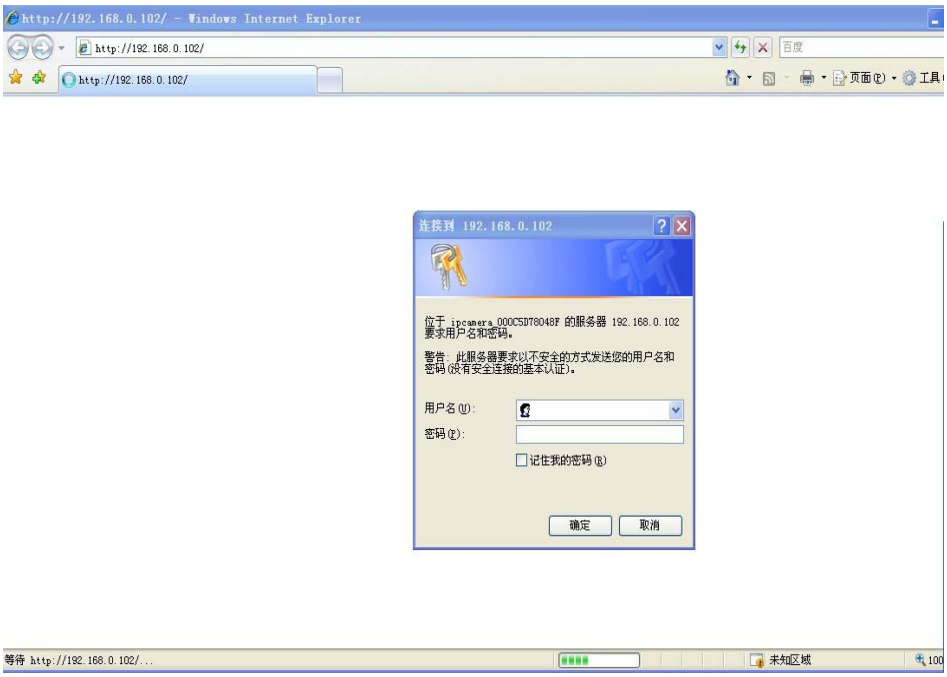

Figure 16. The Log in webpage of IP camera

There is a dialog over the webpage. It is for logging in. Type the administrator's name in the first text and the password in the second one. When everything is OK, click the "确定" button. It means "Yes".

The administrator's name of the camera software in my laptop is "admin", but there is no password so that type"admin" in the first text then click"Yes" button. The software is started up successfully. (See **Figure 17.**)

Figure 17. Type administrator's name and password

When started up the software, there was a webpage firstly.(See **Figure 18.**) It was an options page. On the top of the page there was a language option.The user can choose English or Chinese here. (Actually the reason why there was"Chinese" in the optionis difficult to find. Maybe this camera was made in China.) In the middle of the page is browser option. Choose the browser. (If the user is using Internet Explorer, choose the first one,.If the user is using Firefox or Google browser, click the second one). Then click the words "Sign in". It is a hyperlink to the camera software interface.

Figure 18. The options page of camera software.

Click the first “sign in” because the browser which is usedis Internet Explorer. Then a new webpage opened. In the webpage there is a big video monitoring window. (Resolution is 640x480.) Beside the video monitoring windowthere are all settings which can adjust the screen for different kinds of users. (See **Figure 19.**)

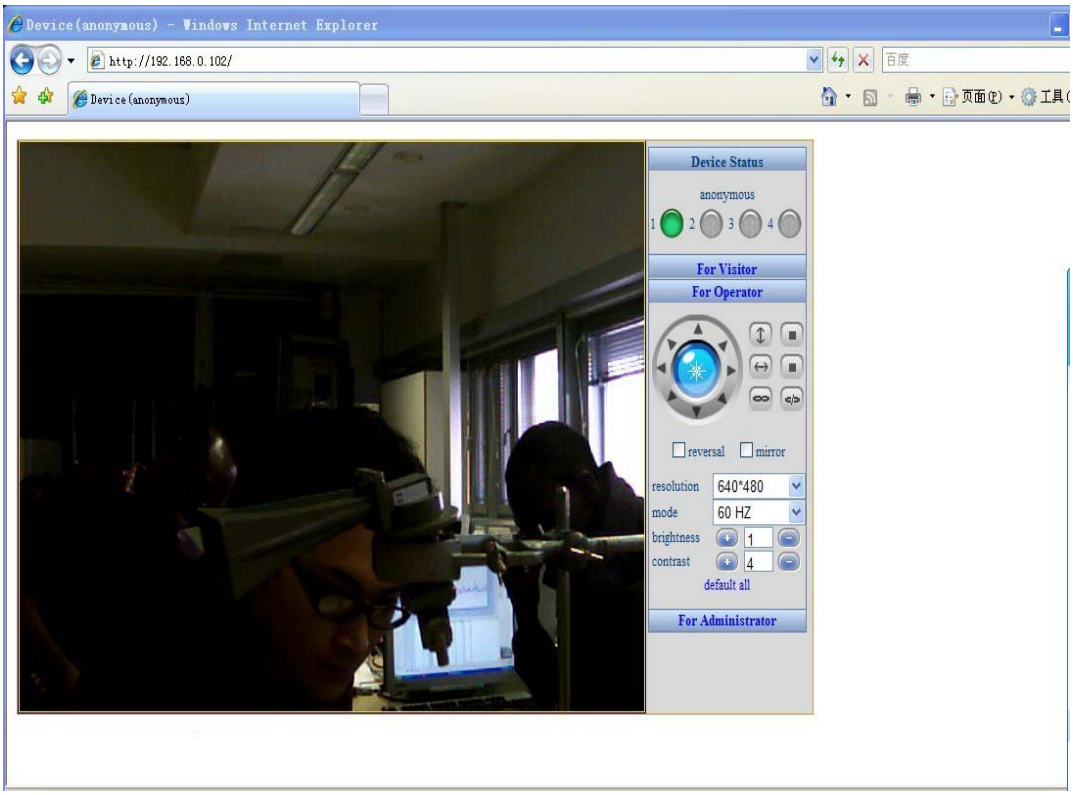

Figure 19. The camera software interface is on the webpage.

On the top of the settings area four circular buttons were shown. If there are four cameras connecting to wireless router, the user can choose one of them by the four buttons.

Under the four circular buttons there werethree options for threedifferent kinds of users: visitor, operator and administrator. **Figure 19** shows operator’s option, it includes the functions which are used to change videos’ sizes, positions, brightness, contrast and refresh frequency, and the operator means the person who just uses the software to monitor the parking lot but does not repair it or adjust some deeper options, such as policeman and security guards.

Click the “For visitor”, the visitor’s option opened. (See **Figure 20.**) It can change the one window to four windows, turn on or turn off the OSD and audio buffer. The timestamp on record by the option can also be added. Visitor means the person only can watch and experience the software but not use it.

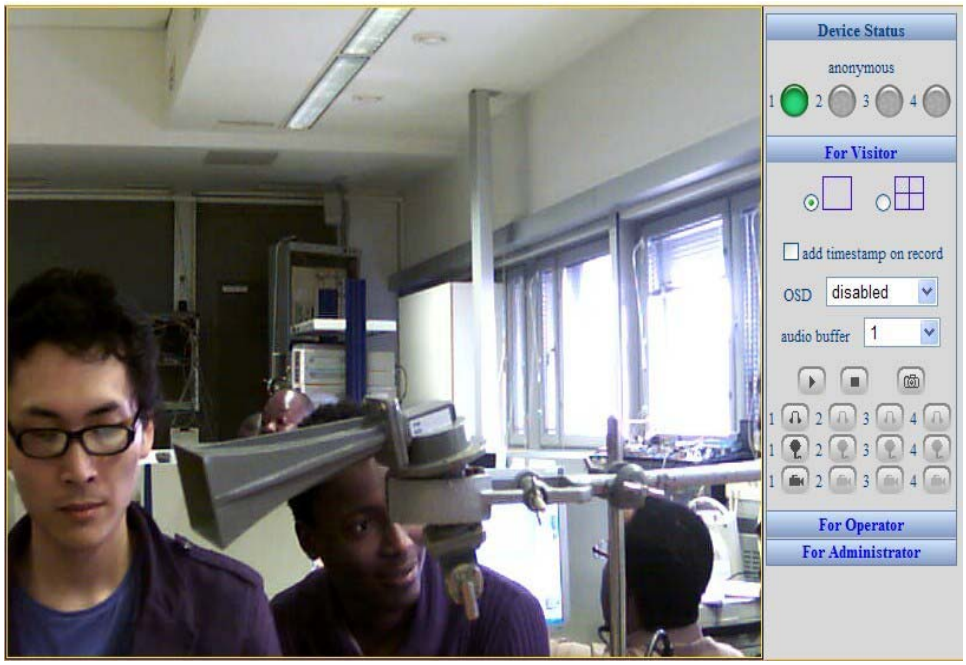

Figure 20.The visitors' option.

Click the "For administrator", the administrator's option opens. (See **Figure 21.**)It can be used to configure the network space, network speed and upgrade of the software. If the user wants to change the administrator's name and password and see more information on the camera, restore original settings and reboot the camera by usingthe options which must be needed. Administrator means the owner of this software or the repairmen such as software engineers.

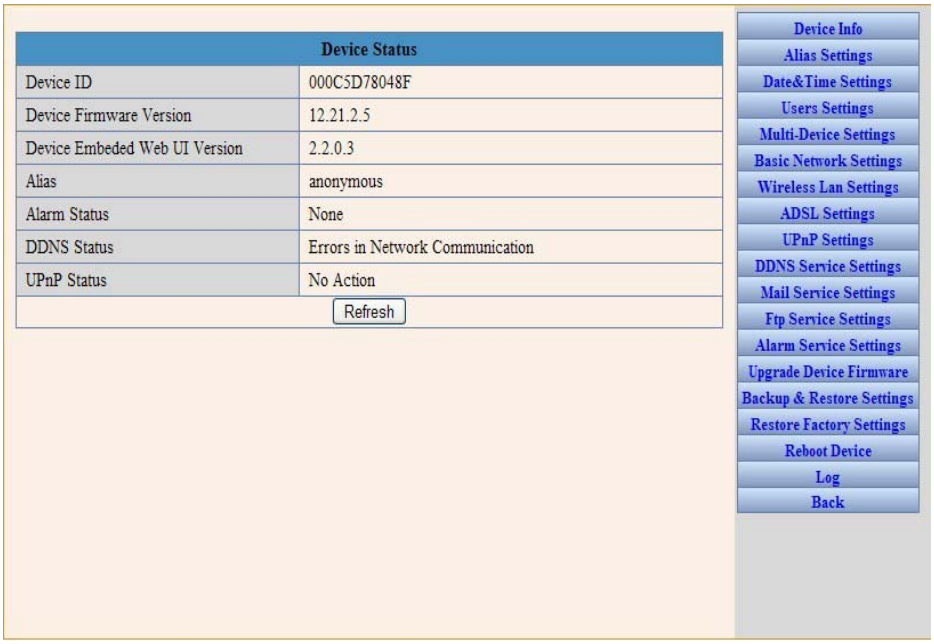

Figure 21.The administrator's option.

2.5 Wireless Range Testing

The wireless camera which was used in this final project is a digital camera; Analog wireless camera's transmission range is about 90m. Digital wireless camera's range is longer than it. (From 95m to 230m.) But it is only atheoretical data. In order to get the actual data, the ranges for the IP wireless camera should be tested.

When the IP wireless camera system installed completely and the camera software ran normally. The camera was put in different places which had different distances from the wireless router. The router and laptopwere even put in a lab but the camerawas put outside of the door. The camera software webpage was watched in the laptop, and thenthe video was detected if it was smooth.

According to this testing, the longest transmission range of the wireless camera is 92 m. If there are some obstacles such as walls between them, the video signal can be transmitted but not very smooth.**Table 1**shows this testing result:

Table 1. The testing result if no obstacles between the camera and the router.

Effect Range(meter)	Is the video smooth, not smooth, or no transmission.
1	Smooth.
5	Smooth.
10	Smooth.
15	Smooth.
20	Smooth.
25	Smooth.
30	Smooth.
35	Smooth.
40	Smooth.
45	Not smooth.
50	Not smooth.
55	Not smooth.
60	Not smooth.
65	Not smooth.
70	Not smooth and transmission is very slow.
75	Not smooth and transmission is very slow.
80	Not smooth and transmission is very slow.
85	Not smooth and transmission is very slow.
90	Not smooth and transmission is very slow.
92	Not smooth and transmission is very slow.
Longer than 92	No transmission, no videos shown.

Table 2. The testing result if there is a wall between the camera and the router**.**

Effect Range (meter)	Is the video smooth, not smooth, or no transmission.
5	Smooth
10	Smooth
15	Smooth
20	Smooth
25	Not smooth
30	Not smooth
35	Not smooth
40	Not smooth
45	Not smooth
50	Not smooth and transmission is very slow.
55	Not smooth and transmission is very slow.
60	Not smooth and transmission is very slow.
65	Not smooth and transmission is very slow.
68	Not smooth and transmission is very slow.
Longer than 68	No transmission, no videos shown.

According to these two tables, the following information can be concluded:

a. If no obstacle between the camera and the receiver, the longest transmission range is 92m.
b. If there is an obstacle between the camera and the receiver, the longest transmission range is 68m.
c. If no obstacle between the camera and the receiver, the longest smooth transmission range is about 40m.
d. If there is an obstacle between the camera and receiver, the longest smooth transmission range is about 20m.
e. Obstacle such as walls,doors and some other objects cannot stop the transmission of digital wireless camera but can effect on it.

2.6 Introducing and Analyzing the Security Camera System in a Parking Lot

Different kinds of parking lots need different types of security wireless camera. systems. Some small parking lots for companies and apartments use wireless camera system, some big parking lots for public places such as markets use wired camera systems. They have two reasons: One is because of the big parking lots, the distances between camera and security rooms are usually over 100m, the video transmissions maybe not very smooth so that it is not good for security. The other one is the cost of the system must be much more expensive because wireless cameras have higher prices.

Figure 22. Security cameras in a parking lot's entrance.**[15]**

However, no matter what types of security camera systems parking lots use. They have many commons: There must be at least two cameras at the entrance. One's lens points the entrance and the other points exit in order to shoot and record the information about every entering or exiting car. Most parking lots have more than two parking areas. Every area needs at least one camera to watch it.

The security camera system should save the videos which it shoots all the time. How long videos it can save depends on the size of hard disk of controlling computer. Under normal circumstances, a 500GB harddisk can save 10 days' videos if the resolution of video is 1024x768 and there are 10 cameras in parking lot. The calculation method is very easy. Every camera can save 200MB (0.2GB) videos per hour. So the calculation formula is:

$$Time = Size\ of\ harddisk\ /\ (number\ of\ camera * 0.2) \qquad (1)$$

Notice that the "0.2GB" camera has the lowest definition which can make human's eyes see car's size, type, feature and license plate number. (See **Figure 23.**)This is very important for security and management. If parking lot owner needs more clear videos, He should change not only better cameras, but also bigger size hard disk. [4]

Figure 23. The car's size, type, feature and license plate number must be clear.**[16]**

3. RFID System of a Parking lot

3.1 Introducing the system

RFID, the full name is “Radio Frequency Identification”,which can also be called as “Electronic Tag”. It is a technology of communication. It distinguishes specific targets and records the information of them through wireless signals. RFID systems do not need physical touches when it read and record specific targets.**[6]**

RFID technology is used for controlling, checking, distinguishing and tracking objects. It plays an important role in Logistics Management, Production Control, Baggage Handling, Post Handling, Identification, Document management, Access Control System, Commodity Sales and many other fields. It has become one of mainstreamtechnologies in modern society.**[6]**

More and more parking lots begin to use RFID technology because parking lot needs Identification and ticket checking. For management it must record the information of all cars which are parking in it. Some parking lots only allow specific car owners to enter and park. They need an automatic system to help them to check and distinguish. **[6]**

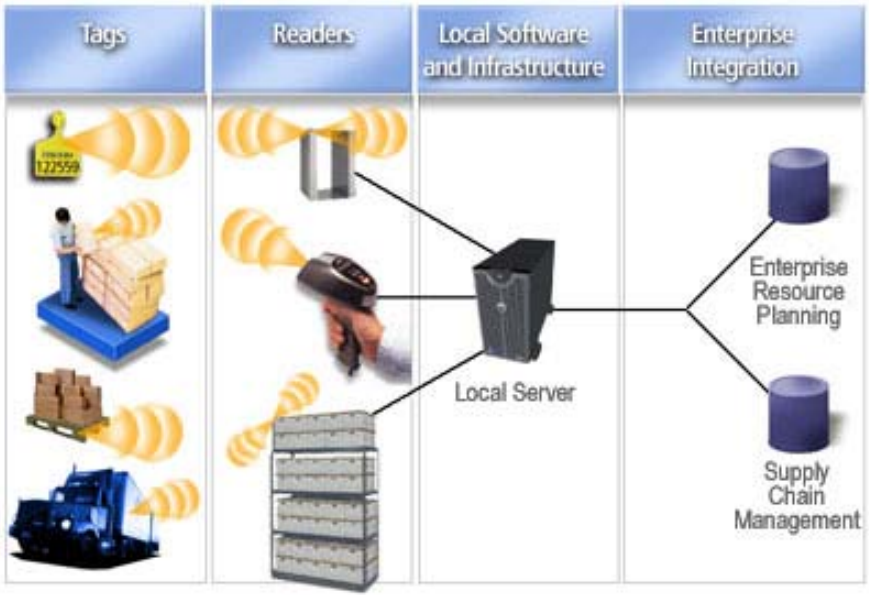

Figure 24. The theory and structure of RFID technology.**[17]**

There are there basic parts ina RFID system: a tag, a reader and an antenna.

A tag is formed by coupling components and chip. Every tag has its unique code. Tags can be installed on devices or cards. A reader is responsible for reading the devices or cards with tags. The reader can be held or fixed it on the wall. An antenna transmits radio signals between the tag and the reader.**[6]**

If the tag enters the magnetic field which is made by the reader, it will receive the signals from the antenna sent by reader. The signals give the tag induced current. The tag uses the current as its energy to send the information or identification in it. The reader uses the antenna to receive the information or identification, and decodes them. The decoded information will be sent to the controlling computer or the center information system to process, record and save. **[6]**

RFID tags have three different types: passive, active and battery assisted passive. Passive tags do not have batteries to supply electric energy. They have to use the electromagnetic sent from the reader to drive themselves. Active tags havetheir own batteries or power supplies;they can transmit signals in a longer range positively. (See **Figure 25.**)Active tags can even receive and save some additional information sent fromthe reader. Every assisted passive tag has a small battery; this tag can receive and send radio signals without the magnetic field made by the reader.**[6]**

Figure 25. The active tag of RFID system.**[18]**

An RFID system has two kinds of transmission between the reader and the tag: Inductive Coupling and Backscatter Coupling. Low frequency RFID devices use the first one and most high frequency RFID devices use the other one.**[6]**

RFID systems have three bandwidths of radio frequencies. The low frequency is from 125kHz to 135kHz. The high frequency is about 13.56MHz. The ultra-high frequency is from 860MHz to 960MHz. Most parking lots in the world use low frequency RFID systems. **[6]**

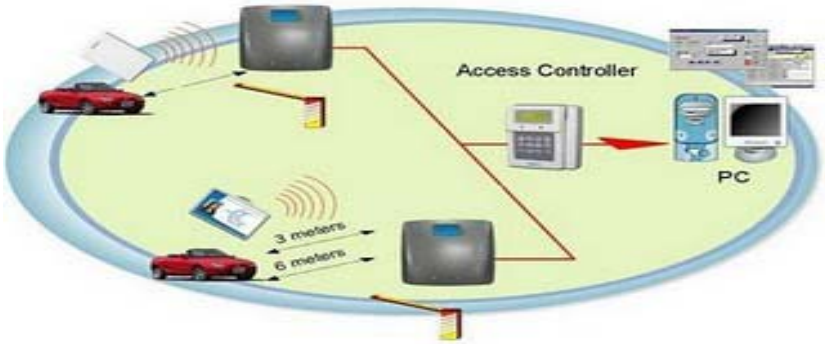

Figure 26. RFID system used in parking lot.**[19]**

3.2 IntroducingSiemensSimatic RF – 660R System.

The system was used in thisfinal project, Siemens Simatic RF-660R, which is an identification system that can write or read RFID passive tags in a long range by using UHF technology.

There are two parts in this system: the hardware part and the software part.The hardware part includes a RF- 660Rreader, two RF-660R antennas, a power transformer, four tags which have their own ID numbers and some wires and cables. These devices need to be connected to a computer which installed Siemens Simaticsoftware for managing the RFID reader and receiving information from the reader.(See **Figure 27** and **Figure 28**.)**[7]**

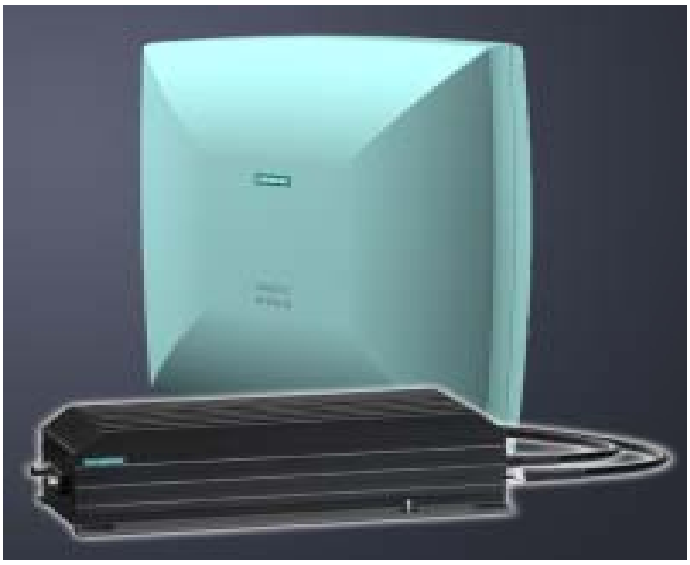

Figure 27. Reader and antenna of Siemens Simatic RFID system.

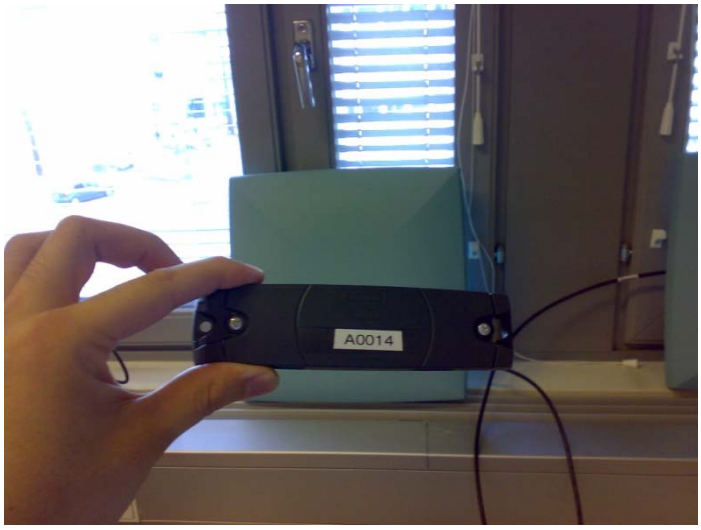

Figure 28. The tag of Siemens Simatic RFID system.

The software part includes two kinds of software which can be installed into a computer. One is Siemens Simatic RF configuration software. (See **Figure 29**.) It is responsible for setting reading styles, ranges and speeds. After the settings have been completed, the RF configuration software will show us the testing results of reading or writing tags. **[7]**

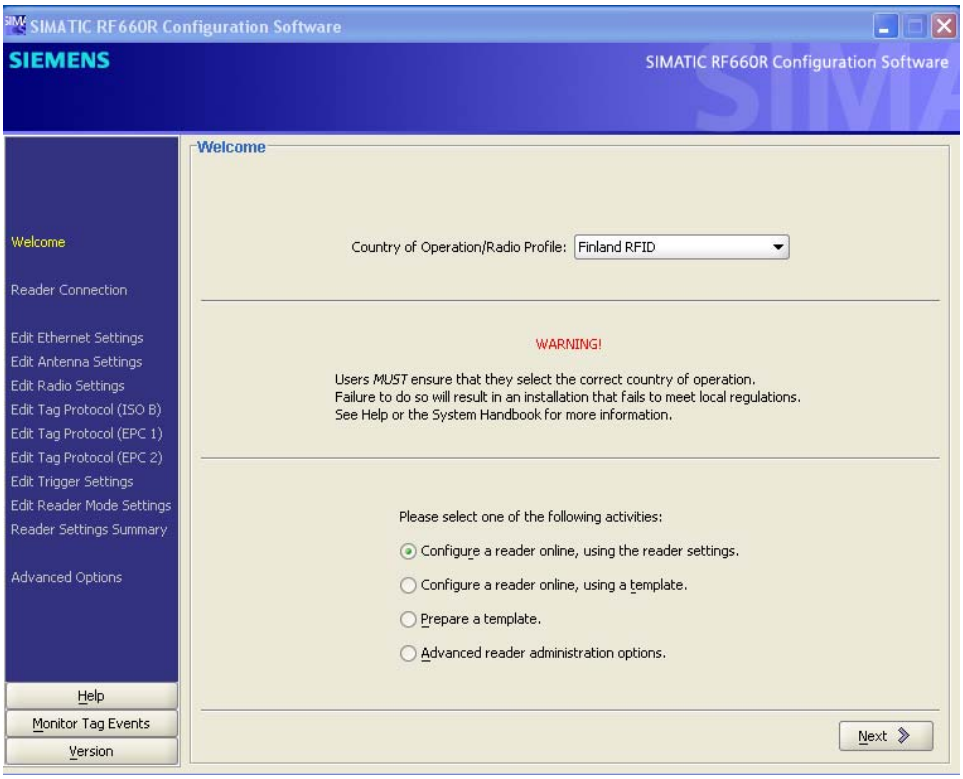

Figure 29. The configuration software of Siemens Simatic RFID system.

The other software is Siemens Simatic RF manager. (See **Figure 30**.) This software is used to create RFID simulation projects in the computer. If the computer has a network cable connecting to the RFID reader's Ethernet port, the projects in the RF manager can receive and record information about reading and writing tags. **[7]**

Figure 30. The RF manager of Siemens Simatic RFID software.

Transmission frequency	865-868 MHz (ETSI: EU; EFTA, Turkey) 869.5 MHz (ETSI SRD: EU, EFTA, Turkey)[1)] 902-928 MHz (FCC: USA) 920.125 - 924.875 MHz (FCC: CHINA)		
Writing/reading range	EU, EFTA, Turkey: < 3.5 m USA: < 4 m China: < 4 m		
Standards	EPCglobal Class 1, Gen 1 EPCglobal Class 1, Gen 2 ISO 18000-6B		
Compatible data carriers	Tags / Smart Labels	Designation	Standards supported
	Smart Labels	RF620L RF630L	ISO 18000-6B, EPCglobal Class 1, Gen 2
	ISO card	RF610T	EPCglobal Class 1, Gen 2
	Container tag	RF620T	EPCglobal Class 1, Gen 2
	Powertrain tag	RF630T	EPCglobal Class 1, Gen 2
	Tool tag	RF640T	ISO 18000-6B
	Tool tag	RF640T (Gen 2)	EPCglobal Class 1, Gen 2
	Heat-resistant tag	RF680T	EPCglobal Class 1, Gen 2

Figure 31. The data sheet of the reader of Siemens Simatic RFID system.

3.3 How to Install the System.

For installing the hardware part,a computer and a power supply were needed. A data wire was used to connect the computer and RS232 port of the reader. The antenna should be connected to ANT port of the reader by a specific data wire. One Siemens Simatic RFID reader has four ANT ports. It means four antennas can be connected to the RFID reader. (See **Figure 32**.)

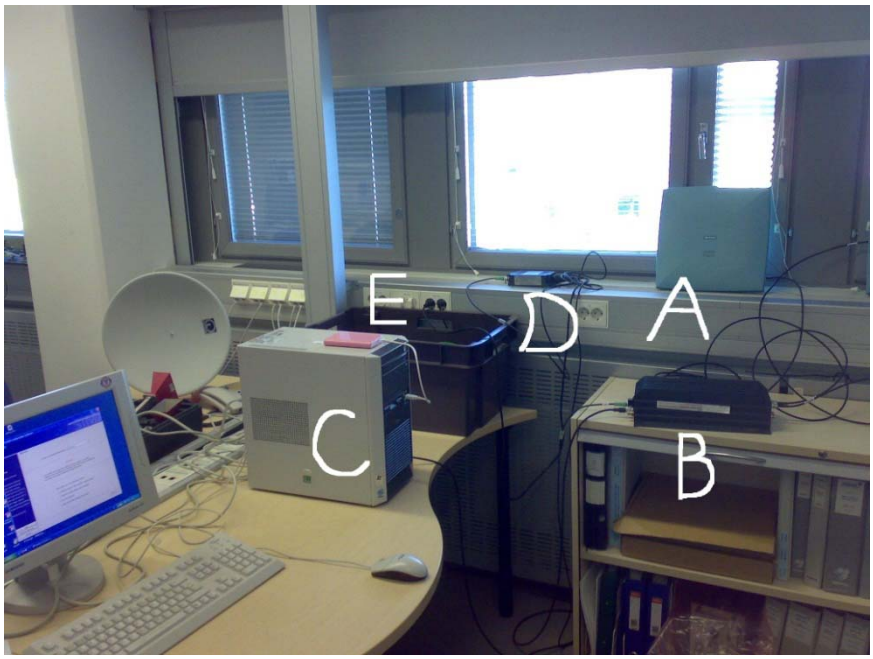

Figure 32. The complete Siemens Simatic RFID system.

In **Figure 32**. A is the antenna. B is the reader. C is the computer. D is the power transformer. E is the power supply. The power transformer is connected to the power port of the reader. Then it is connected to the power supply by the other end.

When the connection was complete,the power supply was used to give electric power to the computer and the reader. The reader has three LED lights: a green light, a yellow light and a red light. (See **Figure 33**.)The green light is called power. It will be litif the reader gets electric power. The yellow light is called TAG detected. It will flashif the reader is reading tags. The red light is called error. If the system cannot work normally nor has some problems, this light will alarm.

Status displays	LEDs	Color	Description
	Power on	Green	Power supply ON
	Tag Detect	Yellow	LED lit, as soon as at least one tag with a correct tag ID is within the field.
	System error	Red	Reader is not active, a more or less major fault has occurred In addition, this LED also indicates the fault status through the number of flashing pulses. Reboot (operating voltage Off → On is necessary). The LED flashes once for the 'INACTIVE' status, rebooting is not necessary in this case.

Figure 33. The three LED lights of the reader of Siemens Simatic RFID system.

Put the CD which has the RF configuration and RF manager into the CD driver of the computer. But before put it in. The operating system of the computer must be checkedif ithas qualified running environment for the two kinds of software. (See **Figure 34**.) When the CD begins to run in the CD driver,the installation wizard appears on the desktop automatically. (See **Figure 34**.) Choose “I accept the conditions of the license agreement.”,and then click “Next” to continue.

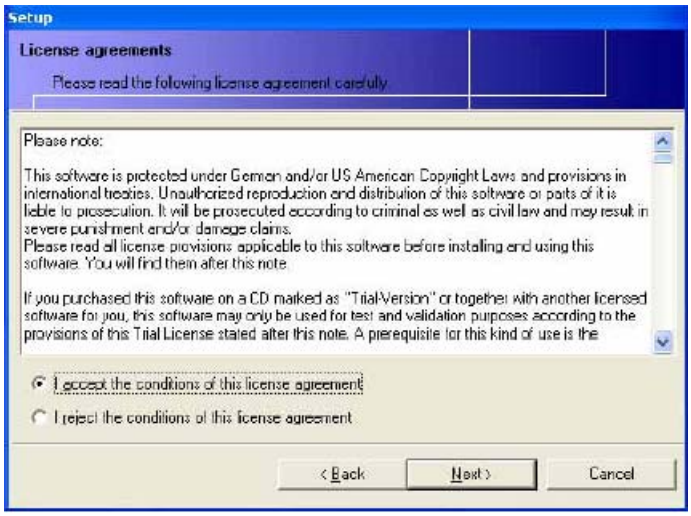

Figure 34. Start to setup.

Selected the harddisk drivers for the installation data and the components will be installed. (See **Figure 35**.)

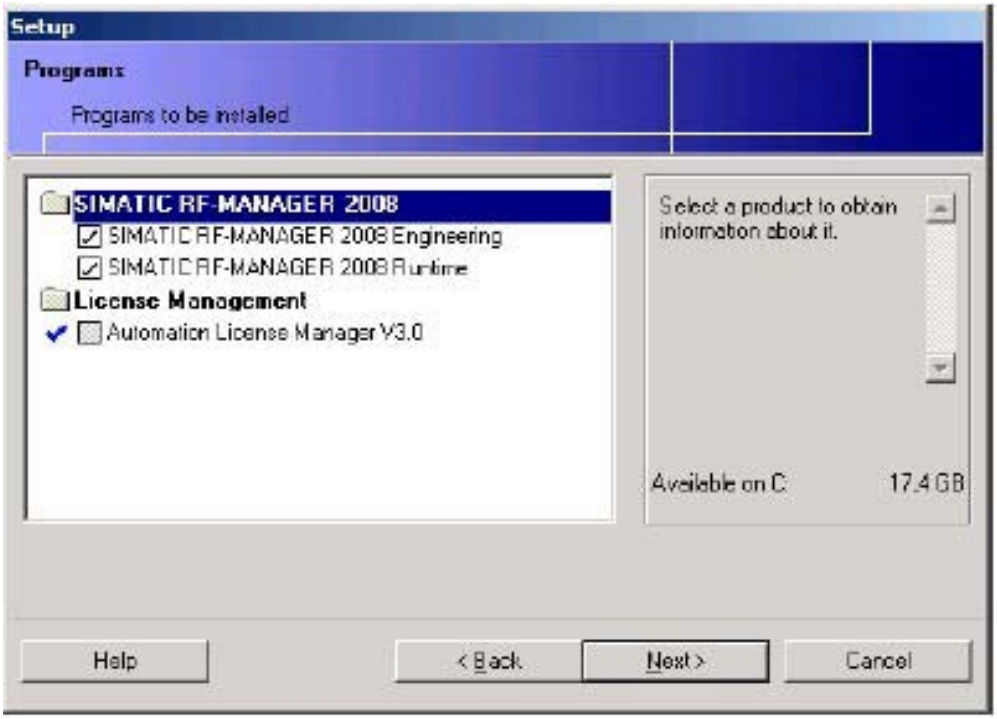

Figure 35. Select hard disk driver and components.

Then click “Next” to install.When the installationis complete.Double clicked“SIMATIC_RF_MANAGER_2008_SP3.exe” then followed the on-screen instructions. The Siemens Simatic RF-660R runtime can be installed.

Take the CD out of the CD driver. Click the start menu, it shows the selection “RF660R configuration software” and choose it. Run this software and choose “Configure a reader online, using the reader settings.” option. (See **Figure 36**.)

In the next window, choose “COM 1”. Click “Connect” to connect the RFID reader and the configuration software.(See **Figure 37**.)

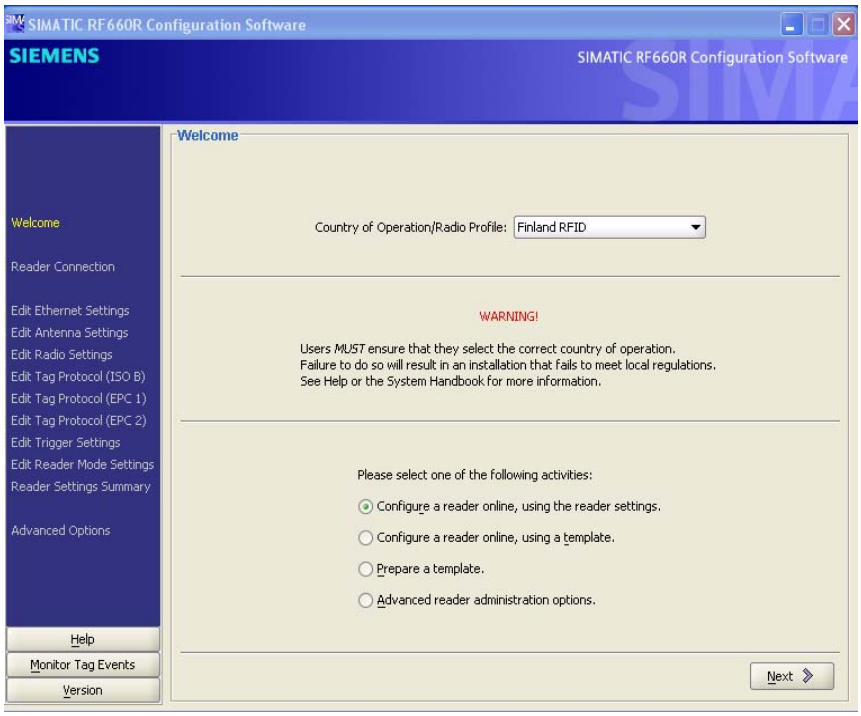

Figure 36. Choose “Configure a reader online, using the reader settings.”.

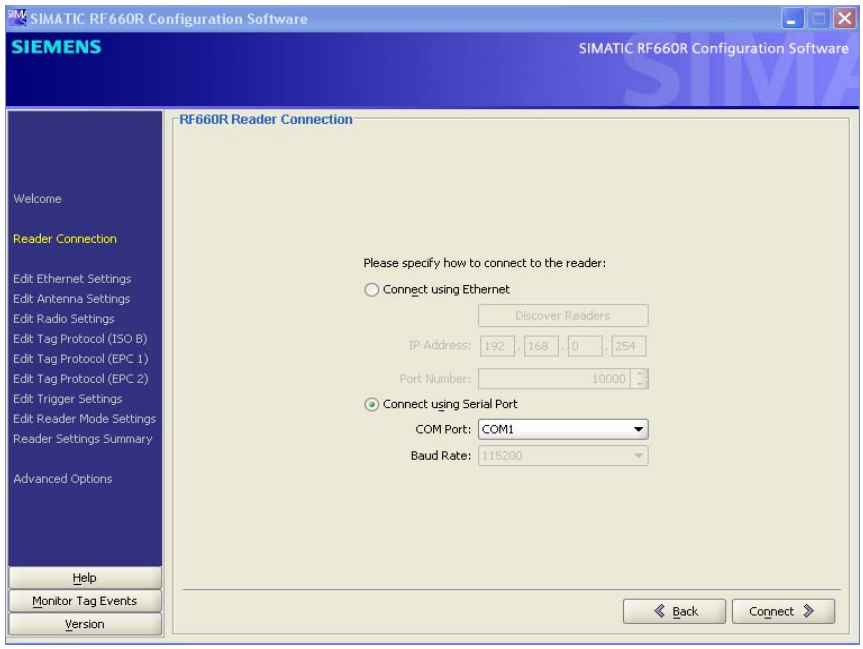

Figure 37. Click “Connect” to connect software and reader.

3.4 How to set the Simatic configuration.

The configuration window appeared after the connection was OK. (See **Figure 38.**) This window was for setting the power of the reader. Set the power to 2000mW.

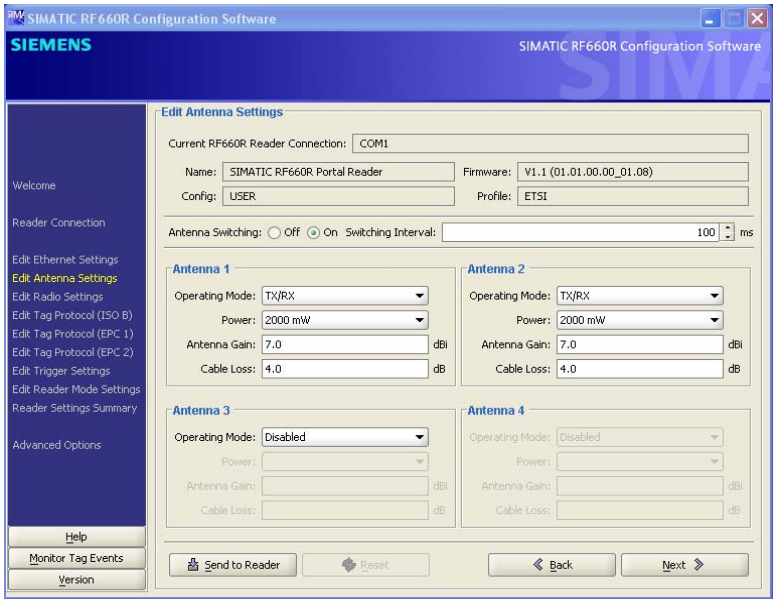

Figure 38. The power settings of the reader.

When the setting was OK, click “send to reader” at first, and then click “Next” to continue.

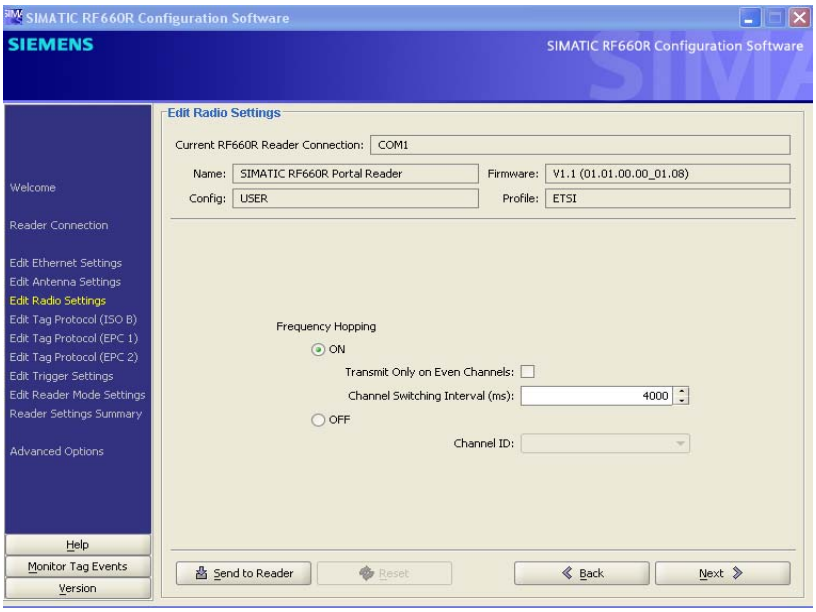

Figure 39. Frequency hopping configuration.

Next window was the Frequency Hopping configuration. It uses electric waves to expand the bandwidths of transmission signals in order to protect the transmission so that it will not be interfered by other waves in the air. (See **Figure 39**.)
In filter configuration, make a decision which RFID tagscan be read by the reader. This part is so important for Identification. Write the allowed tags'ID numbers into this configuration. Other tags cannot be allowed to pass. If all tags can be read, choose the option "All". (See **Figure 40**.)

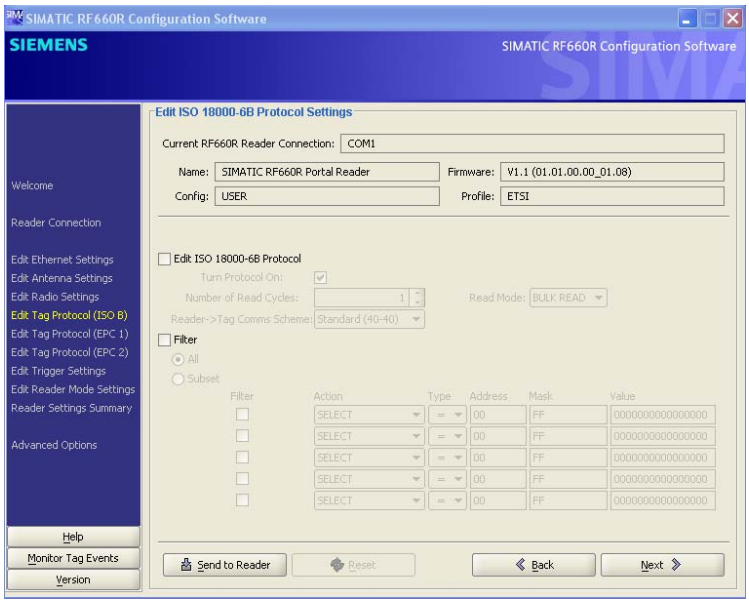

Figure 40. The filter configuration.

In the next window the user can select an operational mode between the following two options: Inactive or Autonomous. In this final project, the selection "Autonomous"is chosen because it is easy for the test. (See **Figure 41**.)

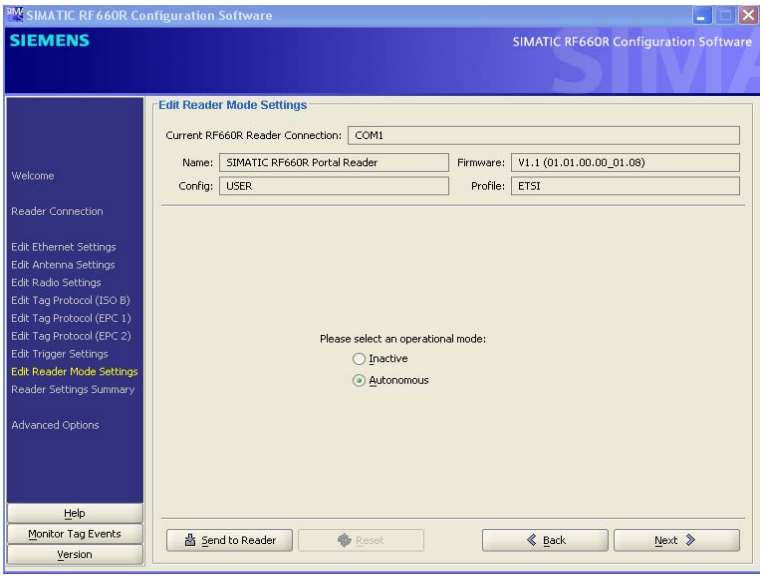

Figure 41. Select an operational mode.

Whenthe autonomous mode has been selected, all configurations are OK. Then sendall of them to the reader and put three tags which have different ID numbers in front of the antenna.(See **Figure 42**.)

Figure 42. Put three different tags in front of antenna.

Come back to the configuration software, click the button “Monitor Tag Events” to open event window. This window can show the events about tags reading by the reader. It can record the tags’ ID numbers, ID types, protocols, sources, channels, first seen times, last seen times and count times. (See **Figure 43**.)

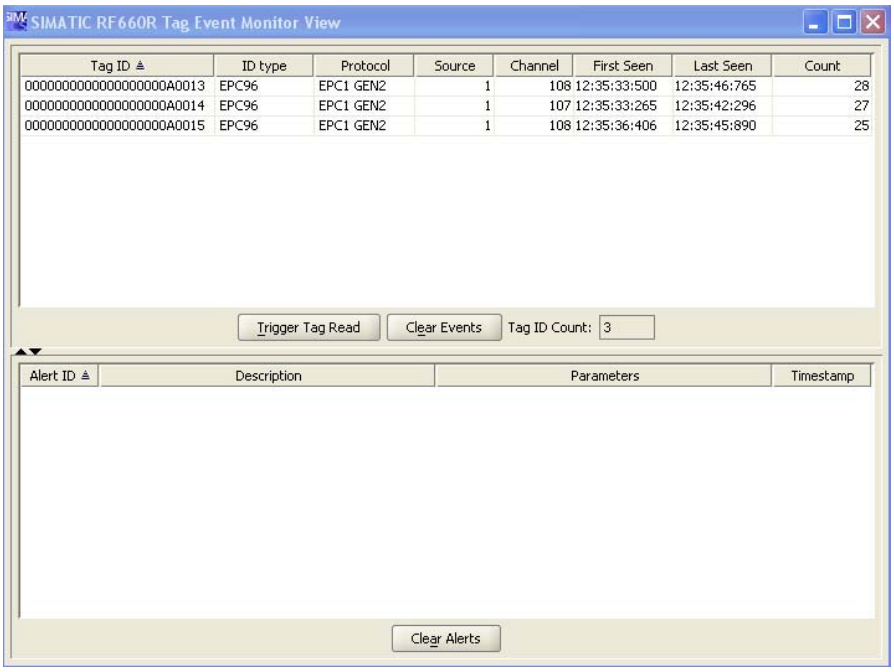

Figure 43. Monitor Tag Events window.

3.5 Testing of the reading speeds and ranges of Simatic RF – 660R.

The tags has different numbers of reading speed because of the different kinds of power of the antenna. More power the antenna has, the higher frequency signals the antennasends. It fast the reading speed of the reader. If the tags stop in front of the antenna,the reader will keep reading the tags and counting the increasing numbers of reading times.Record the reading times per minute. The recorder number divided by 60then got the numbers of reading speed. (See **Table 3**.)

Table 3. The reading speeds by different power of antenna.

Power of Antenna(mW)	Counting Speed (time/sec)
2000	20
1800	15
1600	11
1400	8
1200	2
1000	Cannot read the tag.

The reading rangeis limited. According to the test, the longest reading distance is 2.5 meters. The real reasonis not found but it may be that thesuspended particles and other electric waves which arein the air interfere the signal transmission from the antenna. On the other hand, the Siemens Simatic RF-660 device which is used in thisfinal project did not have high power. These two reasons will be proved in the future.(See **Table 4.**)

Table 4. The reading range testing.

Reading Distance(m)	Can the Reader read
0.5	Yes
1	Yes
1.5	Yes
2	Yes but not stable.
2.5	No

However, the RFID devices in most parking lotsdo not need very long distances to read the electric ID cards of car owners. The reason is that the RFID antennas are usually at the entrance of a parking lot. If a car comes, stops at the entrance and waits for the reading of the RFID device. The maximum distance between the car owner and the antenna is no longer than 2m. If the parking lot uses a long-range RFID device, it will cost too much and it may read too fast because of the high power.

3.6 Using RF manager to simulate a RFID parking lot entrance.

Make sure the software “RF manager” has been installed into the computer. Then click “RF manager 2007” in the start menu. When the software runsnormally, click the “open” button in the toolbar. Find the RF manager file “Getting Started” and open it. There will be anRF manager completed project on the screen. But it is for simulating the production control in factory. (See **Figure 44**.)

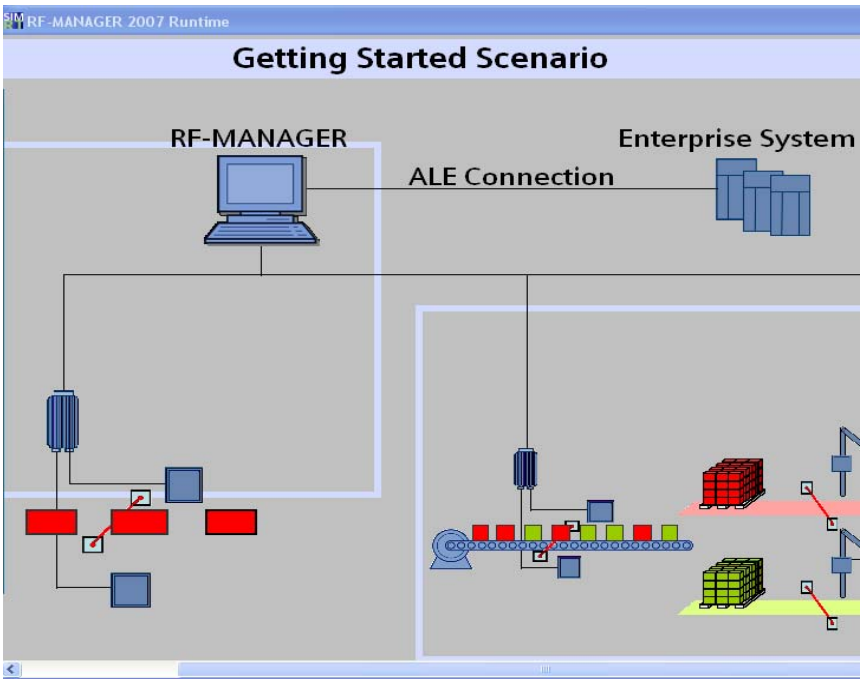

Figure 44. The Getting Started project for production control.

The original project is changed and it is like a parking lot simulation. Firstly select the “Sorting”in taskbar on the left side. Right click it then choose “Properties”. The button’s name of the “General” optionis changed. The new name is“Car park Simulation”. (See **Figure 45**.)

Secondly double click the “Sorting” and opened this part. Then there is an RFID production line in factory. Delete the transfer machine. Change the shape of the product and the distance between the two RFID antennas. Write the names “Start simulating” and “Stop simulating” into these two buttons. It became a parking lot simulation. (See **Figure 46**.)

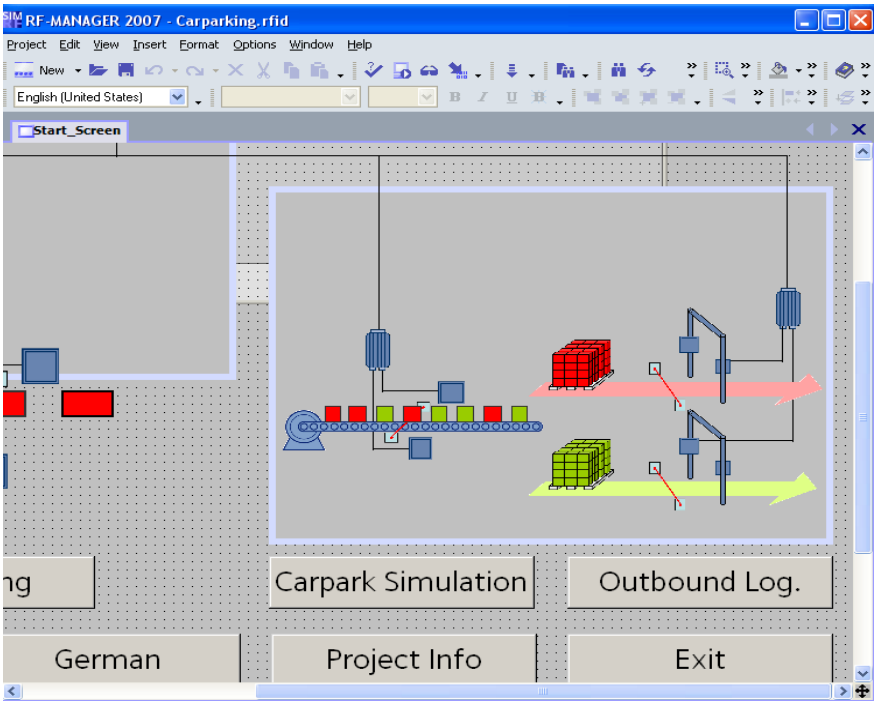

Figure 45. The changed name of this button.

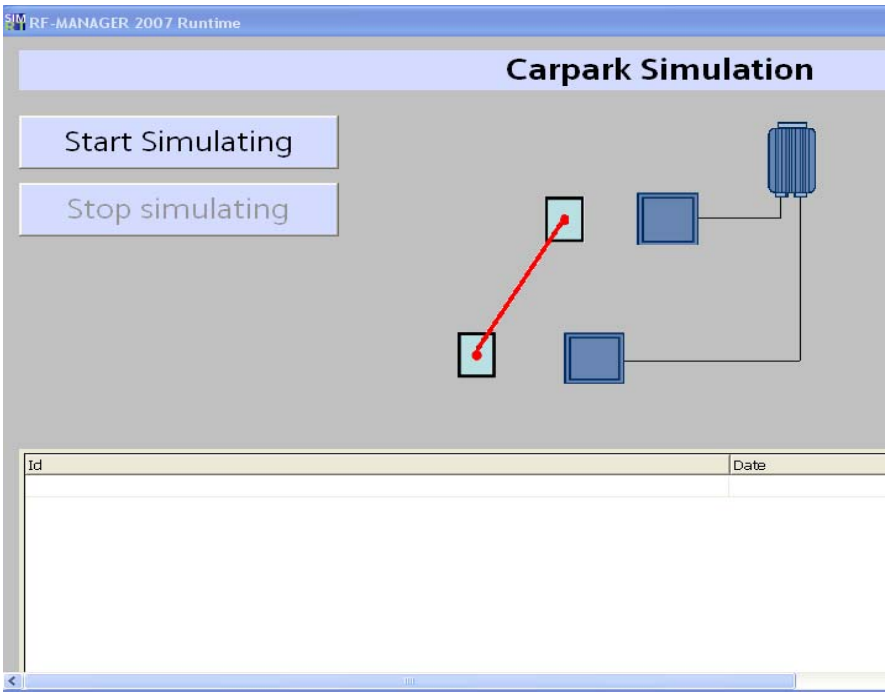

Figure 46. Change the project "Sorting" completely.

It is not finish when the "Sorting" part has been changed. Use an Ethernet wire to connect between the computer and a router then connect the router to the Ethernet port of the Siemens Simatic reader by another wire. (See **Figure 47**.)

Figure 47. Connect the computer and RFID reader.

After the connection is OK, right click the ALE connection in taskbar on the left side. Change the IP address in the general option. (See **Figure 48**.) Then the IP address is same with the router.

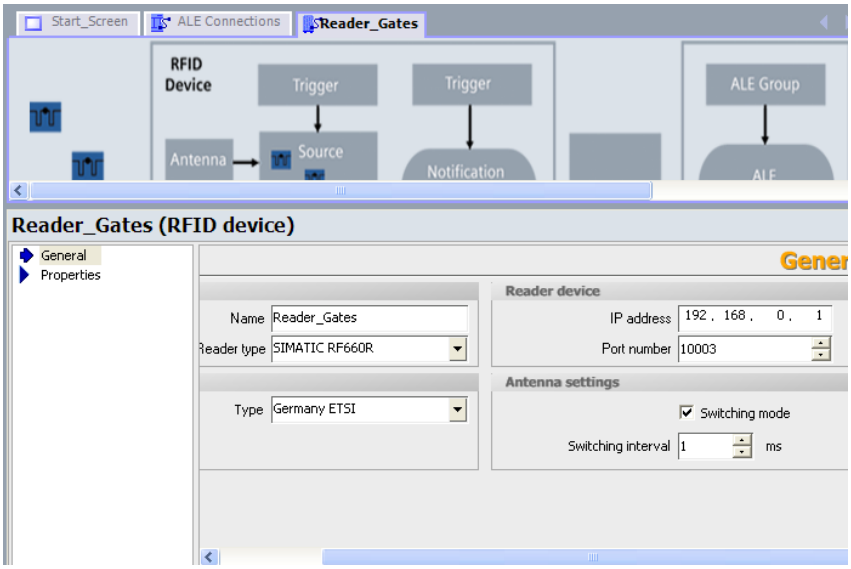

Figure 48. Change the IP address of the device.

Then the simulation system is complete. Connect the reader to the power supply and run this project. When the car park simulation window comes out, click the “Start simulating” button then take a tag to pass through the front of the antenna. The “car”will appear and passthrough the red line made by RFID devices. Its ID number, also the tag’s ID number will be shown in the white area which isunder the simulation graph.

4. Discussing the Differences between Finnish and Chinese Parking Lots

Finnish parking lots are similarto Chinese parking lots in most places. For example, both of them use security cameras. There must be two cameras at the entrance and every parking area has at least one camera. Both of them have entrance bars.

But there still are some differences between the two countries' parking lots. In China, most parking lots use the RFID entrance bar. All cars' owners have to take ID cards if they want to enter the parking lot. (See **Figure 49**.)

Figure 49. Chinese parking lots use RFID to manage entrances.**[20]**

But in Finland, most parking lots use password entrance bars. When the driver wants to drive his car to pass, the driver should type the correct password of this parking lot on the entrance bar's panel. There is a small keyboard on it. If the driver forgets the password, the driver does not have to worry worried about that because there is a phone on the bar. The driver can use the phone to call to the security room and report the name and identity. If the driver's identification is allowed to enter, the security man can use the controlling computer in the security room to rise the railing of the entrance bar and allow the driver to pass. (See **Figure 50**.)

Figure 50. In Finland, most parking lots use password entrance bar.**[21]**

Some parking lots of companies, schools and some institutions only allowed cars' owners to enter. But in most public parking lots, Finnish and Chinese parking lots are different in charging systems.In Finland, every stall in a parking lot has a small charging machine. (See **Figure 51**.) The driver should put coins into it after he has got off. But in China, the charging system is at entrance. All drivers must pay before parking. (See **Figure 52**.)

)

Figure 51.The charging machine of Finnish parking lot.**[22]**

Figure 52. In China, charging system is at entrance. **[23]**

5. Conclusion

Through the final project, I got a lot of knowledge about parking lot management, wireless cameras and RFID systems. They related to a lot of knowledge I have learned atSavonia. I learned how to install a simple wireless camera system and Siemens Simatic RFID system. I learned the methods of using them to make videos and reading tags. In this final project I learned the theory about Siemens Simatic RF manager. It is an advanced simulation and development software of RFID technology. By using it I can simulate a developing parking lot. I also learned how to search useful information from books and websites.

In modern world, more and more people start to use personal cars instead of feet and bicycles. It means parking lots and parking lot management systems become more and more universal and popular. For the security of parking lots, a security camera and RFID are very important. I think they will not stop their development in the future. Maybe the transmission range will become longer and the definition of video is going to be more clear. And there will be many other technologies being used in this parking lot management.

However, there were some problems in my final project that I have not solved yet. For example, how to save the video, how to change the shooting direction of the camera, how the railings of RFID entrance bar work and how to count the number of parking cars. They are matters that I will research and solve in the future.

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