Wireless based Smart Parking System using Zigbee

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***Abstract*—One of main issues of developing big parking space for shopping complexes, office complexes and other types of building that requires large parking space is to notify the visitors of occupied and non-occupied parking space. Most of the visitors might spending up to 30 to 45 minutes just to find an empty parking space. In most recent technology, some parking lot system offered a system that could automatically count when the car entering the empty car space and blocking an infrared signal thus notify the system to count for it. However, this type of sensors actually has an increase of budgeting in order to install and to be maintained. In this project, we have developed a unique solution by providing cost effective solution by using Zigbee technology in parking lot system technology. Instead of using and maintain cable that need to be installed at the ceiling of the parking lot, we developed a system that use wireless technology of Zigbee and it could notify the visitors of empty and non-empty parking lot.**

Keywords-parking, zigbee, wireless system;

I. INTRODUCTION

In modern day, cost and time is the most common factors and effecting any human being whether it is for individual of for a management. As most people migrate from small town to big town, from village to the cities, most people wants to increase their quality of life by getting more wealth and health at the same time. Back in 40 to 50 years ago, shopping complex is not exists yet generally in all places all around the world. For example, a fisherman might sell their catch at their own in the local market, while car maker sell their accessories at their car shop. But as the community grows rapidly every single years, most people need to spend their time wisely and not be able to travel all shops at the same day. Thus, an ordinary shops evolved from decades ago to a multi-purpose shops that most people call it today as a shopping complex.

Selling items at the shopping complex most likely to have better profits than the ordinary store. People just need to come to shopping complex and buy all their household stuff and also car accessories. Vegetables, fruits, clothes, car accessories, home decoration things and many others can be found under one roof. This is why the shopping complexes has becoming more common to people nowdays and companies such as AEON, Giant, MyDIN, and others in Malaysia seems to have their shopping complexes at almost every state here in Malaysia.

However, one of the important aspect that always haunted people to visit shopping complex during peak hour is to find out an empty parking space. While some shopping complexes implementing counting number LED board at the entrance of the parking lot, it does not do much help as the visitors still cannot find out where the location of empty parking space and end up searching for their own. Sometimes, the technology to install counting number LED board is too costly while they need to install and maintain wired connection of each parking sensors at the ceiling of parking lot.

Thus, our research and project is to help the shopping complex owner to install a low cost parking lot system that be able to reduce the cost of installing wired connection for sensors by replacing it with Zigbee technology [1-25]. Zigbee could be used in any other applications such as PCB drilling process data management, WLAN application, and any wireless application [26-28]. Our system also has come out with a display status that could show the current empty parking space in real-time.

II. RESEARCH BACKGROUND

A. Passive Infrared Sensor (Figure 1)

Passive infrared sensors recognize the occupancy status of any parking lot by detecting changes in the vigor emitted by vehicle and the roads [29-33]. Although the sensors working effectively under normal condition or environment in order to measure the speed of vehicle, the accuracy and sensitivity of the sensors are reduced if there is a bad weather such as heavy rain, snow falls, and dense fog.

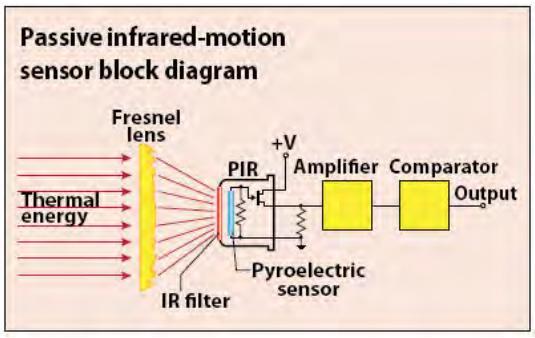

Figure 1: Passive Infrared Sensor.

B. Active Infrared Sensor (Figure 2)

Active Infrared Sensor [33-37] is configure to sense and detect vehicle by emitting an infrared energy and then measuring the amount of energy that has been reflected. It can be used in multiple conditions and operations. The sensor could measure accurately the vehicle position, speed and the class. But it also sensitive to the outdoor environment and conditions.

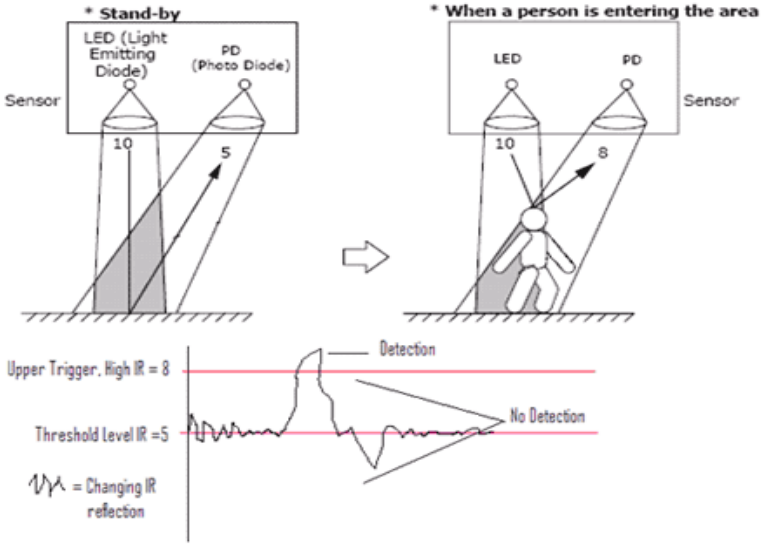

Figure 2: Active Infrared Sensor.

C. Inductive Loop Detectors (Figure 3)

Inductive Loop Detectors (ILDs) [38-40] consists of wire loops and has variety of sizes that exited by signal with frequencies range between 10 to 50 kHz. The oscillation frequency of the inductive loop is directly controlled by the inductance of the loop which changes with vehicle presence.

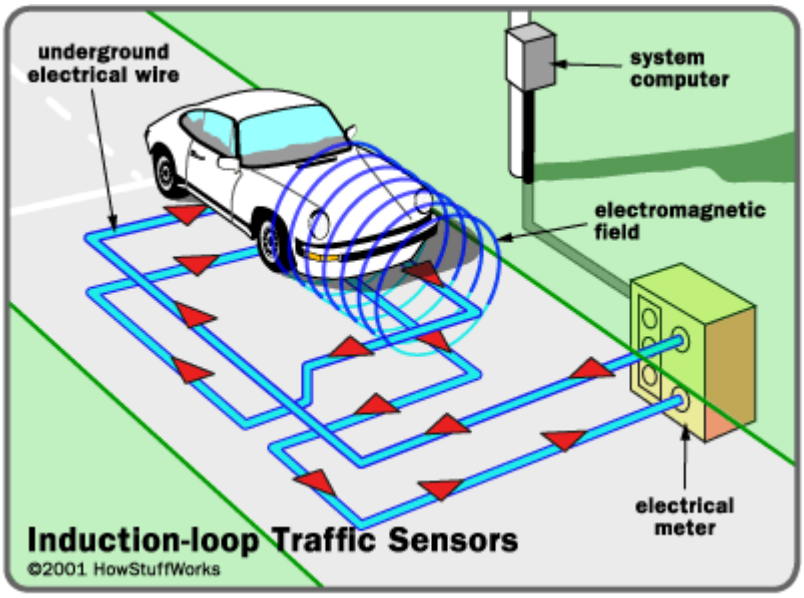

Figure 3: Inductive Loop Detectors.

D. Weight-in-motion Sensor (Figure 5)

This type of sensors has been used and currently been using by various authorities in order to check and balance each vehicle or load in order to determine their actual weight [41-44]. Most government agencies applied this type of system especially in luggage system in airport and custom. The system actually used in it are bending plate, piezoelectric, load cell and capacitance mat.

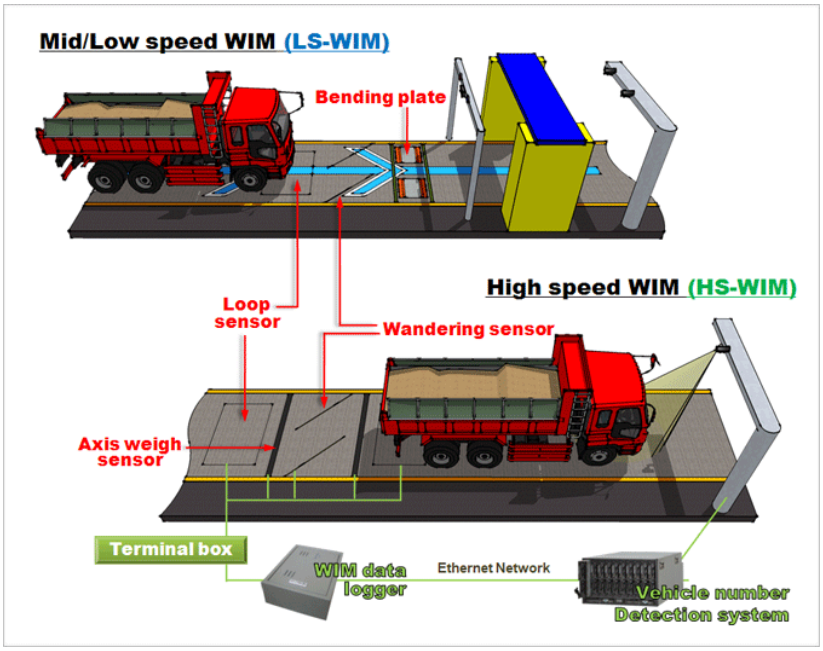

Figure 5: Weight-in-motion Sensor.

E. Vehicle License Plate Recognition (Figure 6)

This is a technology that has been used in most modern country in order to prevent crime and give summon [45-47]. When the vehicle if entering or leaving a highway for example, the system automatically catch the license plate and automatically move the date with the authorities such as police and any government agencies that monitoring crime and summon. Video Image Processing is used in order to read the data from the picture taken by the camera and then tracing the license plate numbers and save it into database. It can be used in parking lot system where the shopping complex owner could potentially know any unwanted visitors that might come to the shopping complex to perform crime.

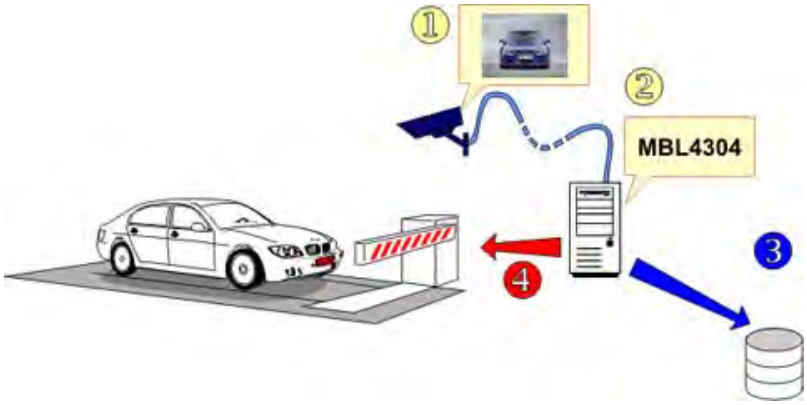

Figure 5: Vehicle License Plate Recognition.

Figure 6: Example of detecting plate.

III. RESEARCH METHODOLOGY

A. Introduction

This research consists of two main phases. First phase involve the research focus on the getting title and objective of this project. Before start this project some research question will do to complete this project. First question, what is the most suitable sensor type for detection of the occupied parking lot. And second question, how to combine all sensor network to system. Based on this question the title and the objective of this project complete for phase one.

Second phase involve do some research about the project and gaining the knowledge. In this phase, the literature review on various types of sensor in market, method that being used in the smart parking system, pic microcontroller that use for this project from various resources including journals, books and other reference was conducted. The aim for the reading was to get some idea on how to make some improvement or enhancement of features previous smart parking system that already been developed in the market. Then, the framework of proposes system will be carried out for completing the project.

B. Project Flowchart (Figure 7)

Our project start by performing data gathering and the research information of our project. Then, we designing the body and the circuit of the propose system after performing literature review of our project. Next, we did analysis of the current body and circuit then when the problem persists, we did debugging and correcting the problem. Finally, once the complete system has been tested and fully worked, we fabricate and construct the circuit in board.

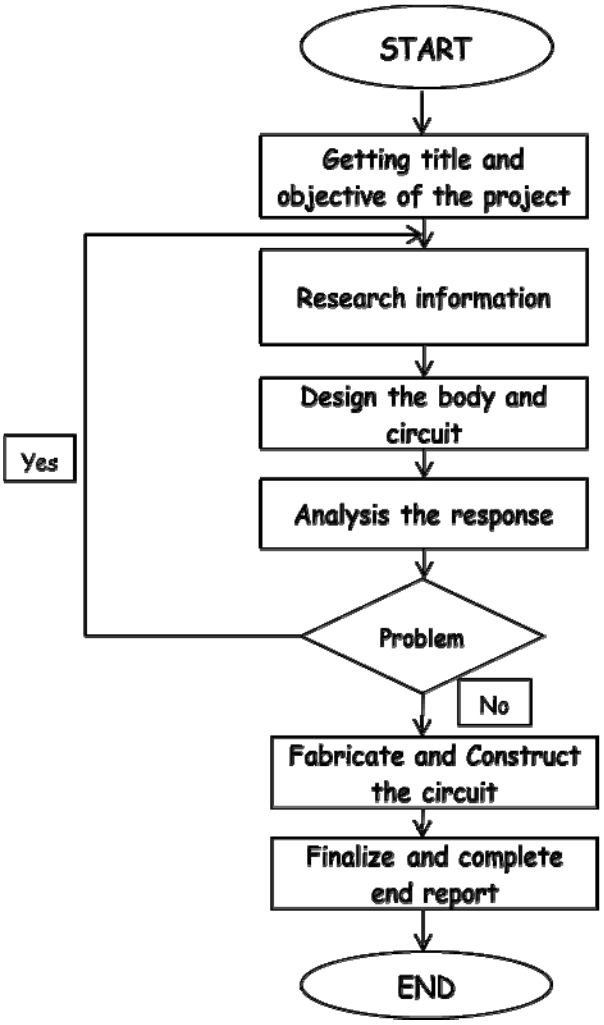

Figure 7 Project Flowchart

IV. IMPLEMENTATION

In general, the signal also can be transmitted through any solid objects such as plastic, wood, glass or fiberglass regardless of the materials but has different capability of signal interference. The operating system allows users to search an empty parking lot with easy and fast, the system uses the ir sensor for detection unit to notice empty parking lots. For display the empty vacant parking lot this system using LCD display to guide the user for search for vacant parking lots. The interface that has been made is to monitor the empty vacant parking lot and this system uses wireless communication to transmit and receive the data from detection units to the monitoring system.

A. Software Implementation

1) Visual Basic Studio

In this project, to develop a graphical user interface for monitoring system for this project Microsoft Visual Basic software is used. To connect the circuit with this GUI, make sure the connection from the circuit is connect to the pc. To ensure the com ports are available, it has been displayed in drop down list in a combo box. After select the com ports from the drop down list, click ‘connect’ button to connect the circuit with this GUI and it will display ‘Connected’ ready to communicate with the circuit. Figure 8 to 10 shows our interface designed using Visual Basic Studio.

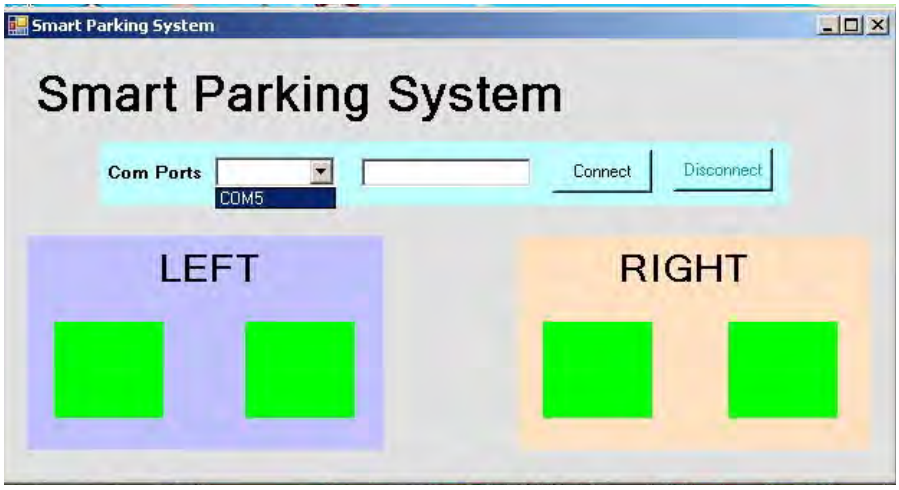

Figure 8: COM Port selection

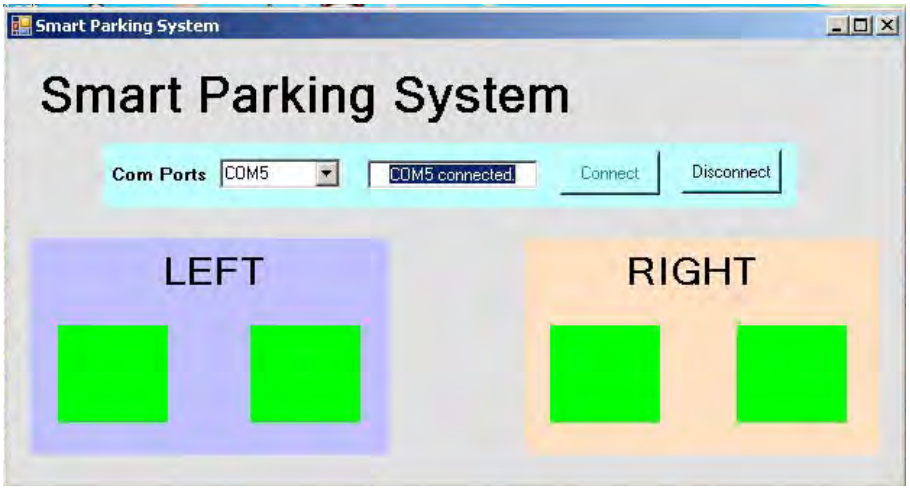

Figure 9: COM Port connected

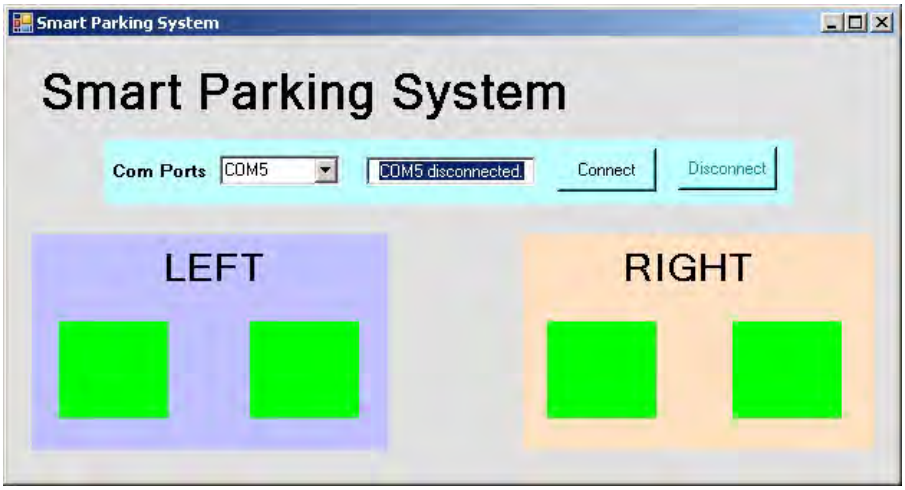

Figure 10: COM Port disconnected

This graphical user interface (GUI) function is for monitoring the vacant parking lot. The input for the GUI is from the circuit of detection unit, when the sensor detection an object it will send data from detection units to the GUI to display the parking lots already occupied. Figure 11 below show the flow chart for the software operation.

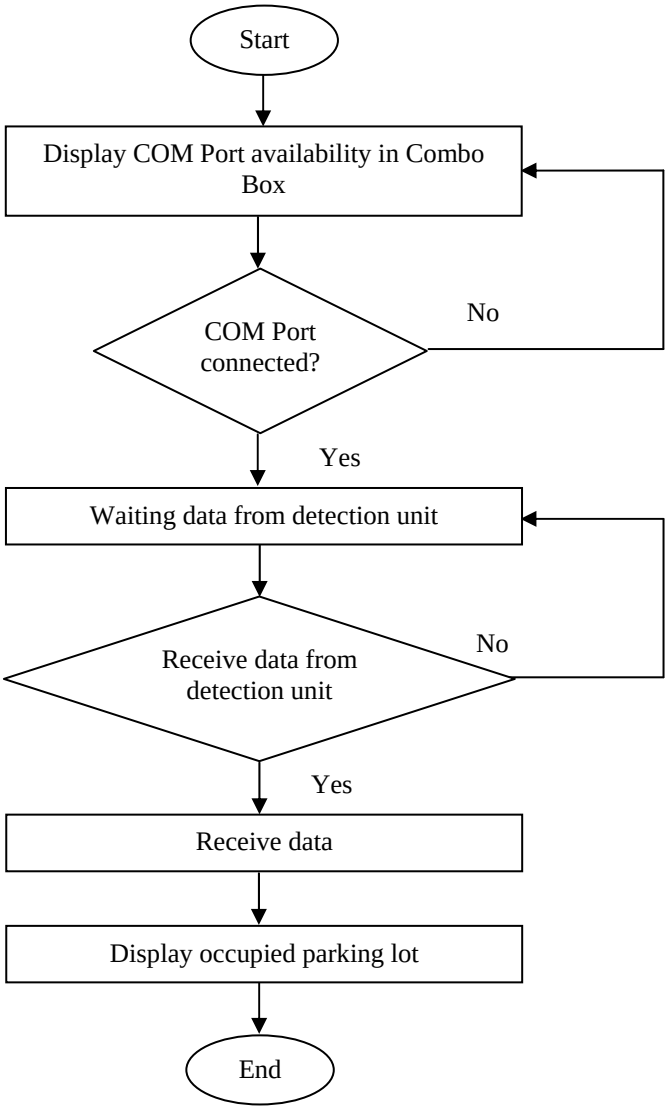

Figure 11: Software Monitoring System Flowchart

In this project, the first things that need to be confirm is the com port setting between software and the receiver xbee. If the receive xbee is not connect properly it will not communicate each other with the detection units and it cannot transfer data to GUI. Figure 12 shows the flowchart of detection unit.

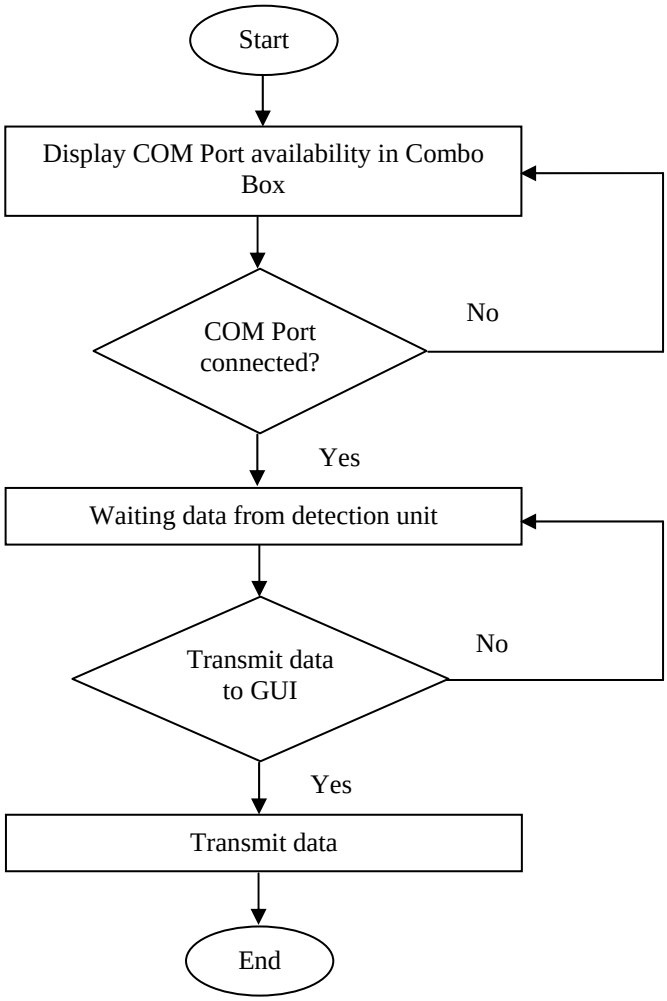

Figure 12: Detection Unit Flowchart

B. Hardware Implementation

1) Designing Circuit

In order to properly design the circuit and fabricate it into the board, a circuit must be properly analyzed with various conditions and recognized any potential hardware setup. This is to make sure that the circuit that we going to designed is fully functional. Thus, it is very essential to perform simulation routine inside simulation software to simulate the circuit environment and tested it various conditions in order to make sure the circuit that we designed is actually robust and efficient. Figure 13 shows the corresponding circuit that we are going to use in this project.

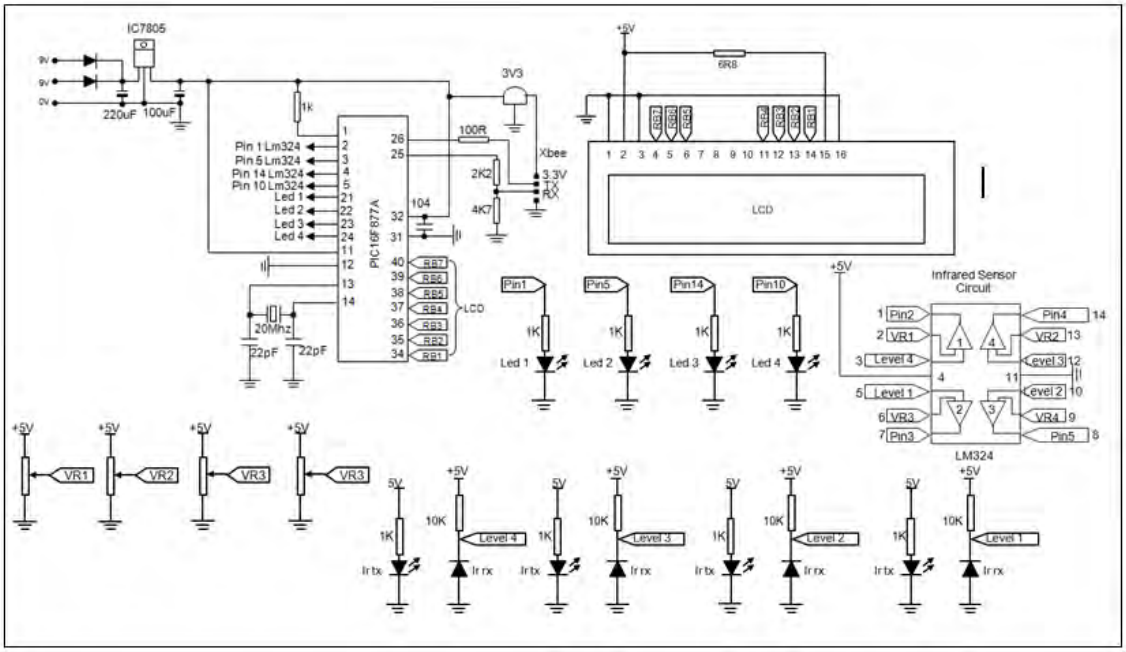

Figure 13: Overall circuit

The figure above show the schematic diagram of the circuit that construct in Proteus simulation software and run the simulation to make sure the circuit fully function and then the next procedure can be proceed. After complete with the simulation of the circuit, the next procedure is to get the PCB layout of this complete circuit. It can be produce by transferring the circuit design workspace in Proteus simulation to PCB layout workspace. The figure below is the PCB layout for the overall circuit and lastly the PCB layout will be print out and ready to be etching process.

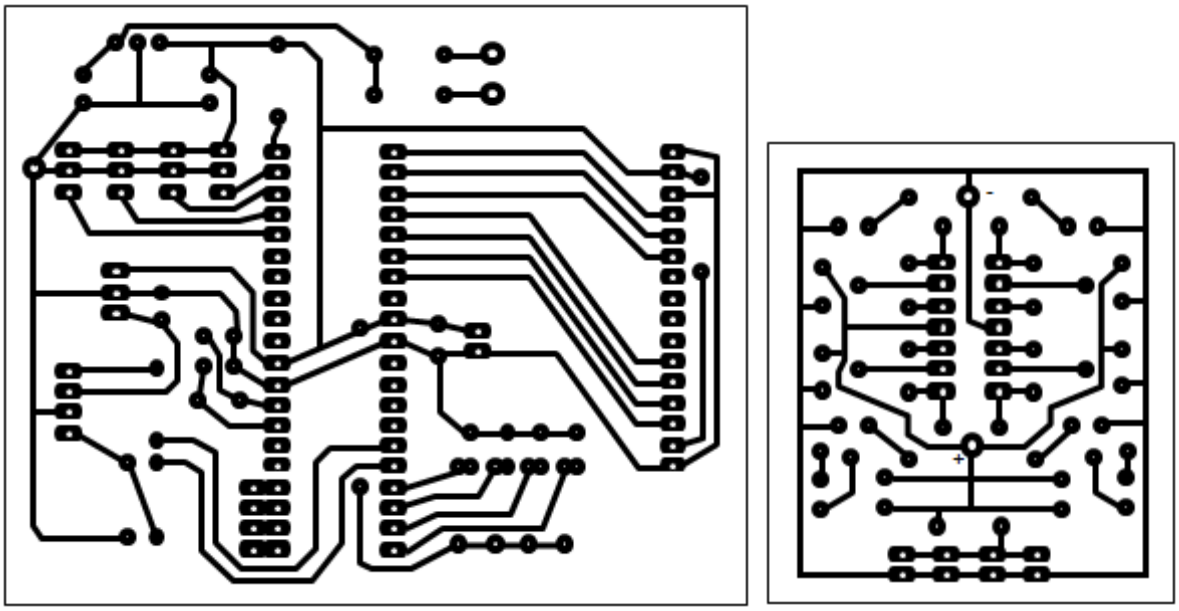

Figure 14: PCB Layout

2) XBee Pro Configuration

The XBee modules need to set before it can be used as a medium of serial communication between software and hardware. The XBee module configuration will run through the X-CTU software by Digi Corp. The XBee and XBee Pro series use the same software to configure it.

The X-CTU software has some other functions XBee module configuration. Each tab has their own function in order to develop communication using XBee modules. Here is an explanation of its function:

- **PC Settings**

Allow user to select the desired COM port and configure ports to fit the wireless settings.

- **Range Test**

Allow user to perform a range test between two radios.

- **Terminal**

Allow access to the computers COM port with a terminal emulation program.

- **Modem Configuration**

Allow the ability to program the firmware settings via a graphical user interface.

To configure XBee Pro module, it can be completed by using X-CTU software. The software will automatically detect an available COM port. By clicking the "Test / Query" button, the software began to interact with the module to test the selected COM port. Figure 5shows that the message box appears if the COM ports are OK.

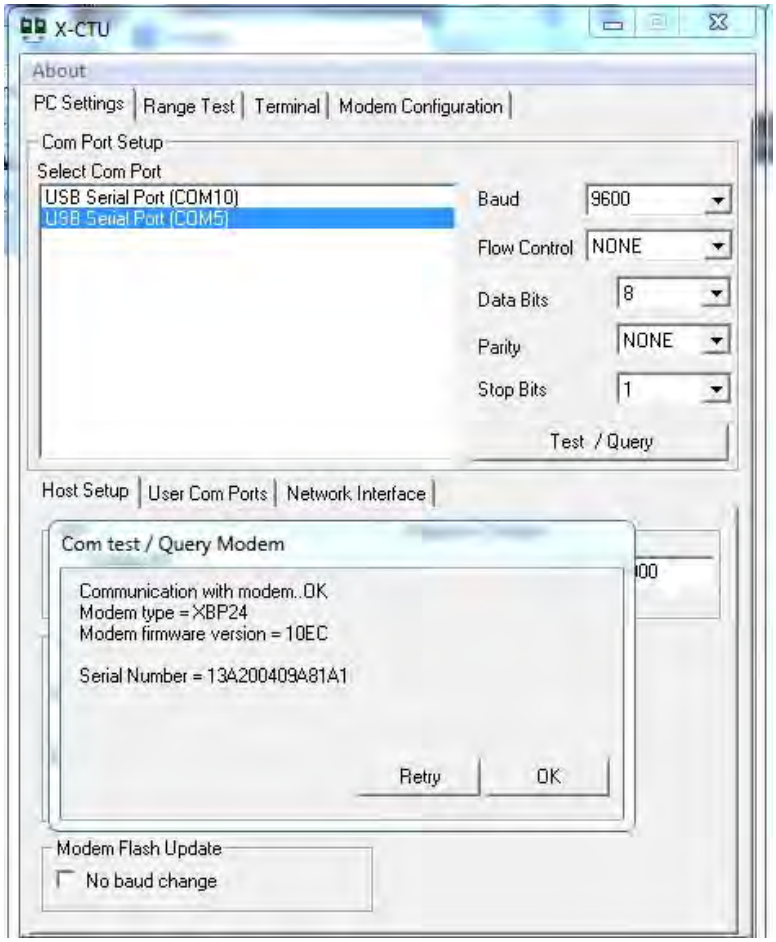

Figure 15: COM Port test

Next, at Modem Configuration, the specified information about the module can be adjusted according to desired user. To create a connection between two modules, some changes must be made by modified the selected properties as shown in Figure 16.

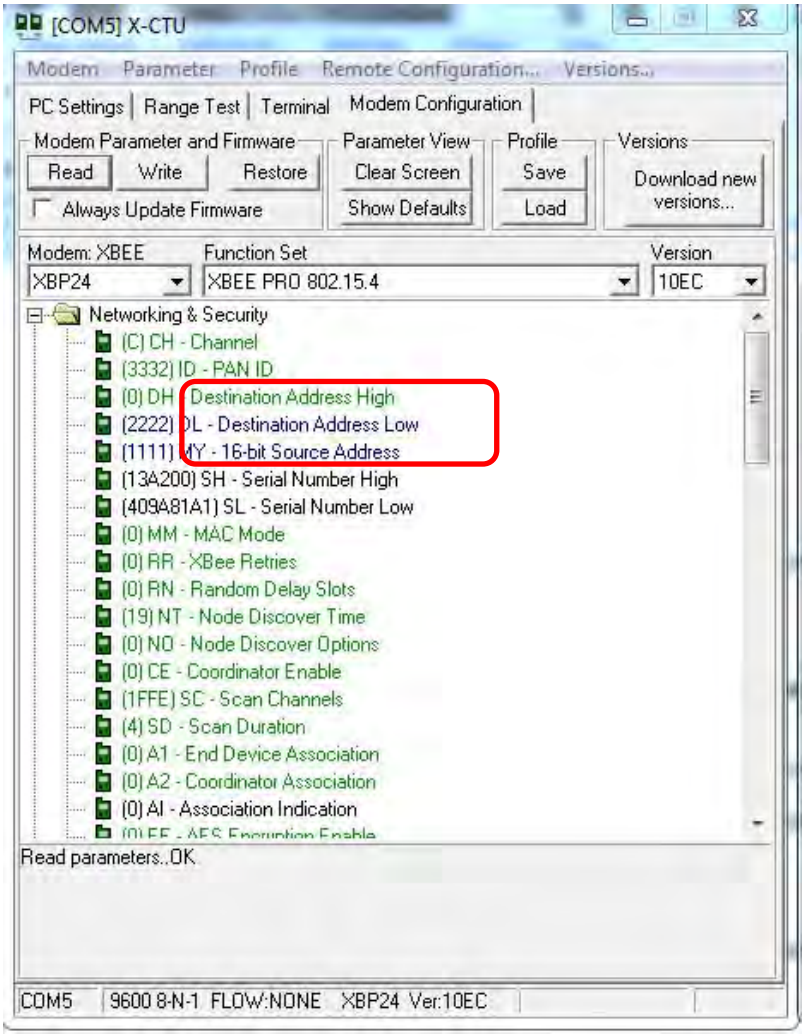

Figure 16: Modem Configuration

As in Figure 16 three properties need to be modified in order for these modules to communicate with each other. The Destination Address High is set according to the user, for this project it is set as 0. This address will be the receiving and transmitting address for the module, so that the two modules must use the same address. Serial Number High and Serial Number Low represent the serial of the module itself. Figure 17 shows the setting between both modules.

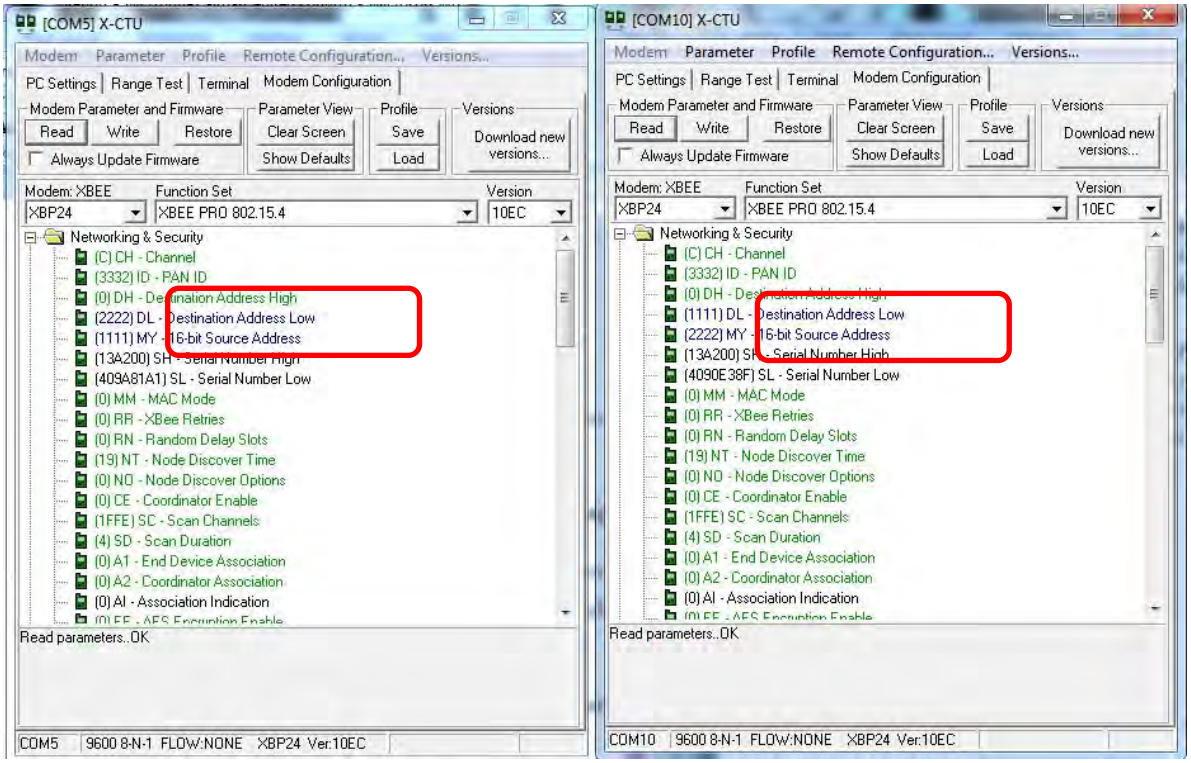

Figure 17: Configuration of Both Modules

After all settings have been made, the test should be done to find out whether the communications function. As in Figure 18 it shows that the transmission and receiving of data to work properly. The blue color represents the data transmission while the red color represents the data received. Therefore, the communication between the software and hardware will work properly via wireless serial communication.

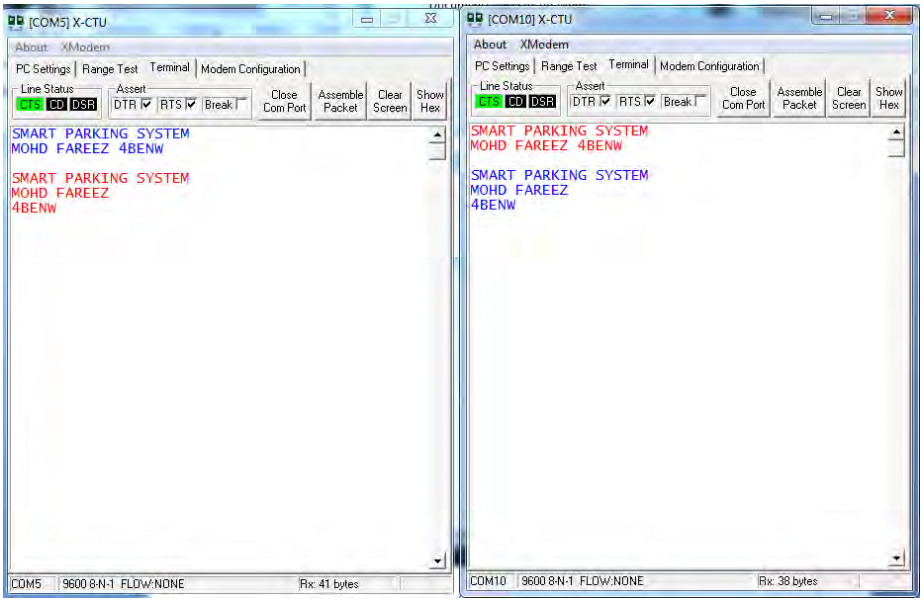

Figure 18: Transmit and Receive test.

C. *System Operation*

Before start this system, the model of the parking system need to be supply with 9V current for the system operate smoothly. If the supply current below than 9V the system cannot function correctly, it can cause the system cannot detect the object smoothly because the current that supply to detection units is not enough to operate the overall circuit. After the system is supply with 9V current the Xbee module will be started up and will communicate with each others. This step is necessary to ensure that the parking model is communicated

with monitoring system correctly. Figure below show the Xbee module is started up and communicate with the monitoring system.

Figure 19: Xbee Startup

At the monitoring system interface, the COM port needs to be selected and connected by clicking the drop down list in a combo box object to select the COM port and clicking the "Connect" button to ensure the software and hardware is connected. Figure below referring the selecting the COM port and display status of the monitoring system is connected. When the parking model and the monitoring are connected the system is ready to operate. The parking models have 4 detection units and it can be display at monitoring system as LEFT and RIGHT sides.

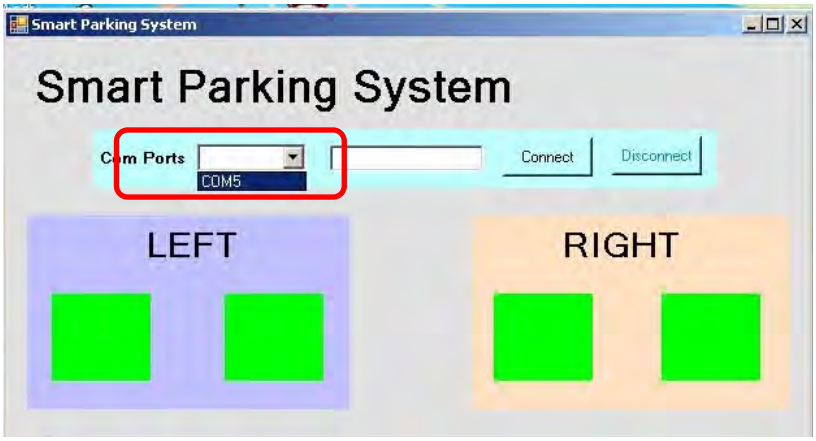

Figure 19: COM Port selecting

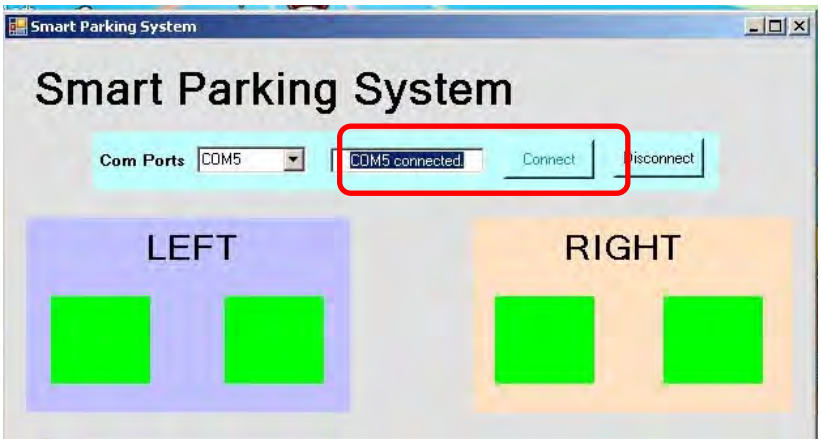

Figure 20: System Connected

1) Left Detection

After the parking system and the monitoring interface are connected this system can be fully functionally. At the parking model it will be display the indicator of occupy/occupied parking slot by referring

the LED indicators. The red LED represent as an occupied parking slots meanwhile green LED as occupy parking lot. The display unit at the parking model will display and count the parking lot, if the all the sensor detect object it will display “FULL” to represent the parking lot for all slots already occupied. Figure below will show the detection object and the graphical user interface of monitoring system functionally. Figure 21 and 22 shows the left detection steps.

Figure 21: LEFT 1 detection

Figure 22: LEFT 2 detection

When the ir sensor detect an object, it will trigger the microcontroller to change the indicator for green led to red led which mean the led indicator represent a parking lot. After that, the data from the detection unit will count the detection object will be display at the display units as shown as figure 21 and figure 22.

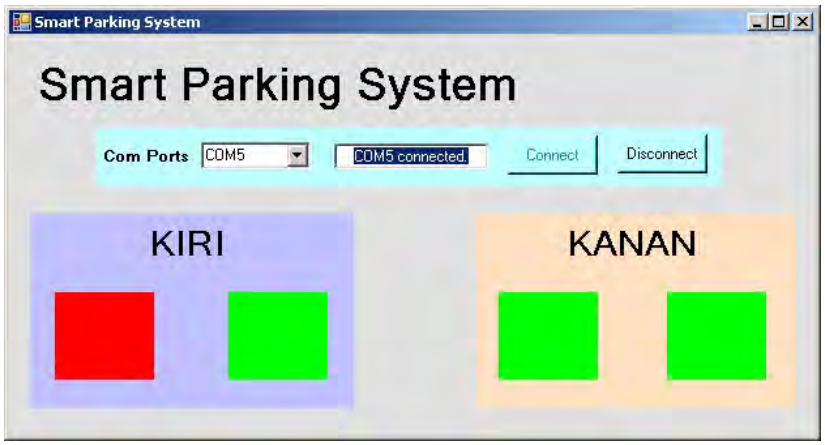

Figure 23: LEFT 1 Monitoring system

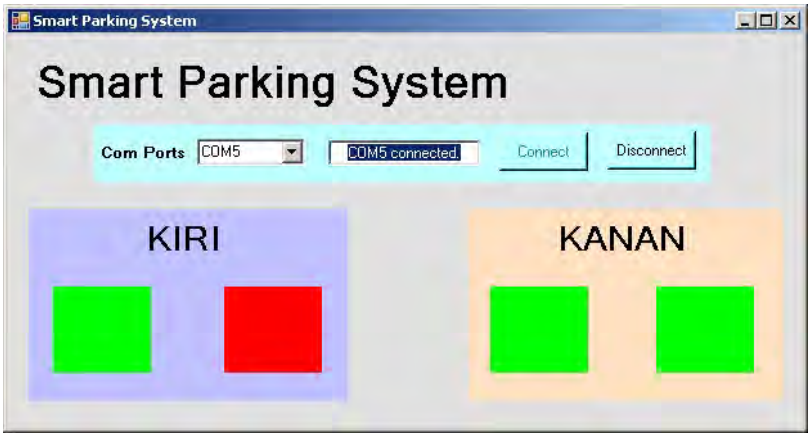

Figure 24: LEFT 2 Monitoring system

Then from the detection unit, microcontroller will sent data to xbee transmitter to allocate the detection at parking system and will be display at monitoring system as shown as figure 23 and figure 24

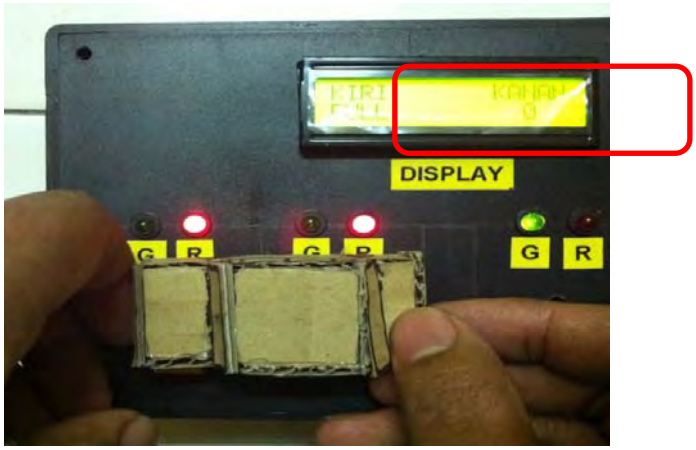

Figure 25: Display status 'FULL'

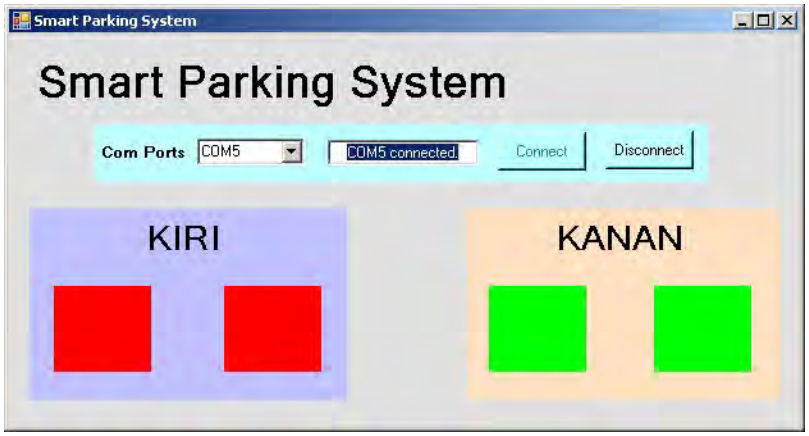

Figure 26: LEFT side detection

When the LEFT detection detect an object the display unit will display “FULL” indicator to show all parking at LEFT side already occupied. Figure 25 show the parking lot is occupied and display “FULL” at display unit and figure 26 shows the monitoring system at “FULL” condition.

2) RIGHT Detection

For right detection it same as the left detection function. If the ir sensor detects an object, the indicator changed from green led to red led which mean the led indicator represent parking lots occupy/occupied. After that, the detection unit will count an object and will be display at the display units as shown as figure 27 and figure 28.

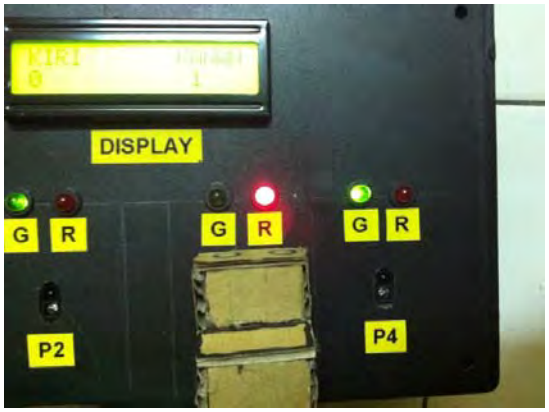

Figure 27: RIGHT 1 detection

Figure 28: RIGHT 2 detection

After that from the detection unit, microcontroller will sent data to xbee transmitter and received at receiver module and will be display at monitoring system as shown as figure 29 and figure 30.

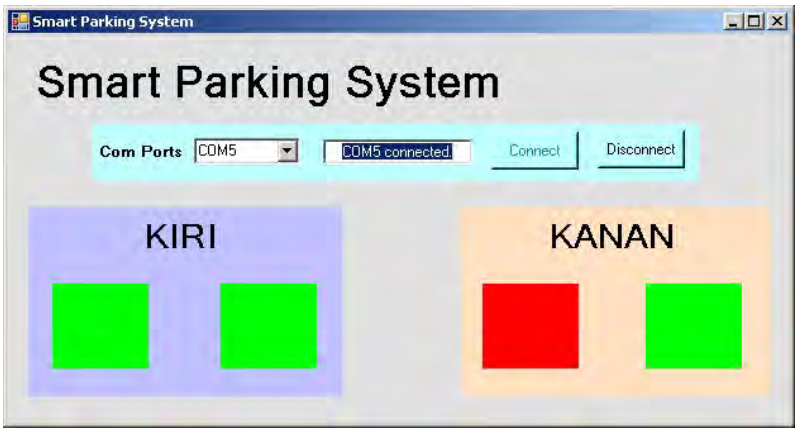

Figure 29: RIGHT 1 Monitoring system

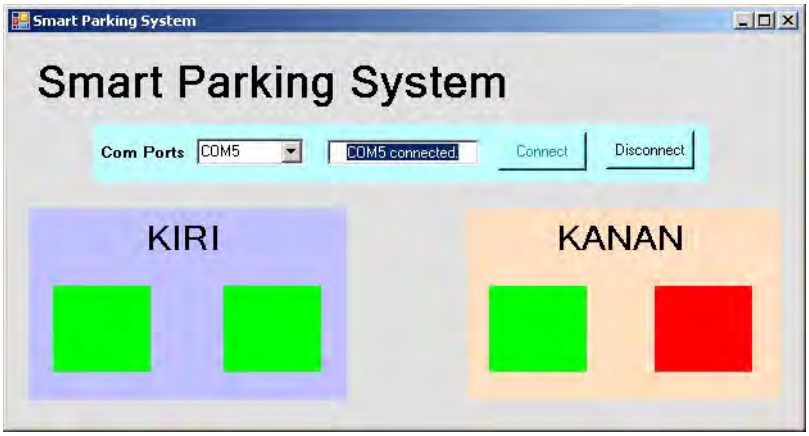

Figure 30: RIGHT 2 Monitoring system

Figure 31 Display status 'FULL'

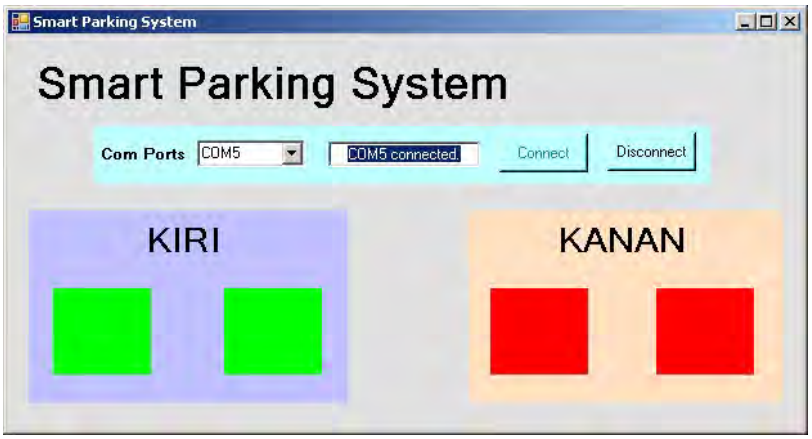

Figure 32: RIGHT side detection

When RIGHT detection detects an object display unit will display "Full" to show all parking on the RIGHT side is occupied. Figure 31 show the parking lot is occupied and display “FULL” at display unit and figure 32 shows the monitoring system at “FULL” condition.

V. CONCLUSION AND FUTURE WORK

As a conclusion, the project Smart Parking System has been successfully designed and tested. It has developed by integrating entire features of the hardware and software used in this project. The presence of any information has been reasoned and placed carefully thus contribute to the best work of the units. Besides that, the software and hardware architecture of a parking system has successfully developed for driver guidance. The

graphical user interface is friendly user and can be monitor the parking system easily. In addition, to enhance motion sensor will be used and specifications of the sensor is very important.

Besides that, this system can reduce the man power and could face with new insights or new technology. By using this system, visitors or users simply follow the direction of the system to the occupy parking lots easily. This system also helps the visitor or users to searching vacant parking lot in shorten time.

In future works, this system can be improved by adding other applications such as reservation parking system by using gsm or online booking. The driver or user can book their parking lot at home or on the way to the shopping mall. This can reduce the time of the user to searching the vacant parking lot. The guidance for driver or user to searching the parking lot must be display clearly, for example at the entrance of the building or parking level must have a parking layout and display the empty parking lot clearly.

As a further study, different sensor systems can be added to improve this system to detect the object and guide the driver or users fastest.

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