DESIGN AND FABRICATION OF WIRELESS BASED AUTOMATED CAR PARKING PROTOTYPE SYSTEM

[1]SU NAING MYINT, [2]MIN MIN OO

[1,2]Department of Electrical Power Engineering Mandalay Technological University
E-mail: [1]cherrymaymalaysu@gmail.com, [2]minminooep@gmail.com,

Abstract- Now a day's numbers of cars have increased; because of this car parking is a big issue which in turn causes traffic jam problem. To overcome this problem, "Automated Car Parking System" is the best solution. The system is based on PIC and RFID. It consists of one main display at the ground floor which is basically counter that displays number of cars in each floor. In each slot consists IR sensor which indicate that parking space is available or not on that particular slots. There is facility of lift to carry the car to up and down. Movement of lift is controlled by motor. The driver will park his vehicle on a pallet at the platform of the car park. Then the sensor will detect the available empty parking spaces and display them on the LEDs panel. At the LEDs are providing to indicate position of lift. After the driver selects the desired parking space on the mobile phone, the vehicle will be transported to that parking space. In order to retrieve the vehicle, the driver will select the location of his vehicle on the mobile phone. The system will retrieve the vehicle from the parking space and send it back to the original position where the driver is waiting. There are three portions in automated car parking system. They are RFID system, car lift control system and Bluetooth serial system. For the RFID system, 13.56 MHz passive reader and tag pairs are used. In this system, human power is not used therefore error is less also required low space with provides highest security and greatest flexibility. No need for energy intensive ventilating system. Due to this advantage system used in public parking, rail station, airport, hotels, mall.

Keywords- RFID module, PIC microcontroller, IR obstacle sensor, H-Bridge motor driver

I. INTRODUCTION

Today, the world's population is exploded in mega cities and capitals over all developing and under development countries. Many of citizens shifted to capital area new opportunities and jobs to improve life style. City planning and awareness of life is more and more problem to day by day at these areas [1].

Many of authorities, planner and designer find out more flexible design for housing, apartment and landscaping design to solve this population problem. Towers, high buildings, compound apartments are basic of these system solution. Since, landscape area is smaller, only one solution is to build more higher and layered building for more capacity.

Figure 1 shows overall block diagrams for car parking system. System is composed of a lift to carrying car and three floors building. There are three cars can be kept in one floor as maximum. So, maximum capacity can be nine for three floors. First floor, second floor and third floor are used. So, a RFID card protected security is enhanced in floors access. Idea is to use car lift without go outside from car. Operator or user of parking system needs to stop access area of lift. If lift is free, car is carried to first floor.

If first floor is full, second floor is automatically chosen by system. If lift is busy, an alarm indicated that access is stopped. For accessing the floors, user must enter valid predefined security card number with RFID. If number is granted, green LED will light on and car will be carried to floor.

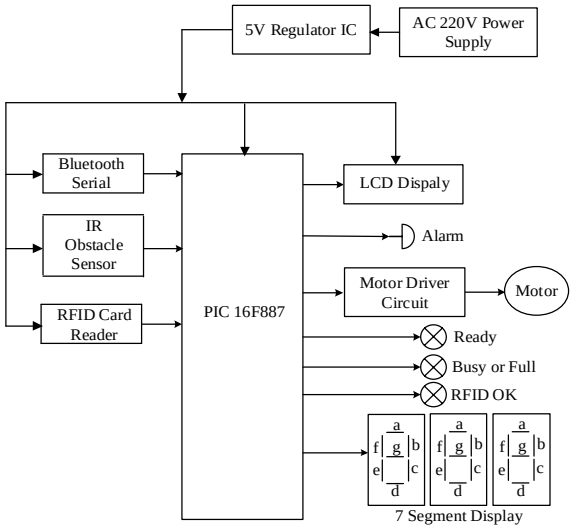


Figure 1. System Block Diagram of Automatic Multi-storied Car Parking System

II. HARDWARE IMPLEMENTATION

In this paper, the system is mainly composed of PIC microcontroller, motor driver circuit, IR sensors and dc motors, RFID, HC06 bluetooth module, smartphone and 7 segment display driver circuit.

A. Bluetooth to Serial HC-06 Wireless Module

In this research, mainstream CSR Bluetooth chip, Bluetooth V2.0 protocol standards is utilized. This serial module's operating voltage is 3.3V [2]. It can

work within the baud rate for 1200, 2400, 4800, 9600, 19200 and 38400 respectively. The core module size is 28mm × 15 mm × 2.35mm.The working current is 40mA and sleep current is less than 1mA.This module can be used for the GPS navigation system, utility meter reading system, the industrial field, collecting and controlling system with a Bluetooth smartphone to the Bluetooth adapter, PDA and other devices to seamlessly connect. In this research, it is mainly used to transmit the command from smartphone to the vehicle with 9600 baud rate as shown in Figure 2.

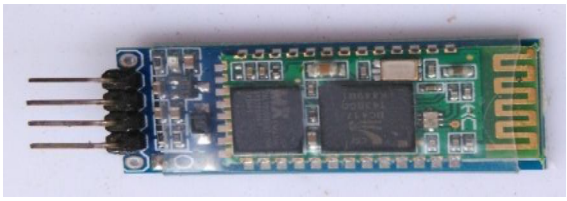


Figure 2. HC 06 Bluetooth Module

B. Infra-red (IR) Obstacle Avoidance Sensor

This system consists of IR obstacle avoidance sensor. This IR obstacle avoidance sensor connects to the each slot of the system. IR obstacle avoidance sensor consists of transmitter and receiver module. Transmitter sends the pulse and receiver receives the signal. The main workings of sensor are to sense the car and to send the signal to the microcontroller. After that microcontroller take proper action.

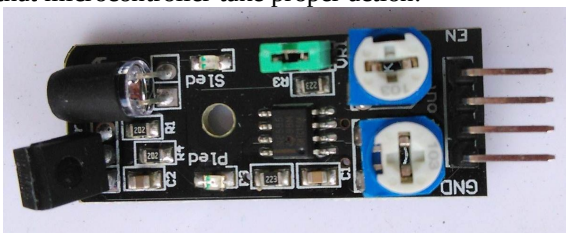


Figure 3. Infra-red (IR) Obstacle Avoidance Sensor Module

1. Transmitter section

The transmitter section sends out a wave at a certain frequency such as 38kHz or other frequencies [3]. The frequency choosing depends on the receiver IR sensor. In this system, the transmitter is designed for 38 kHz frequency. The 555 timer is used as an astable state. The variable resistor can adjust up to a certain frequency. The transmitter circuit diagram is designed as shown in Figure 4.

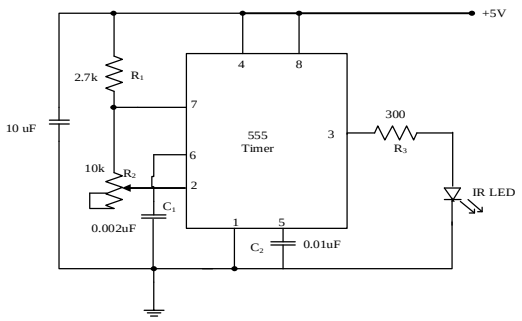


Figure 4. 38 kHz IR Transmitter Circuit [3]

The frequency oscillation of the astable operation for 555 timer is

$$f = \frac{1.44}{(R_1 + 2R_2)C_1} \qquad (1)$$

f = frequency (Hz), R2 = variable resistor (8.123k ohms), C1 = capacitor (0.002 µF).

2. Receiver section

The receiver section is designed to pick up the transmitted frequency. The 555 timer is also used in the receiver circuit as the monostable state [3]. The output condition of the 555 timer IC is need to be stable and send these signal to the PORTA0~A5 and PORTB1~B3 of the PIC 16F887 microcontroller as shown in Figure 6. TSOP 1738 IR sensor is used for the system because of the transmitted frequency is 38 kHz. The TSOP 1738 is a standard IR remote control receiver. The circuit diagram of the IR receiver section is shown in Figure 5.

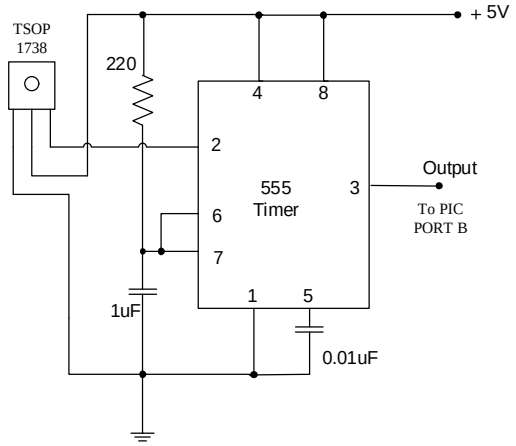


Figure 5. 38 kHz IR Receiver Circuit [3]

3. RFID Technology

Radio-frequency identification (RFID) is an automatic identification method wherein the data stored on RFID tags or transponders is remotely retrieved. The RFID tag is a device that can be attached to or incorporated into a product, animal or person for identification and tracking using radio waves. Some tags can be read from several meters away, beyond the line of sight of the reader. It is the use of a wireless non-contact system that uses radio frequency electromagnetic fields to transfer data from a tag attached to an object. Some tags require no battery and are powered by the electromagnetic fields used to read them. Others use a local power source and emit radio waves (electromagnetic radiation at radio frequencies). The tag contains electronically stored information which can be read from up to several meters (yards) away.

Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object. While RFID's original uses were

primarily for inventory tracking in retail environment, this technology has quickly created a presence in an extremely diverse number of fields including easy gas payment, credit card replacements [4].
RFID system has three major Components:
1. An RFID tag – transponder.
2. An RFID reader – transceiver.
3. A predefined protocol for the information transferred.

III. FUNCTIONAL DESCRIPTION

In this car parking system, PIC microcontroller is used to control the overall system. In this system there are two types of classification, which mean a RFID system and car lift control system. For controlling this situation determining RFID discrimination is composed by RFID reader and RFID tag. For authorization process, matching with the user information already stored in database system. SD card adaptor is used as database and data storage device. For the first identification and classification, radio frequency produced by RFID reader and RFID tag are used to identified whether register person or not. For second, Android mobile phone is used to check the room by the users. 16×2 line LCD display is used to alert notification message depend on identification process. As shown in Figure 1, the construction of Automated Car Parking System consists of two parts: the hardware and software implementations. Both software and hardware will be accomplished using PIC 16F887 microcontroller. The PIC microcontroller was chosen for reasons of speed memory storage, number of I/O ports and digital ports ability. This program is written by Basic-pro language because it is easy to understand than other programming languages. PIC 16F887 is used to control all I/O and processing. There are nine inputs for IR sensor circuit with pins RD4~RD7and RB1~ RB5. Car detection circuit, floor arrived signal circuit (RA0~RA5) and RFID signal from two inputs are connected to RB6 and RB7. PORTB0 is used for Bluetooth signal from GSM mobile. Pin connections are shown in Figure 6.

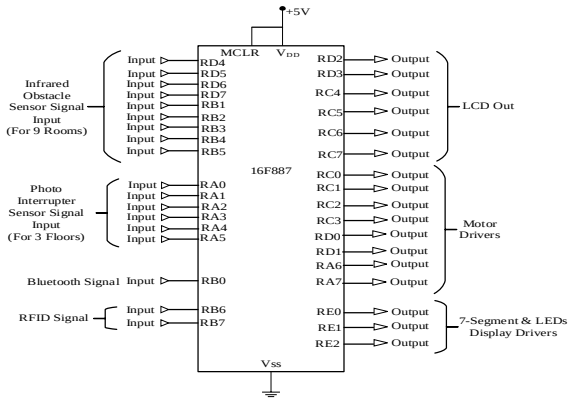


Figure 6. PIC 16F887 I/O Pin Assignment Diagram

For output, 74HC595 IC is used as LED monitor for Ready, Busy or Full and RFID OK status. PORTC0~C3, PORTD0, D1 and PORTB5, B7 are used for H-Bridge motor driver control signal. RE0, RE1 and RE2 are used as 7-segment displays with 74HC595 eight-bit registers. PORTD2, D3 and PORTC4~C7 are used as data inputs for LCD displays.

System design is based on digital control techniques, all I/O ports are used as only digital ports. 4 MHz internal frequency is used for clock source of PIC. To accomplish the system, the choosing of software is very important. The Basic-Pro Program is used to implement the system. Figure 8 shows the flow chart for automatic car parking system.

RFID reader reads the ID number from the RFID tag. Then, the reader sends the ID number to the PIC for checking with the database. If the ID number is valid, the user will be selected the room number with the mobile phone. And then, the car is presented that the room number will be showed at LCD and 7-segments. If the ID number is invalid, the alarm will be opened. PIC 16F887 microcontroller is used as control unit.

16F887 microcontroller consists of 40 pins. It contains a Central Processing Unit (CPU), Random-Access Memory (RAM), Read-Only Memory (ROM), Input/output (I/O) lines, serial and parallel ports, timers and sometimes other built-in peripherals such as Analog-to-Digital (A/D) and Digital-to-Analog (D/A) converters. By using the sophisticated PIC 16F887, the automated car parking system uses fewer components that would have been required in the system. This microcontroller can be reprogrammed because it uses flash-read only memory for program storage.

The automated multi-storied car parking system contains power supply unit, PIC 16F887 and other components. 7805 regulator IC is used for the power supply unit. 220V AC input voltage is supplied to the power supply unit and the output is DC 5V. Pin 11 and 32 of the PIC 16F887 are connected to the VDD while pin 12 and 31 are connected to the ground (VSS). In this system, pins Port D, C and E are used for output pins and Port A and B are used for input. Pins Port B6 and B7 are connected to the RFID module. Pins Port B0 is connected to the Bluetooth Serial module. Port C pin 0 to 3 and Port D 0,1 and Port A pin 6, 7 are connected to the H-bridge motor drivers. Port E pin 0 to 2 are connected to the 74HC595 while Port D pin 2 and 3, Port C pin 4 to 7 are connected to the LCD as shown in Figure 8. The 5V power supply is connected to VDD and MCLR of the PIC 16F887.

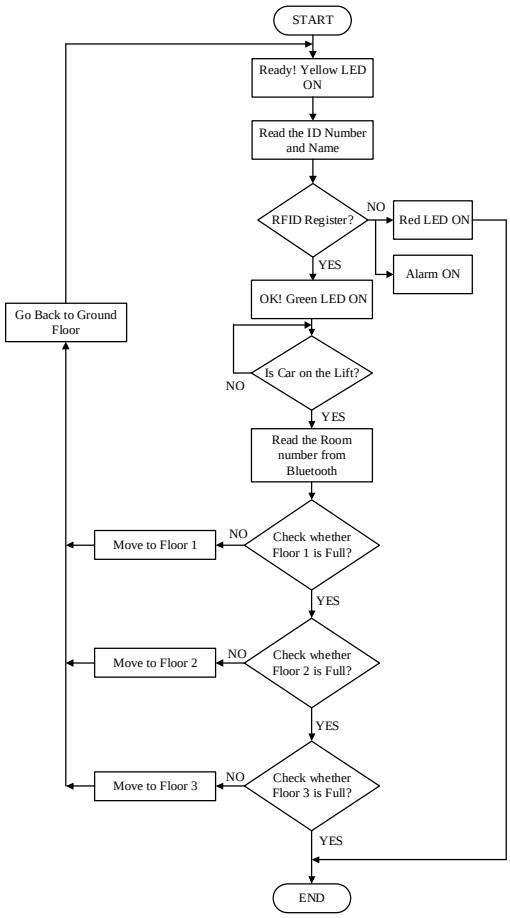


Figure 7. The Work Flowchart of Automatic Car Parking System

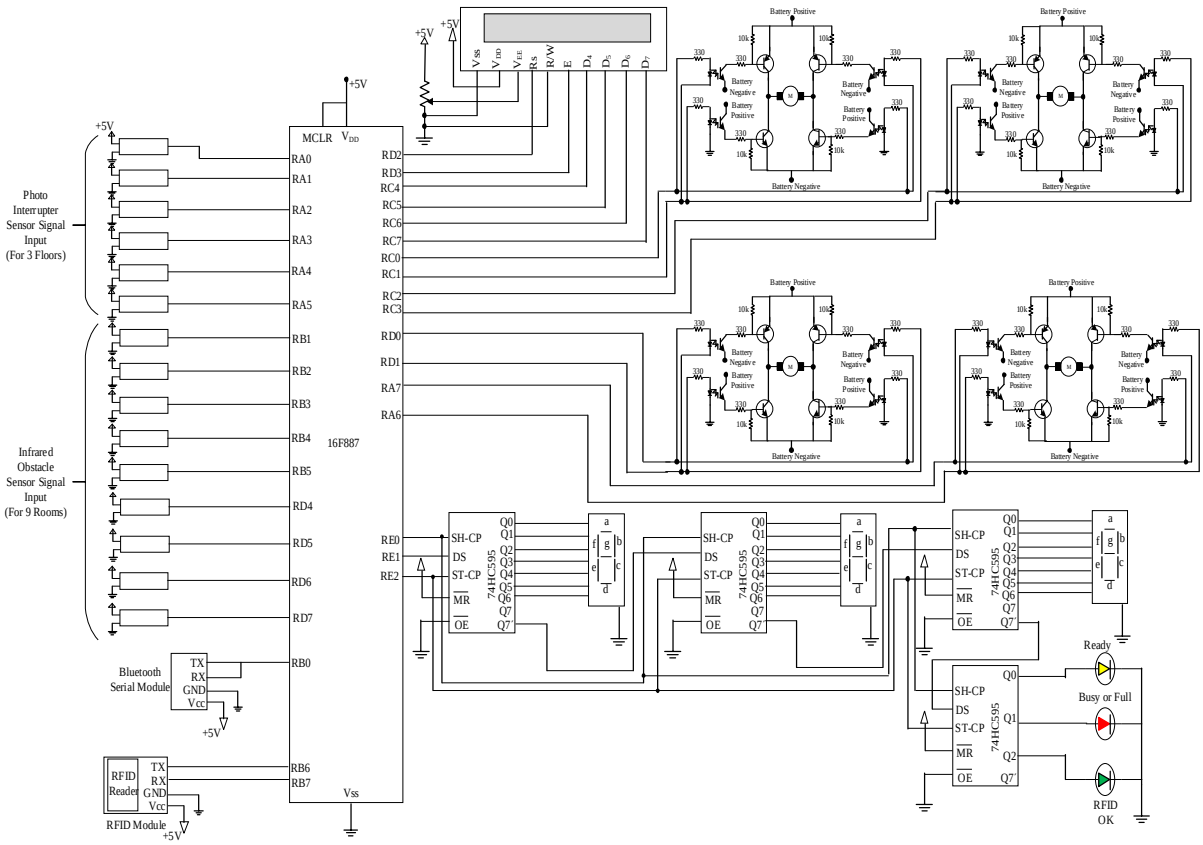


Figure 8. Overall Circuit Diagram of Automated Multi-storied Car Parking System

IV. SIMULATION RESULTS

Before constructing the automated car parking system, the database construction and simulations are needed. Therefore the simulation results and experimental results of the system which is implemented are described. For the database, the user ID and owner name are constructed in PIC16F887 with Basic-Pro Program. In this experiment, passive RFID tag and reader pairs are used. For the simulation results, PROTEUS 7.7 PROFESSIONAL is used. In PROTEUS, RFID reader, RFID tag and IR sensor do not have. So, virtual terminal is used for RFID reader and tag and the bush button are also used for IR sensors.

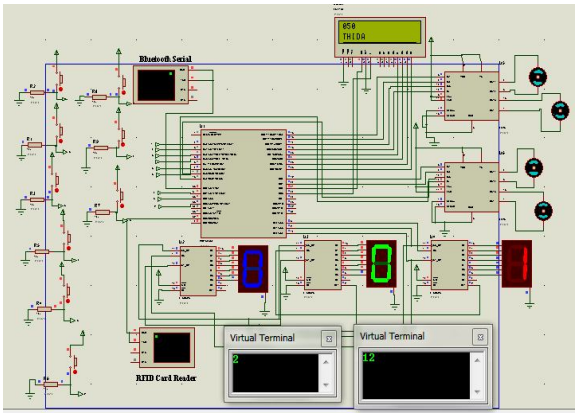


Figure 9. Simulation Result for Automated Car Parking System when RFID Card is running

In order to control the DC motor which is used for the lift, it is achieved by the combination of microcontroller and virtual port communication between Basic-Pro Program and Proteus software. In the Proteus software, the user enters the input signals into the RFID edit virtual box and microcontroller receives this signal according to the card number and user name are shown on LCD. And then the user enters again the input room number into the Bluetooth Serial edit virtual box and microcontroller receives this signal and the motors will be rotated according to the room number is shown on LCD and 7 segments. The database table is as shown in Table I.

TABLE I
RFID DATABASE TABLE

ID Number	Name
048	Su Su
049	Mya Mya
050	Thida
051	Aung Aung
052	Tun Tun

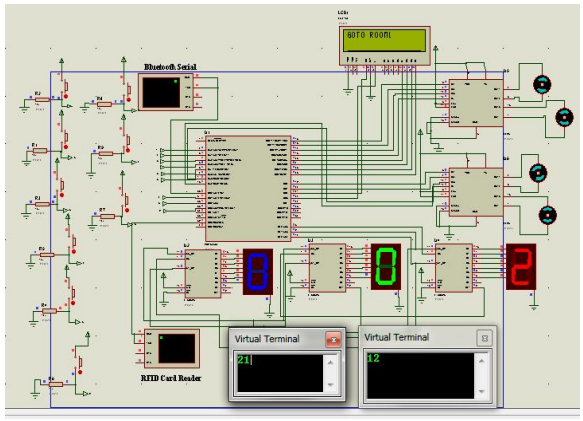


Figure 10. Simulation Result for Automated Car Parking System when Bluetooth Serial Module is running

And then, the simulation results of automated car parking system are shown when RFID card is running as shown in Figure 9 and when Bluetooth serial is running as shown in Figure 10.

V. EXPERIMENTAL RESULTS

A. Calculation of H-Bridge Motor Driver Circuit

Supply, VCC = VLOAD = 5 V
Power, PMOTOR = 2.5 W
Saturation voltage, VCE(SAT) =1.5V (from datasheet)
DC current gain, hFE = 30 (from datasheet)

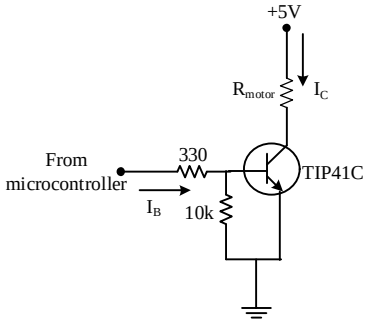


Figure 11. TIP41C NPN Driver Circuit

For TIP41C (NPN) driver circuit,

$V_{MOTOR} = V_{CC} - V_{CE\,(SAT)}$
$= 5 - 1.5 = 3.5$ V

$P = V \times I$

$$I_{MOTOR} = I_C = \frac{P}{V} = \frac{2.5}{3.5} = 0.7 \text{ A}$$

$$\text{Base current, } I_B = \frac{I_C}{h_{FE}} = \frac{0.7}{30} = 0.023 \text{ A}$$

Base voltage, $V_B = V_{IN} = 5$V (from microcontroller)
$V_{BE} = 0.7$ V

$$\text{Resistance of Base, } R_B = \frac{V_B - V_{BE}}{I_B}$$

$$= \frac{5 - 0.7}{0.023} = 186.956\,\Omega \text{ (min)}$$

So, standard value of base resistance 330Ω is chosen. In this circuit, capacitor RB = 330 Ω (standard value) is used and selected to give suitable base current for motor driver TIP41C (NPN) circuit. In the driver circuit as shown in Figure 11, the transistor stays turned off if the base is grounded, it turns on when current flows through the 330 Ω resistor and into the base. A typical microcontroller's output pin can generally put out either 3.3V or 5V as a logic "true" output. Given that the user need only approximately 23 mA to turn the transistor fully on, the user could compute the necessary base resistor by subtracting the base-emitter voltage drop (0.7V) from the logic high voltage (3.3 or 5V) and then dividing by the desired base current (23 mA) to get the appropriate resistor (at least 330 ohm or above respectively).

When pin RC0~RC3 and RD0, RD1, RA6 and RA7 is connected with the four set of H-Bridge motor driver circuit for four DC motor.

When pin RC0 on the PIC is set to be an output and "high" (logic 1 level) it puts 5V on the RC0 input of the driver circuit. This causes the optocoupler's LED to illuminate and that causes the transistor to turn "on." The optocoupler's transistor connects the base of the TIP41C NPN and TIP42C PNP transistors to ground and that turns that transistor on as shown in Figure 12. Similarly when RC1 is made "1" by the PIC, it turns on the sink transistor using a similar mechanism. The transistors are changed from state "Forward" to state "Reverse" and back again, but neither "Forward" nor did “Reverse” specify.

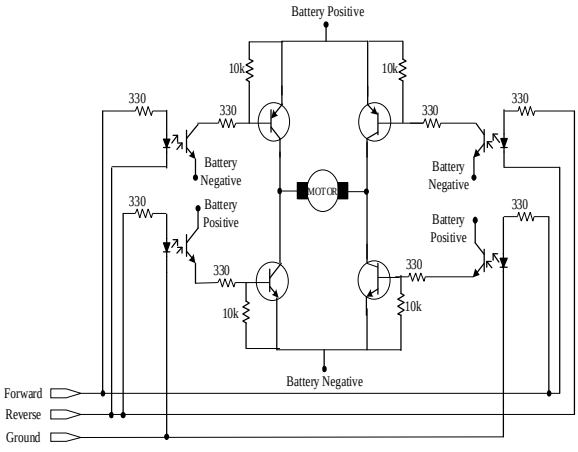


Figure 12. Circuit Diagram of H-Bridge Motor Driver for Automated Car Parking System

B. Practical Results

Based on a simple basic idea, this IR obstacle sensor is easy to build, easy to calibrate and still, it provides a detection range of 10- 30 cm. This sensor can be used for most indoor applications where no important ambient light is present. It is the same principle in ALL Infra-Red proximity sensors. The basic idea is to send infra-red light through IR-LEDs, which is then reflected by any object in front of the sensor.



Figure 13. Signal Received by IR Obstacle Sensor with frequency 38.78 kHz

By using these electrical components, hardware experimental testing result of automated multi-storied car parking system is shown in Figures 14 and 15. The system is constructed with a small demonstration model as shown in Figure 16. Model is composed of three floors, a lift and a motor mechanism assembly. Motor assembly is constructed by using small pulley, rotor and spring rope. When motor is driven forward or backward, a lift from model is moved upward or downward by means of pulley.

For calculation the value of resistance R2 from Figure 4 and equation 1,

$R_1 = 2.7k\ \Omega$

$f = 38.78k$ Hz (measurement data from Figure 13)

$C_1 = 0.002\mu$ F

$$f = \frac{1.44}{(R_1 + 2R_2)C_1}$$

$$38.78k = \frac{1.44}{(2.7k + 2R_2) \times 0.002\mu}$$

$$R_2 = 7933.136 \approx 8k\ \Omega$$

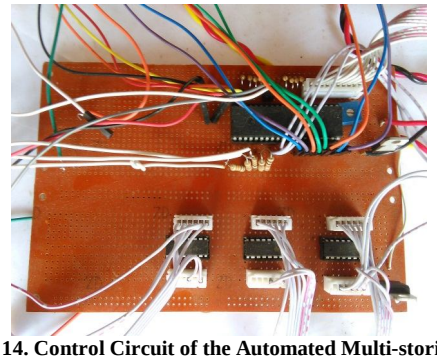


Figure 14. Control Circuit of the Automated Multi-storied Car Parking System

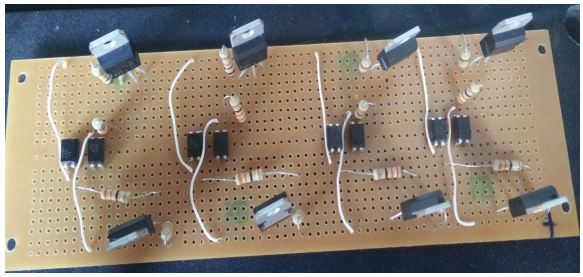


Figure 15. Control Driver Circuits for two DC Motors

After all sensors and motor supply are connected properly, system is power up. The lift is kept on the ground floor of the system. When a small object (car) is placed on the lift, the lift is moving upward until room 1 at floor 1 IR sensor is detected as shown in Figure 9. After sensor is detected light from floor-1, the lift motor is stopped. After object is removed from the lift (this mean that car is go down to the floor), the lift goes down to the ground floor and stay standby until the next car is arrived over the lift.

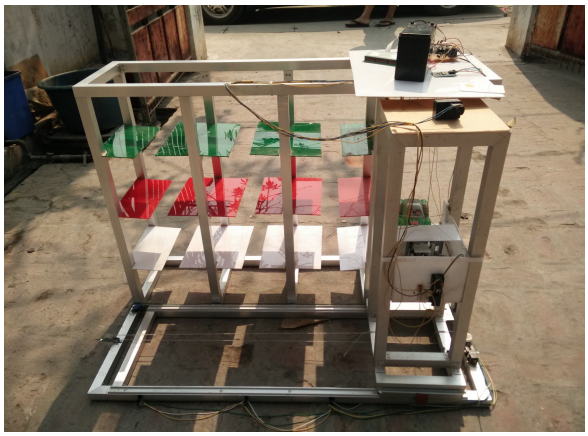


Figure 16. Prototype of Automated Car Parking System

To achieve the construction of automated car parking control system using RFID and IR sensor, electrical components must be selected.

VI. DISCUSSION AND CONCLUSION

Automatic multi-storied car parks provides lower building cost per parking slot, as they typically require less building volume and less ground area than a conventional facility with the same capacity. However, the cost of the mechanical equipment within the building that is needed to transport cars internally needs to be added to the lower building cost to determine the total costs. Other costs are usually lower too, for example there is no need for an energy intensive ventilating system, since cars are not driven inside and human cashiers or security personnel may not be needed. A multi-storied car parks offer greatest possible flexibility for the realization of optimum parking solution. A fast parking applications process in which the driver does not have to maneuver his car or drive backwards, guarantees highest comfort and security. A single lift serves 6 to 12 parking spaces per level taking up a minimum of space. Time-saving vertical and horizontal movements take place simultaneously ensuring fast parking and retrieval times.

Advantages of Multi-storied car parking system:-

- Provide enough parking spaces.
- Provide lower building cost per parking slots.
- Required less building volume and ground.
- Provides highest comfort and securities.
- Human error is less.
- Fast and time saving parking with greatest flexibility.

Limitations of a multistoried car parking system: There are some limitations of the system are occurs such as

- Slots are pollutant due to the motor oil.
- Challenge for authority to realize need and quickly.
- Estimate cost is high.
- Periodic maintenance is required.
- Provide backup systems during electricity failure.

So, we can reduce the traffic problem by using multistoried car parking system. We can park more cars in small space. We also reduce time and cost required for conventional parking system with high degree of security.

REFERENCES

[1]. [1] Mousawi, H.A.: “Performance and reliability of (RFID) Radio Frequency Identification”, Master Thesis, Agder University College of Norway, (2014).

[2]. http://mcuoneclipse.com/2013/06/19/using-the-hc-06 bluetooth-module, (2013).

[3]. [3] http://www. “Infrared Obstacle Detection Sensor Circuit.html”.

[4]. [4] Anonymous: “An Introduction to Practical Electronics, Microcontrollers and Software Design”, Feb 1, 2013, http:// www.techideas.co.nz/

[5]. [5] “Capacitor Input Filter Calculation” – ElectroSchematics.com, www.electroschematics.com.

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