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ELECTRONIC ENGINEERING

Microcontroller Based Car Parking Control System

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Abstract — **Nowadays, there is a gradual increase in car usage. Therefore, more car parking are needed in some places such as Supermarket, Shopping Mall and Department Store etc. Moreover, those car parking are needed to be systematic, secure, modern, safety and efficient. This paper is aimed to fulfill these necessities. This research paper is devoted the microcontroller based car parking control system. The control system consists of input, control and output section. The input section includes infrared sensors and PS/2 keyboard. PIC microcontroller is used as the main control unit. LCD, barrier circuit, LED, and beeper are included in the output section. Based on the status of the infrared sensors, the microcontroller drives the output section. The software is implemented by using PIC Basic Pro compiler.**

Keywords — **Car Parking, IR Sensor, Keyboard, LCD, PIC16F877**

I. INTRODUCTION

Cars are dominant mode in transportation. Unlike past, since a large number of cars are produced now, the number of cars in the world has been increasing from year to year. Most of the people go from one place to another by cars. So, car parking lots are essential in crowded places such as markets, shopping centers, cinemas, department stores, hotels and Universities, etc.

On the road where there is no parking lot near by, parking cars unsystematically can obstruct other cars and pedestrians. If cars are parked randomly inside the car parking, cars can't be placed up to maximum number of cars that can be held there. Therefore, car parking systems that are orderly, secure, safety and modern are essential. The aim of this paper is to design and construct the microcontroller based car parking control system that can fulfill these necessities.

In this car parking system, each space to park a car is named as an address such as room 1, room 2, etc. Moreover there is a green light to indicate the available space in the car parking. The user can see the address of the space available to park on the LCD board at the entrance of the car parking. The corresponding address green light in the car parking is turned on. So the user can easily find the space to park in the car parking. This parking control system can also prevent car accidents and nonsystematic parking in the car parking area. Since there is a sensor in each space for a car, the number of cars in the car parking can easily be known.

So, everybody can easily use this parking control system.

II. HARDWARE IMPLEMENTATION

A. *Overall Control System*

Figure 1 shows the overall block diagram of the microcontroller based car parking system. The area in parking lot is organized into parking spaces. Each parking space has their respective address to identify the location and there is a sensor in each space to sense whether there is a car in the space or not.

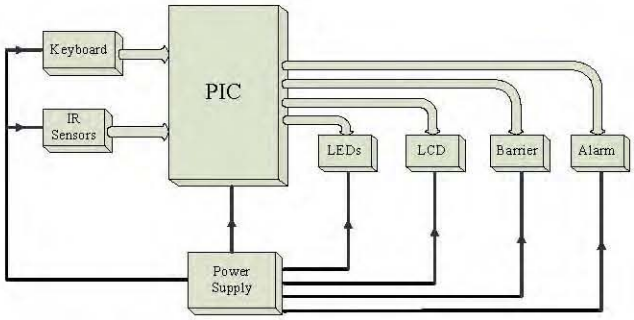

Fig. 1 Block Diagram of Car Parking Control System

There is also a sensor near the barrier at the entrance of the parking lot. When this sensor senses there is a car to park, it signals the microcontroller. And then the microcontroller checks that there is free space to park the car or not. If there is no car in the parking lot the address that is nearest to the entrance is displayed on the LCD. The barrier is also lifted by the controller. Inside the parking lot, the green light is also indicated in respective parking space so that the driver can easily find the space to park. Each time a car is coming to park, the same procedure happens. The microcontroller checks for free space, if there is free space, the address of the next consecutive parking space is displayed on the LCD and the barrier is also lifted. There is a green light in respective space indicating to park here. This procedure will happen until all the parking spaces are occupied.

If the microcontroller knows that there is no free space to park, the message "NO PLACE TO PARK' is displayed on LCD. And the barrier is locked by the microcontroller at that moment. If there is a car coming to park while one car is leaving, the coming car is messaged to wait by displaying "Wait for a while" at LCD display. Only when the leaving car is already left from the parking lot, the car waiting to park has

permit to enter the parking lot and to park. So, there will be no collision and accident between incoming car and outgoing car.

If someone wants to know the information about the number of cars parked in the parking lot and the number of free parking spaces, can be know by using keyboard. By pressing button on keyboard, the information that wants to know will be displayed at the LCD. An alarm is used to signal the operator of the car parking system when someone does not park in assigned parking space.

B. Selection of Microcontroller

PIC is used as the main control unit in this system. The main functions of the PIC are input sensing and monitoring, data processing and output control. Since PIC is the main part of the system, choosing a right PIC is important.

First, the PIC that is chosen must have many input and output pins since the system uses a separate sensor for each parking space and there is a Green LED in each parking space.

Second, the PIC that is used requires larger bytes of storage program memory. Moreover, the PIC must support PWM module because the modulation frequency that is required to drive the IR LEDs is used from the PWM output of the PIC.

The PIC that can be chosen for this system are PIC 16F628A and PIC 16F877A. But PIC 16F628A is not chosen because it has fewer input and output pins than PIC16F877A. So, PIC16F877A is the best choice for this system. It has 33 bi-directional I/O pins and 8Kbyte of storage program memory. Moreover it can support two PWM outputs.

C. Sensor Section

This section is divided into two: IR transmitter and receiver.

IR transmitter:

Lots of things that radiate heat can generate infrared. So, to certain that the intended IR signals get across to the receiver without errors and to avoid other 'fake' signals, the infrared LED is driven by a modulation frequency. The common modulation frequency is between 30 and 60 KHz. The frequency that is used for this system is 38 KHz and is generated from PWM output of the PIC.

But IR LED cannot be driven by a modulating frequency all the time. This is because IR receiver cannot sense the presence of IR signal all the time. So only when the presence of the car at the entrance of the gate or in each parking space is required to sense, IR LEDs are turned ON and after sensing, IR LEDs are turned OFF.

IR receiver:

IR receiver that has three pins: 5V supply, ground and data (or output) pin. The data pin of the IR receiver is connected with the microcontroller. Fig. 2 shows the sample for one pair of IR transmitter and receiver. Whenever IR receiver receives the IR signal from the transmitter, its output (data) line is Low. Otherwise when a car or something is between transmitter and receiver, output (data) line of the receiver will be HIGH since it does not get the IR signal from the transmitter.

Fig. 2 Sample of Infrared Transmitter and Receiver

D. Barrier Circuit

The barrier is implemented at the entrance of the car parking control system. The motor that is required for the barrier circuit is a small, permanent magnet motor. This motor needs to operate in three stages: forward, reverse and stop condition. This is done with a controller circuit.

The motor controller circuit is shown in Fig. 3. When pins RE1 and RE2 are LOW, bases of transistors are not biased and the motor is in stop condition. When RE1 is HIGH and RE2 is LOW, base of transistor Q1 is biased. So motor operates in forward direction. In contract to this, when RE1 is LOW and RE2 is HIGH, base of transistor Q2 is biased, and motor operates in reverse direction.

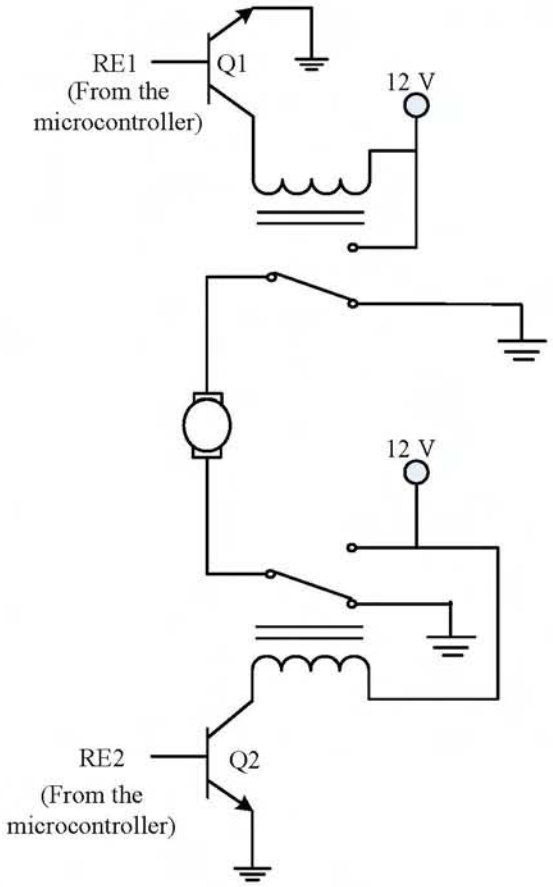

Fig. 3 The Circuit Diagram of Motor Controller Circuit

E. Alarm system

Alarm system is used to signal the operator when the driver does not park in the assigned parking space or when the driver hits the barrier at the entrance of the parking accidentally or carelessly. Moreover, the alarm will be sounded when the driver who does not leave from the car

parking at a certain amount of time or when he/she stops the car on the road inside the car parking.

To make the alarm system, a speaker is connected with the PIC using the capacitor and the alarm signal is generated by the PIC with the help of the software.

F. PS/2 Keyboard

If someone wants to know the information about the number of cars parked in the parking lot and the number of free parking spaces, he or she can know by using keyboard. By pressing button on keyboard, the information that he/she wants to know will be displayed at the LCD.

If keypad is used, many of microcontroller's pins will have to be used. So instead of using keypad, PS/2 keyboard is used. By using PS/2 keyboard, only two of microcontroller's pins are required. These two pins are data and clock of the PS/2 keyboard. Since keyboard is used in this system, the interfacing with the keyboard is studied.

PC's keyboard implements a bi-directional protocol. The keyboard can send data to the Host and the Host can send data to the Keyboard. The Host has the ultimate priority over direction. It can send a command to the keyboard at anytime.

The keyboard and the system communicate over the clock and data lines. The source of each of theses lines is an open-drain device on the keyboard that allows either the keyboard or the system to force a line to low level. When no communication is occurring, the clock and data lines are on high level kept by pull-up resistors.

Every keyboard only has one scan code for each key. The keyboard sends scan codes to the computer. The scan codes tell the Keyboard Bios, what keys have been pressed or released. Taking the 'A' Key as an example, the 'A' key has a scan code of 1C (hex). When the 'A' key is pressed, the keyboard will send 1C down its serial line. If it is still being held down, for longer than it's spermatic delay, another 1C will be sent. This keeps occurring until another key has been pressed, or if the 'A' key has been released.

However the keyboard will also send another code when the key has been released. Taking the example of the 'A' key again, when released, the keyboard will send F0 (hex) to tell that the key with the proceeding scan code has been released. It will then send 1C to know which key has been released.

Keyboard to Host Protocol:

The keyboard is free to send data to the host when both the KBD Data and KBD Clock lines are high (Idle). The KBD Clock line can be used as a Clear to send line. If the host takes the KBD Clock line low, the keyboard will buffer any data until the KBD Clock is released, i.e. goes high. If the Host takes the KBD Data line low, then the keyboard will prepare to accept a command from the host.

The transmission of data in the forward direction, i.e. Keyboard to Host is done with a frame of 11 bits. The first bit is a Start Bit (Logic 0) followed by 8 data bits (LSB First), one Parity Bit (Odd Parity) and a Stop Bit (Logic 1). Each bit should be read on the falling edge of the clock.

Figure 4 shows a one byte transmission from the Keyboard. The keyboard may not generally change its data line on the rising edge of the clock as shown in the diagram. The data line only has to be valid on the falling edge of the clock. The Keyboard will generate the clock. The frequency of the clock signal typically ranges from 20 to 30 KHz. The Least Significant Bit is always sent first.

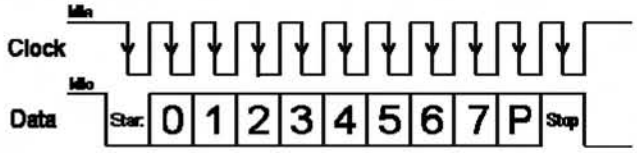

Fig. 4 The Waveform Diagram of One Byte Transmission from the Keyboard

When a key on the keyboard is pressed, an interrupt will occur. This interrupt causes the microcontroller to respond to the events very quickly. When an interrupt occurs the microcontroller leaves its normal flow of program execution and jumps to a special part of the program, known as the Interrupt Service Routine (ISR).

G. Overall Circuit Diagram of the System

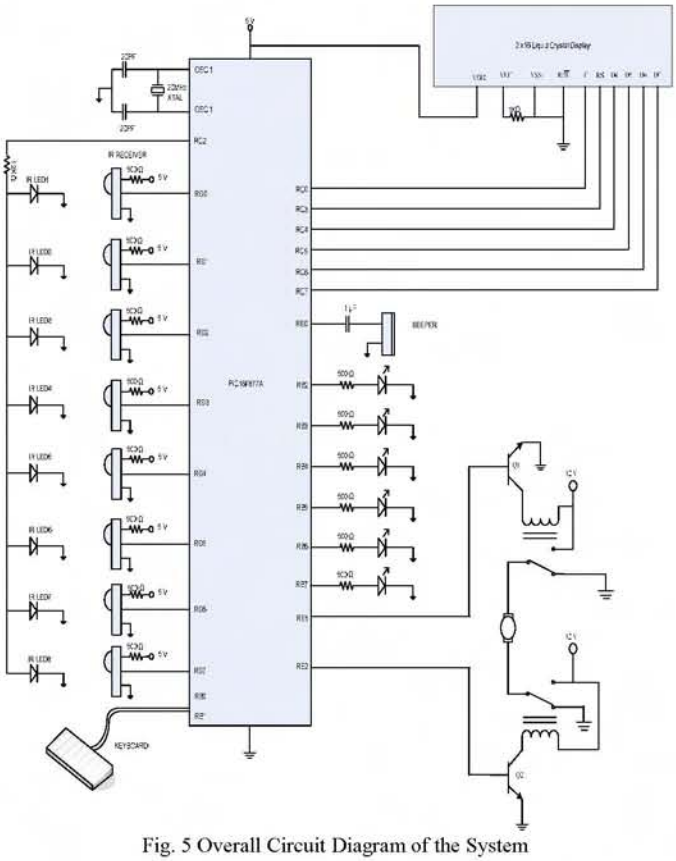

Fig. 5 Overall Circuit Diagram of the System

PIC is used as the main control device. There are eight inputs for sensor section and PORTD is used as input for this. PORTB, RB0 and RB1 are used as input for PS/2 keyboard.

In output section, PORTC, RC2 is used as the PWM output and RC0 and RC 3 to RC7 are connected to LCD. PORTB, RB2 to RB7 is used for parking space indicator to signal the driver to park there. PORTE, RE0 is used to

produce alarm signal and RE1 and RE2 are used for barrier control circuit.

All I/O pins are used as digital I/O. External crystal and two capacitors are connected to the OSC1 and OSC2 pins to provide a clock signal for the microcontroller.

III. SOFTWARE IMPLEMENTATION

Program for the car parking control system is composed of Main Processing loop (Sensing/ Assigning/ Displaying) and Interrupt Processing loop (Display/ Turning off Alarm). The system flowchart of car parking is shown in Fig. 6.

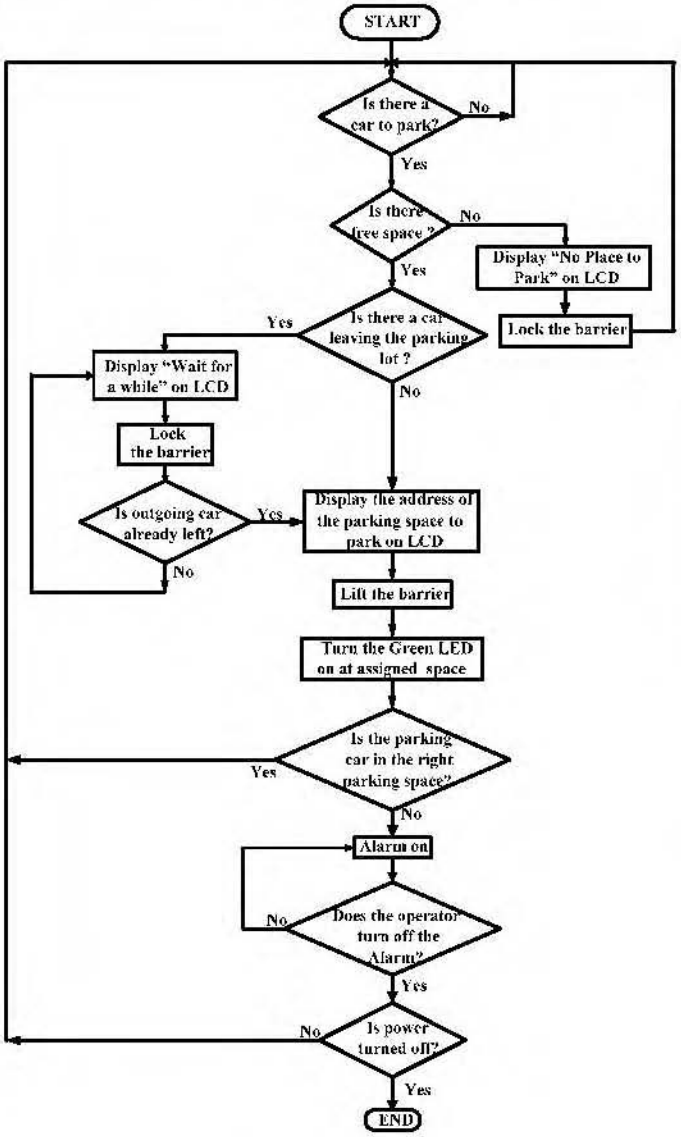

Fig. 6 Flowchart of the System

IV. TEST AND RESULTS

The operations of the system can easily be divided into subsequent steps:

1. Sensor at the entrance checks whether there is a car to park or not.
2. If there is a car to park, sensors at respective rooms sense the presence of free parking space to check that the rooms are available or not.
3. These sensors also checks whether there is a car leaving the car parking or not.
   (a)If a car is leaving, the microcontroller displays "Wait for a while" on the LCD.
   (b)If any car is not leaving, go to step 4.
4. (a) If there is free space, the microcontroller opens the barrier, displays the address of the nearest free parking space, closes the barrier, turns on the green LED at respective parking space.
   (b) If there is no free space, the microcontroller displays "NO PLACE TO PARK" on the LCD.

Sensor 1,2,3,4 and 5 check the parking car is in the assigned parking space. If the parked car is not in assigned space, the microcontroller turns the alarm on. The small demonstration model for car parking control system is constructed and tested. This testing is shown in Fig. 7 and 8.

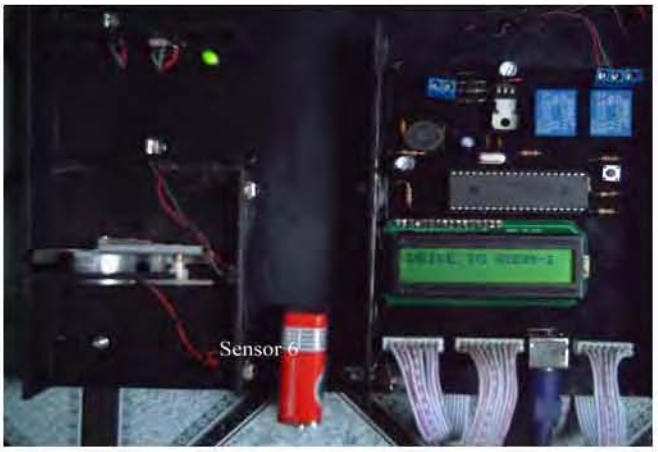

Fig. 7 The Result of Testing Step 1 to 4

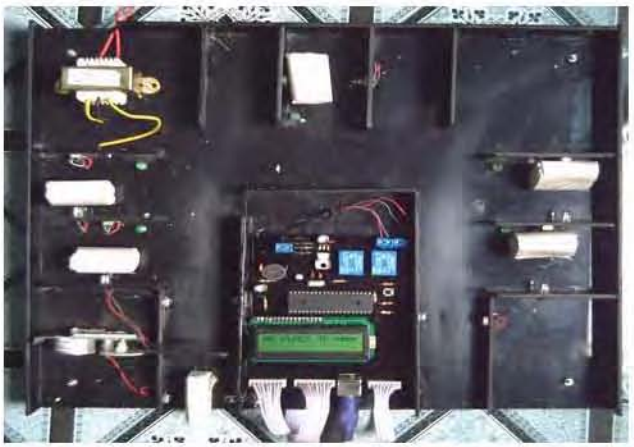

Fig. 8 The Result of Testing Step 1 to 4

To test the interfacing with the keyboard, PS/2 keyboard is connected to the PS/2 port that is assembled on the car parking controller card. If a key on the keyboard is pressed, the keyboard's clock line changes from high to low. When this change occurs, the microcontroller stops the normal

execution and jumps to interrupt service routine. In the interrupt service routine, the microcontroller stores the serial data and checks whether the received data matches with the predefined data. When they are matched, the microcontroller operates the specified function. In this system only 10 keys on the keyboard are predefined in PIC program. The functions of the key that are used for this system is shown in Table I.

TABLE I
FUNCTIONS OF THE KEYS USED FOR THIS SYSTEM

Keys	Functions
1	Status of Room 1
2	Status of Room 2
3	Status of Room 3
4	Status of Room 4
5	Status of Room 5
*	Status of all rooms
-	Open the barrier
+	Close the barrier
/	Beeper On/Off
Num Lock	Clear the LCD screen

V. Discussion

Nowadays, the number of car usage has been increasing from day to day. So car drivers can face difficulties in parking their cars in crowded places. This car parking system is designed to facilitate the car drivers to overcome these difficulties.

The system is demonstrated with a small model which is composed of LCD, a barrier, six Green LEDs, a beeper and five parking spaces. A barrier system is implemented by using a small dc motor and a limit switch. When the motor runs in forward or reverse direction, the barrier is opened or closed.

When the system is tested on a solder less breadboard, the system can operate properly. But when the system is constructed as a small demonstration model, the interferences between the sensors are encountered because of their close vicinity. This problem is overcome by adjusting the position of the sensors.

After all the components are connected and when the power is applied to the system, the microcontroller checks the sensor at the entrance. When a small object (car) is placed at the entrance, the microcontroller gives the address of the free parking space, lifts the barrier and turns the green LED on at the respective parking space. This procedure is done until all the parking spaces are occupied.

When one of the parked cars wants to exit the car parking, the driver just leaves the car parking without giving a signal to the operator. But the microcontroller knows that a car has left the car parking because of the sensors at the respective parking space and at the exit.

The PS/2 keyboard can be used at anytime. When one of the predefined keys is pressed, the respective function or information is done or displayed at the LCD. If the pressed key is not the predefined key, the system would not response it.

VI. Conclusion

In present work, the car parking control system has been tested with a small demonstration model. Sensing the presence of car at the entrance of the parking, displaying the address of the assigned parking space and interfacing with PS/2 keyboard are worked well as expected.

The demonstrated system is implemented with five parking spaces, a barrier and a liquid crystal display at the entrance of the car parking and PS/2 keyboard.

The advantages of this system are being a compact control and automation system and being modernized. Moreover, when a sensor in one parking space is not working properly, other parking spaces can work well independence of the defected one.

As a further extension number of car parking spaces can be upgraded by modifying software and hardware. This system can be enhanced to password protected system. The password can consist of letters since PS/2 keyboard is used. So the system is more secure. Moreover, this system can be upgraded to a time-base billing system. This can be achieved by adding digital clock circuit and data storage device.

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