Design and Implementation of Car Park Control System Using Microcontroller

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Abstract

The system is mainly intended to reduce the wastage of space for car parking control system by using PIC microcontroller. If a car arrives at the ENTRY barrier, the sensor senses and then the program checks and counts. If the count is greater than or equal to 100, the car park is full and message "FULL" is displayed. When the car park is full, the lock mechanism is activated. If a car leaves from the car parking, the EXIT barrier opens and then the count decreases. The lock mechanism is disabled as soon as spaces are available in the car park. If the count is less than 100, then it is assumed that there is space in the car parking and the message "SPCE" is displayed. The numbers of cars are displayed on the monitor. This system uses two programming languages: PICBASIC and C++ programming language.

Keywords: SPCE, FULL, H-bridge DC Circuit, ENTRY, EXIT, IR Sensor.

1. Introduction

Today, computers are efficient in the industrial control system. Computers are widely used in many areas such as Industry, Communication, Research and Business. All over the world, microcontroller is used instead of computer to reduce cost, size, human power and electricity.

Microcontroller differs from a microprocessor in many ways. In order for a microprocessor to be used, other components such as memory, or components for receiving and sending data must be added to it. In short, this means that microcontroller is designed to be all of that in one. No other external components are needed for its application because all necessary peripherals are already built into it. Thus, this can result in saving the time and space needed to construct devices [5].

Microcontroller is also called embedded controller, because the microcontroller and support circuits are built into the devices they control. There are many types of microcontroller such as Microchip's PIC, Motorola's 68HCXX, Zilog's Z8, Z80 etc. PIC microcontrollers have gained popularity in robotics and control applications for their simplicity of use and modifiability [8].

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes [8].

2. Related work

There are many related works in this field. J.C.Viegas [1],presented the ventilation of underground car parks is important to avoid health problems associated with the inhalation of combustion products released by car engines, in particular carbon monoxide CO. A new mechanical ventilation system has appeared, based on the use of axial ventilators (jet fans) suspended under the car park ceiling. O. Shoewu and O.T. Baruwa [2], state that the system described in this paper monitors two gates, the entrance and exit. The automatic gate senses any vehicle approaching it. It automatically opens, waits for a specified time, and closes after the time has elapsed. As soon as the gate closes, the system counts, registers, and displays the number of vehicles. The system also serves as an automobile parking control unity by periodically checking the number of vehicles that have entered the area and computing the available space limit in the parking area. Once the available space limit is reached, the system triggers an alarm for a specified time and the entrance gate remains inaccessible until another vehicle comes out through the exit gate.

3. Background theory

3.1. PIC microcontroller

PIC microcontrollers are produced by microchip

and it can be divided into three types: Baseline, Mid-range and High performance.

The Baseline microcontroller group includes PIC10 family, and portions of PIC12 and PIC16 families. These devices utilize 12 bit program words architecture with 6 to 28-pin package options. The Baseline Architecture enables the most cost-effective product solutions. A range of low operating voltages makes this architecture ideal for battery-operated application. The typical member of the Baseline group has a low pin count, flexible flash program memory, and low power requirements [3].

The Mid-range architecture group includes PIC12 and PIC16 families that feature a 14-bit program word. These families are 8 to 64-pin package options and higher pin count packages with flash and OTP program memory. The flash products offer an operating voltage range of 2.0V to 5.5V, interrupt handling, a deeper hardware stack, multiple A/D channels and EEPROM data memory. The Mid-range PIC16 microcontrollers have interrupted handling capability with 8-level hardware stack [3].

The high performance groups are PIC18 family. Their program memory is 16-bit with 18 to 80-pin package options and this microcontroller group operates with high speed. The PIC18 has enhanced core features, 32 level- deep stack and multiple internal and external interrupts. The separate instruction and data buses of the Harvard architecture allow a 16-bit instruction word with separate 8-bit data. These families have a much larger instruction set than members of the baseline and mid-range families [3].

In market, there are many types of PIC .This system uses 16F628A. The difference between 16F84A and 16F628A is shown in Table 1 [6] [7]. Since the system uses PWM module. PIC16F628A is selected.

Table 1. Difference between 16F628A and 16F84A

Function	16F628A	16F84A
Program memory	2048 words	1024 words
Data RAM	224 bytes	68 bytes
Data EEPROM	128 bytes	64 bytes
Interrupt Sources	10	4
I/O Pins	16	13
Timer Module	Timer 0,Timer 1, Timer 2	Timer0
Voltage Range (Volts)	3.0-5.5	2.0-5.5
Capture/ Compare/ PWM modules	Capture, Compare, PWM	–

The PIC16F628A are 18-pin Flash-based member and low-cost, high-performance, CMOS, fully static, 8-bit microcontroller.

PIC16F628A devices have integrated features to reduce external components, thus reducing system cost, enhancing system reliability and reducing power consumption [6].

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4. Overview of the system

The system of this paper contains the following subsystems:

-Light sensing circuits
-dc motor driver to lift the barriers at the ENTRY and EXIT gates
-control unit (PIC controller)
-display unit

The block diagram of the system is shown in Figure1.

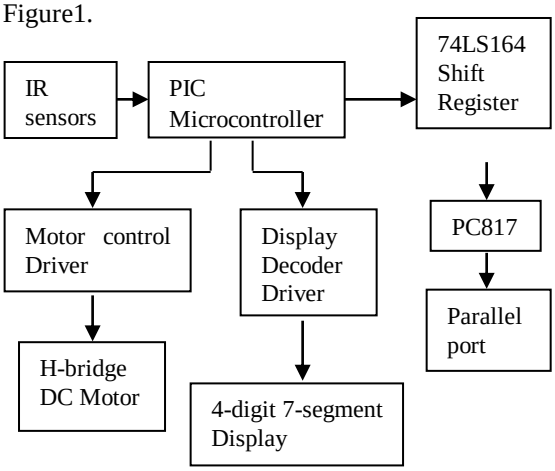

Figure 1. Block diagram of the System

4.1. Sensing unit

The sensor used in this proposed system is IR sensor. The IR sensor is placed at the beside of the each gate. IR LED is used for transmitting the IR light. IR detector is used for receiving the IR light as shown in Figure 2. The transmitting side transmits the light and the receiving side receives the light. If the receiving side doesn't receive the light, the car reaches the ENTRY gate. IR sensors are controlled by PIC microcontroller. Infrared transmission is an optical in nature carried by beam of light invisible to

the naked eyes. IR radiation is electromagnetic radiation whose wavelength is longer than that of visible light (400-700nm), but shorter than that of terahertz radiation (100μm-1mm) and microwave (≈30,000μm). IR waves are using a 32-56 kHz modulated square wave for data communication.

IR LEDs emit infrared radiation which is focused by a plastic lens into a narrow beam. The beam is modulated to encode the data. The receiver uses a silicon photodiode to convert the infrared radiation to an electric current. It responds only to the rapidly pulsing signal created by the transmitter and filters out slowly changing infrared radiation from ambient light.

When the car is present, the output is usually low and PIC RB4 pin becomes logic zero. If no car is detected, the output is high. RB4 pin becomes logic one. There are four IR detectors in this system. They are connected with RB4, RB5, RB6 and RB7 pins.

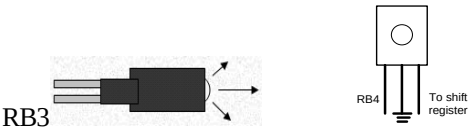

Figure 2. Block diagram of IR transmitter and receiver

4.2. Motor control

H-bridge DC motor drive circuit used in this proposed as shown in Figure 3.

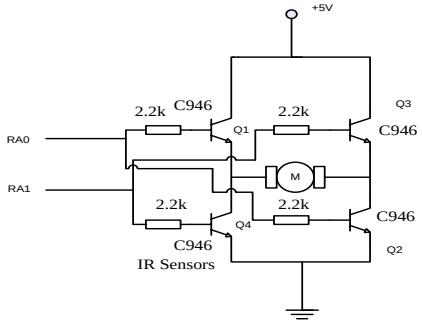

Figure 3. H-Bridge DC motor driver circuit

The ENTRY gate DC motor driver is controlled with RA0 and RA1pins from PIC. PIC gives the logic signal to RA0 and RA1 pins. If RA0 is 1 and RA1is 0, the base of the transistors Q1and Q2 is biased and this makes the transistors Q1 and Q2 to saturate. At this saturation, the base of the transistors Q3 and Q4 are not biased and this makes the transistors Q3 and Q4 to cutoff. The terminals Q1 and Q2 of the DC motor get positive potential difference with respect to the other terminal of the DC motor and the motor gives clockwise rotation lifting the barrier [4].

If RA0 is 0 and RA1 is 1, the base of the transistors Q3 and Q4 is biased and this makes the transistors Q3 and Q4 to saturate. At this saturation, the base of the transistors Q1 and Q2 are not biased and this makes the transistors Q1 and Q2 to cutoff. The terminals Q3 and Q4 of the DC motor get positive potential difference with respect to the other terminal of the DC motor and the motor gives anti-clockwise rotation lowering the barrier. Logic 0 or 1 at both RA0 and RA1 will never activate the motor. PIC controls car park barrier for a gentle motion [4].

Similarly, at the EXIT gate of the car parking, the barrier of the EXIT gate is controlled by RA2 and RA3 pins from PIC to lift and lower the barrier of the EXIT gate. The rotating motor has 2s (seconds) delay time.

4.3. Display system

Display system consists of two parts. The first part is 4- digit 7-segment display unit and the second is monitor display. Circuit diagram of 4-digit 7-segment display is shown in Figure 4.

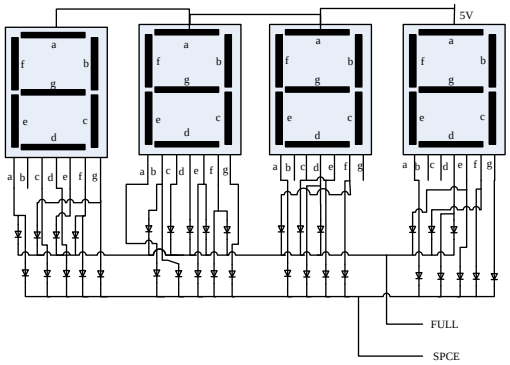

Figure 4. Circuit diagram of 4-digit 7-segment display

Bit patterns for characters “FULL” and “SPCE” are shown in Table 2.

Table 2. Bit patterns for character “FULL” and “SPCE”

	F	U	L	L	S	P	C	E
a	0	1	1	1	0	0	0	0
b	1	0	1	1	1	0	0	0
c	1	0	1	1	0	1	1	1
d	1	0	0	0	0	1	0	0
e	0	0	0	0	1	0	0	0
f	0	0	0	0	0	0	0	0
g	0	1	1	1	0	0	1	0

The message “FULL” or “SPCE” is displayed by the 4-digit 7-segment display board. It is located at the entrance of the parking garage to notify the

customers of the available spaces before entering the garage. If RB1 pin is logic zero, “FULL” character is shown on 4-digit 7-segment display board. If RB2 pin is logic zero, “SPCE” character is displayed.

The numbers of cars and the numbers of spaces are displayed on the monitor screen. The proposed system uses the parallel port to display the number of cars and spaces by using the output from the PIC to parallel port. Shift register is used for shifting data from PIC to parallel port. Opto-coupler is used between shift register and parallel port to protect the microprocessor from damage.

5. Experimental results

In this proposed system, 4 IR LEDs and 4 IR detectors are used to sense the arrival and departure of the car. The sensor provides an input signal to the system. There are two infrared sensing circuits at both ENTRY and EXIT gates. The first sensor senses to lift the barrier and the second sensor counts the number of car. RB4 and RB6 pins are used for first sensor and RB5 and RB7 pins are used for second sensor. RB3 pin is used for 4 IR LEDs.

There are two motors in this system, one for rotating the barrier at the ENTRY gate and another is used for the EXIT gate. The motor gives clockwise rotation for lifting the barrier and anti-clockwise for lowering the barrier. The motor uses the gear. It is used for reducing the rotation of motor. The gear reduces the motor speed because this system wants to use the barrier to rotate 180º with 2s (second) delay time. RA0 and RA1 pins are used for ENTRY gate motor barrier and RA2 and RA3 pins are used for EXIT gate motor barrier.

Complete circuit diagram is shown in Figure 5 and system flow diagram is shown in Figure 6.

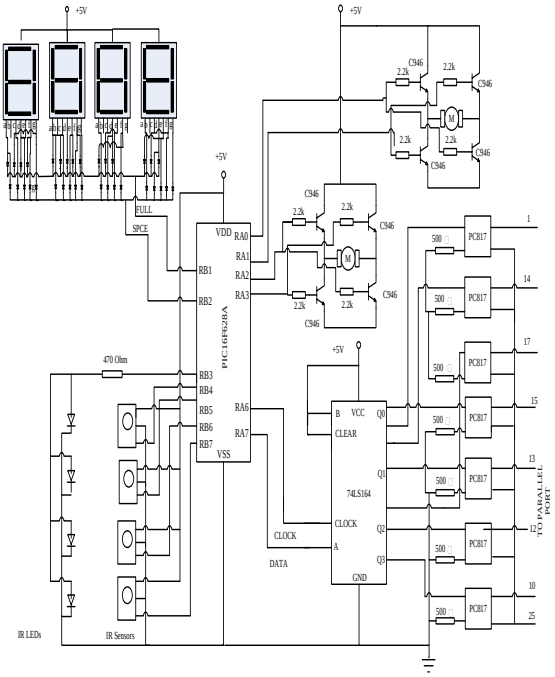

Figure 5. Complete circuit diagram

4-digit 7-segment display unit and monitor screen are used for displaying system. The message “FULL” or “SPCE” is displayed by 4-digit 7-segment display board. The eight LEDs inside each 7-segment can be arranged with a common anode. Common anode connected to the +5V. The segments are turned on with a logic zero.

If the numbers of cars are equal to 100, the car parking is full and the ENTRY gate is lock. The system disallows any additional vehicle that wants to enter unless another vehicle leaves through the EXIT gate. The output cannot be fed directly to the 7-segment display; therefore, it needs a driver. The unit sends signals to the driver each time a vehicle crosses the gate. The common anodes of 7-segment are connected with IN4148 diode from its cathode of each 7-segment to appear “FULL” character.

If the numbers of cars are less than 100, the car parking has space. The common anode of 7-segment are connected with IN4148 diode from its cathode of each 7-segment to appear “SPCE” character. System flow diagram is shown in Figure 6.

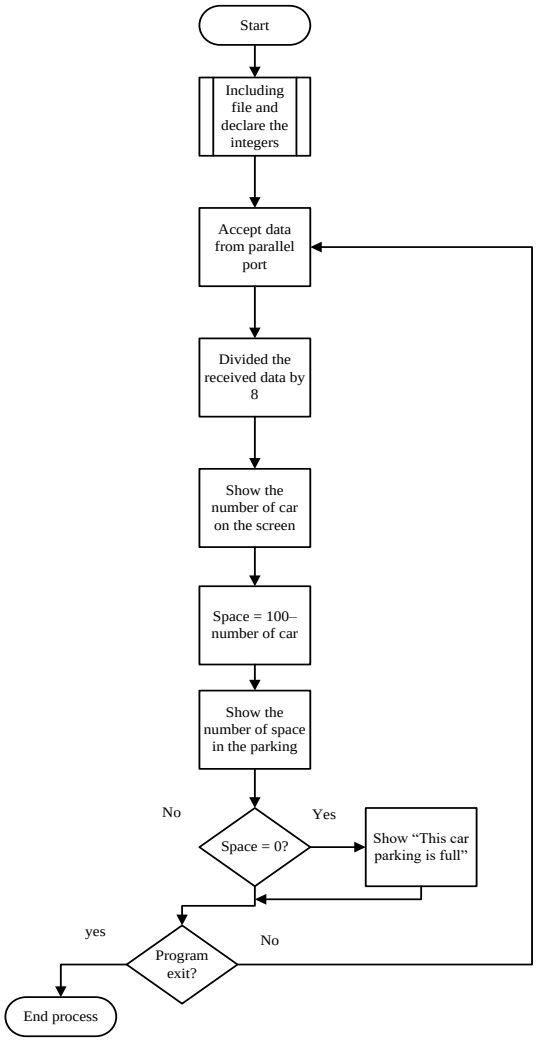

Figure 6. System flow diagram

The numbers of cars and the numbers of spaces are displayed by computer. Shift register 74LS164 is applied to shift data between PIC and parallel port. Opto-isolation circuit is utilized between shift register and parallel port to prevent from damage.

6. Conclusion

Nowadays, there are many computerized system in our country. In many places, car parking is needed. This system reduces human efforts, costs, and time. The system saves the driver roaming round and round the car park looking for a space and so can reduce carbon emissions. This system senses with infrared sensing circuits, counts with personal computer and barrier rotates with motor. The messages "SPCE" and "FULL" are displayed by 4-digit 7- segment display. The numbers of spaces and the numbers of cars are displayed by personal computer. This system can also consider on different types of cars and other vehicles.

This system could be upgraded with other communication ports. There isn't sensor in the car parking for looking actual space. Moreover, this system could be improved by putting sensor in the car parking as well as by redesigning to be compatible with any upgraded Window OS. To achieve full automation, a real time system should be employed and a Closed Circuit Television (CCTV) system could be used for proper monitoring and security purposes. This can helpful in detecting the presence of vehicles before the system is activated. It could be much better to make time and text visible on computer screen.

7. References

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