Western Washington University

PROJECT DESCRIPTION

PARKING SPACE FINDER

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Class: Etec 471
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INTRODUCTION:

Indoor parking garages are the way to save space in cities. Compared to outdoor parking, indoor parking garages occupy a smaller space because they are expanded vertically to multiple floors; therefore, they can contain thousands of cars. The disadvantage of the indoor parking garage is that it takes time to find a parking space and of course wastes gas.

This paper is a description for a Parking Space Finder system. This system helps drivers to find spaces before they enter an indoor parking garage, by providing the available spaces on a display. This system will save drivers time, money, and emotional stress.

FUNCTIONAL DESCRIPTION: (Please refer to Figure 1 & 2)

Every parking space has a car detector and a 1-wire memory chip called the slave device. The car detector can be a switch. When there is a car in a space, the switch turns on otherwise the switch turns off. There are two 5VDC power supplies, one can be the local power source for the slave devices, the other is for the control panel and the LED display, etc (see Figure 3). The slave device has its own registration number to provide a guaranteed unique identity for absolute traceability. The slave devices connect to a microcontroller through a 1-wire bus and a 1-wire line driver. The 1-wire line driver helps the microcontroller to communicate with the slave devices over long distances without distortions. The microcontroller checks the level of a port of one slave device. The microcontroller will interpret whether the parking space has a car. The available space will be shown on a display. This ends the cycle of determining the status of a parking space. The microcontroller continues to do the same to other slave devices.
Because of small space, the LED display shows only 42 LED(s) for 42 parking spaces.
HARDWARE DESCRIPTION: (please refer to Figure 3)

The Parking Space Finder can be broken down into four main parts: The bus master, the slave devices, the 1-wire line driver, and the display.

The bus master is a Motorola MC68HC912B32 (68HC12) microcontroller. The chip contains 32K bytes of electrically erasable, programmable read only memory (EEPROM), 768 bytes of EPROM, and 1K byte of random access memory (RAM). Since the 68HC12 has only 1K byte of RAM, an external RAM (16K nonvolatile RAM) is needed to store memory for this project. This external RAM is used to store the ROM numbers of the slave devices. The 68HC12 also contains a synchronous serial peripheral interface (SPI). The SPI is used to interface with LED display driver. The 68HC12 uses three of its general-purpose I/O pins of port DLC to communicate with the slave devices through the 1-wire line driver. The 68HC12 also uses 22 pins from its other ports to communicate with the external RAM. A 16MHz crystal is used to drive the timing for the 68HC12.

For this project, I will design a Parking Space Finder for an indoor parking garage with 100 spaces. I need 100 1-wire memory chips (DS2406) as the slaves and 100 switches as the car detectors, one DS2406 and one switch for each parking space. The switch connects to port PIO-A of the DS2406, therefore the switch controls the level of port PIO-A. Pin Data of the DS2406 is connected to a bus (1-wire bus). The bus master accesses to port PIO-A of a DS2406 through the 1-wire bus to find out the level of the port. In order to transfer data through long distance, a 1-wire line driver is needed. This 1-wire line driver helps to transfer data through the 1-wire bus without distortions. The display includes 100 LED(s) and 100 numbers; one LED and one number represent for each parking space. When a car enters a space, one of the LED(s)
Figure 3 - Functional block diagram.
turns off; otherwise it turns on. The display is connected as a LED matrix display and as a map of the indoor parking.

The size of the LED matrix display for this project is 2 ft high and 3 ft wide. The size of the display is depended on the number of parking spaces. From SPI of port S, the MCU sends signals through a serially interfaced LED display driver system to the LED matrix display. The serially interfaced LED display driver system decodes signals from the bus master, therefore the LED matrix display will be controlled properly.

In this project, the components are spread hundreds of meters apart, therefore it is impractical to use only one power supply. Two power supplies should be used in this project. One power supply is for the bus master, the 1-wire line driver, and the LED matrix display. For this power supply, a wall adapter 120VAC / 5VDC – 6A regulated is used. This power supply should have enough power for all 100 LED(s), the bus master, and the 1-wire line driver at the same time. The other power supply is for the slave devices and the car detectors. For this power supply, a wall adapter 120VAC / 5VDC – 9A regulated is used. This power supply can be used to power all the slave devices and the car detectors. There should be a common ground for the power supplies.

SOFTWARE DECRPIPTION:

For this project, I plan to use the C program language and Assembly language using a cooperative real time kernel. The program for this project will consist of a main module, a 1-wire device module, and a LED module. The 1-wire device module gathers the level of port PIO-B of slave devices, one at a time. In addition, the 1-wire device module also creates time
slots to read signals from the slave devices and calculate the CRC (Cyclic Redundancy Checks) to make sure the serial number of the DS2406 is read correctly. The range of time slot is: $60\mu s < t(\text{slot}) < 120\mu s$. The LED module decodes the signals from the bus master to control the LED matrix display.

**Figure 4-** Program structure.

**DESCRIPTION OF USER INTERFACE:**

The user interface for the project is a LED matrix display. The display is also a map of the indoor parking garage. Each parking space is presented by a number and a LED (figure 2). When the LED of one space turns on, there is no car in that space. When the LED turns off, that space has a car. The LED matrix display is large enough and located at a convenient place, therefore drivers can easily look for the empty spaces on the display.

In this project, The ROM numbers of the slave devices are discovered, one at a time by Read ROM command; then the ROM numbers will be stored in the external RAM. In a real project, there is a program to read the ROM numbers of new slave devices and store them in the external RAM. This is for the case when some of the slave devices are bad.
DEVELOPMENT PLAN:

One-wire devices are new to me, therefore during winter break I will continue to study about these devices and try to gather all components needed for my project. During winter quarter while I am taking the Etec 454 class to learn about C programming language for embedded systems, I will build all the hardware required for my project on circuit boards. Also at this time I will learn more about the 68HC12, especially about its SPI and I/O ports and I will apply what I learn in the Etec 454 to begin programming for my project. I will spend a lot of the time programming, since I do not have much experience. I will spend some time to study about the LED matrix display and the LED display driver.

In spring quarter I will continue to write code for each module and try to test the code on the circuits, which I already made. I believe there will be some adjustments to the circuits in order to make it work. The following is the approximate schedule of what I will do:

Winter quarter:

**Week 1:** Borrow the 68HC12 from Professor Morton and connect to the circuits, and continue to build the circuits.

**Week 2:** Study about the time slots requires for reading the DS2406 1-wire device.

**Week 3:** Study about the ROM function commands for the DS2406 1-wire device and then select one ROM function command that useful for identifying a DS2406.

**Week 4:** Continue study about the ROM function command.

**Week 5:** Study about general purpose I/O ports and how the I/O ports communicate with 1-wire line driver, 1-wire bus, and SPI.
Week 6: Study about LED matrix display, LED display driver, and the 16K nonvolatile SRAM.

Week 7: Apply what I learn from the Etec 454 embedded class to write codes for my project.

Week 8: Continue writing codes (concentrate in ROM function command and channel access for the DS2406).

Week 9: Continue writing codes.

Week 10: Study for final.

Week 11: Study for final.

Spring break: continue writing codes.

Spring quarter:

Week 1: Continue writing codes and begin writing codes for the LED matrix display.

Week 2: Continue writing codes.

Week 3: Continue writing codes.

Week 4: Check and testing project.

Week 5: Check and testing project.

Week 6: expect finishing all programming.

Week 7: setup the hardware neatly for demonstration.

Week 8: Final testing of project.

Week 9: Study for final.

Week 10: Study for final and demonstrate the project.

Week 11: Final week.
DEVELOPMENT HARDWARE and SOFTWARE:

The Etec Lab 340 has all the development systems needed for my project. I will use the equipment in the lab, such as the oscilloscope, the power supply, and the DMM. The oscilloscope is used to test the time lots which required to read the ROM numbers and all other timings such as reset time, present pulse time, etc. The DMM is used to check the voltage amplitudes for the input and output of the components. I will also use soldering station, tools, breadboard, and wire to set up the circuits. The Motorola 68HC912B32EVB evaluation board will be use as the bus master.

I will use the computers in the lab to write codes for the project, since the computers have all the software that I need, such as C, Assembly compilers, Introl code, and P-Spice, etc.

Since the Etec Lab 340 has all the hardware and software needed for developing my project, I will spend all the time for the project in this lab.

DEMONSTRATION:

For demonstration purposes, the Parking Space finder will be built in a small model that has 9 parking spaces. In this model, the car detectors are some switches. Each parking space has a number and this number also is the number for one of the LED(s). When a car enters a parking space, the switch at the space turns on and the LED, which has the same number as the space, turns off. The components of this project are: a 68HC12 microprocessor, power supplies, a LED matrix display, an 1-wire line driver (some resistors, capacitors, transistors), 1-wire memory chips, switches, a LED display driver, wire, and an external RAM chip.
ELECTRICAL SPECIFICATIONS:

- Base on Dallas 1-wire system protocol:
  - The minimum sample time period per slave device: 440ms
  - Maximum distance: 600 meters
- Maximum 124 slave devices and 124 LED(s)
- LED brightness: 100 MCD
- Worst case current consumption for the control panel and the LED display: 4.0A.
- Worst case current consumption for 100 pieces of the 1-wire chip (DS2406): 82mA * 100 = 8.2A.
- Normal operating temperature range: -10°C to + 45 °C.
- The maximum size of the PCB is 6x4 inches, and maximum height is 2 inches.

PRELIMINARY PART LIST:

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**Subtotal:** $617

* I will design a switch for each parking space. When a car comes in a space, the switch turns on, otherwise the switch turns off.