ECEN 5803- Mastering Embedded System Architecture

Homework set 3

Due Date: 2021/10/18

Theory and Analysis:

1. Circuit Board Design. What are typical standard specifications when ordering a standard low frequency prototype circuit board? List at least 14 requirements.

2. Select the best processor to meet the listed requirements. Limit your search to processors from Applied Micro, Freescale, and Texas Instruments. Use the processor selection spreadsheet you have been given, or any online processor selection tools. Document the steps you took to come to your conclusions.

Requirement for a Network Access Point

1. Under $50
2. DDR3 Memory Interface
3. NAND Memory Interface
4. 3 PCIe ports
5. 3 Gigabit Ethernet ports
6. 2 USB or ULPI ports
7. 4 UARTs
8. SPI and I2C port
9. SD Card or MMC port
10. Wake on LAN capability

3. Determine the best operating system for each situation:
   a. Free, for an x86 single board computer with real time requirements.
   b. Low cost, for an ARM applications processor for a security camera.
   c. Any cost, for a PowerPC processor in an automotive application with real time.
   d. Free, for a small Freescale MCU.
   e. Low cost, for an MCU in an IOT application.
   f. Low cost, for a Point of Sales terminal (POS) application.
   g. Any cost, for the PC you are now working on.

Justify your reasoning in each case.

Build vs. Buy

4. Your company needs to determine whether or not to buy or build an embedded system for their X-Ray Machine. The NRE to build the system is $1200k and the design will take 18 months to complete. Volume is expected to be 2400 machines/year. At that volume, unit cost of the custom design is $400.
Unit cost of the commercial off the shelf (COTS) unit is $2500. Gross profit for the machines is $10000 each with the COTS solution. Fixed costs are $500k/month. FDA approval for the COTS solution takes 6 months (delaying release by that amount of time) and costs $200k/month.

FDA Approval will have to be repeated if the build system is to be used, adding 6 month delay and $1200k to the cost of the build. Calculate:

a. The profit made in the first 2 years, assuming the COTS solution. _____
b. The costs savings/month for the design and build solution versus the COTS solution. _____
c. The number of months until breakeven for the build solution _____
d. Circle what your company should do BUY BUILD

5. Code Inspection: Inspect the following embedded software and identify all errors:

```
Int a, b, c, d;
int main()
{
        char x='Y';
        while(x='Y')
        {
                //...
                cout<<"Continue? (Y/N)";
                cin>>x;
        }
        menu(x, a);
        a=b; /* assignment
        c=d; /* of both pairs */
        if( 0 < a < 5) c=b;
}
__interrupt double compute_area(double radius)
{
        double area = PI * radius * radius;
        printf("\nArea = °/.•f", area);
        return area;
}
void menu()
{
   //...
}
```

6. Memory Addressing

You have been assigned to select a NOR FLASH device to connect to your MPU. The data bus is x16, and the external address bus has 22 bits. How much memory in bytes can you access with this configuration? Find a part or parts that meets this requirement and enter it here. What is the fastest read access time for this part?

Book Questions: Review 3.6, 3.30; Problem 3.18;

Review 3.6: What is a finite-state machine, and what is its purpose?

Review 3.30: What are the four fundamental parameters that one should consider when selecting or designing a clock system or time base?

Problem 3.18: A technique called pulse width modulation (PWM) is commonly used in embedded applications as a method for controlling small motors. The pwm signal for driving the motor has a fixed frequency and a variable duty cycle. At a duty cycle close to 0%, the motor is running at a slow speed; with a duty cycle close to 100%, the motor is running at close to full speed.
a. Design such a timer that can control the duty cycle of the output waveform in +-5% increments
b. What frequency have you selected for the PWM signal? Why?

Book Questions: Review 11.15, 11.23, 11.31. Thought: 11.10 Problems: 11.4 Review: 12.7, 12.8 Problems: 12.11

Review 11.15: What is reentrant code?

Review 11.23 What are some of the major characteristics that distinguish a real-time operating system from one that is not real-time?

Review 11.31. Describe the sequence of steps that are necessary to handle an interrupt once one has occurred.

Thought 11.10. What kinds of embedded designs are best suited for implementation using a foreground/background model?

Q 11.4. If an embedded system has five processes with the following execution times, propose a schedule in which the average waiting time is the smallest: P1(9), P2(25), P3(4), P4(8), P5(12). Illustrate the schedule using a UML sequence diagram.

Q 12.7 What is meant when a task is said to be schedulable? deterministically schedulable?

Q 12.8 What is CPU utilization? Why is it important?

Q 12.11

Embedded system has the following tasks (exec. times, periods): P1(4,16), P2(3,8), P3(2,7).

a. What is the CPU utilization for such a system?
b. Can the set of tasks be scheduled using a rate-monotonic schedule?
c. If the set of tasks can be scheduled, give the UML sequence diagram for the schedule.

Grading Rubric

[3 points] Analysis Questions, if complete and correct for each.
[1 point] each Review question from the book.
[2 points] each Problem question from the book.