T-106.5300 Embedded Systems Exam – 12.5.2010

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INSTRUCTIONS:

- Read the **entire** exam before starting
- Stay in the scope of the question
- Answer all questions in any way possible.
- Justifications and explanations are considered
- The time available for the exam is three hours
- The total point value of the exam is 110. You need 100 points to score 100%

- If you are an exchange student leaving the country very soon, and need to know quickly if you passed the exam, please write "EXCHANGE STUDENT" near your name on the answer sheet

BACKGROUND INFORMATION FOR THE QUESTIONS:
(Referred to as 'the system' or '<Exam Problem> system' in later mentions)

COLLISION AVOIDANCE SYSTEM FOR A PASSENGER CAR
The system monitors the surrounding environment to assist the driver. If something needs to be done, it first warns the driver to take action, and if nothing or not enough happens, the collision avoidance system takes action itself.

Known facts:

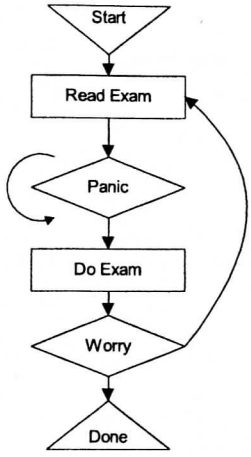
- Typical car with 4 wheels
- Sensors for detecting stuff in steering path
  - Two classes of sensors
    - Far – to notice potential dangers
    - Near – to trigger corrective action
- Works in two ways
  - First it warns the driver to the danger (audio and visual)
  - If driver does not take action, the car will attempt to avoid collision by:
    - Warning (lights, horn)
    - Taking action (steering, reduction of speed)

- Steering, engine control, and any other useful information or control systems are available with simple interfaces (use what you need)
- Passengers are protected by independent safety systems (airbags etc.) not in your control

Goals:

- Design a **collision** avoidance system
- Avoid unnecessary complexity in the control system

---------- THE EXAM STARTS BELOW ----------



1. Kernels (40pts total)

NOTE: No fault tolerance or remote-control features are needed for this question

1.1. Draw the flowchart of the program structure to describe the operation and sequence of operation if the control system for the device described on the first page was built with a:

1.1.1. polling kernel (10pt)

1.1.2. interrupt kernel (10pt)

1.1.3. process kernel (10pt)

1.2. Which of the above is best suited to implement the control system according to the goals listed in the beginning? Explain why? (10pt)

2. Fault Tolerance (40pts total)

How could the control system in Question 1 be made more fault-tolerant?
No remote-control features are needed for this question

2.1. Define fault-tolerance in general (4pt)

2.2. Briefly describe how you could use each of the following mechanisms to enhance fault-tolerance in the exam problem:

2.2.1. Sanity checks (4pt)

2.2.2. Fail-safe (4pt)

2.2.3. Interlocks (4pt)

2.2.4. Watchdog timer (4pt)

2.3. Briefly describe what changes are reasonable and necessary to the exam problem system to ensure a basic level of fault tolerance in normal operation. (10pt)

2.4. Which of the types of systems in Question 1 is best suited for these modifications? Describe and justify. (10pt)

3. Remote control (10pts total)

3.1. What control system or related changes are needed to add remote control ability to the system in questions 1&2 (the physical method of remote controlling has been accomplished for you by unspecified means, ie. You have a black box)? (5pt)

3.2. How does that affect your choice in question 2.4? Describe and justify. (5pt)

4. General questions. Answer briefly: (20pts total)

4.1. What specific car hardware improvements would have made your programming tasks easier for the car project? (5pt)

4.2. Why is the Therac-25 case significant in the embedded systems field? (**15pt**)

---------- THE EXAM ENDS HERE ----------

Please give feedback about this course either on paper or on the web form