T-106.530 Embedded Systems Exam - 13.12.2004

Olli Seppälä, Endre Domiczi

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 total point value of the exam is 110. You need 100 points to score 100%

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

The system is a normal escalator which shuts itself off automatically when there are no passengers, and smoothly restarts when a passenger is approaching the first step.

Known facts:

- Sensors
  - Entering – incoming passenger (0/1, ie. binary output)
  - Exiting – departing passenger (0/1)
  - Speed – current stair speed (meters per second)
  - Emergency Stop button (0/1)
- System is to function smoothly, no sudden starts or stops

Goals:

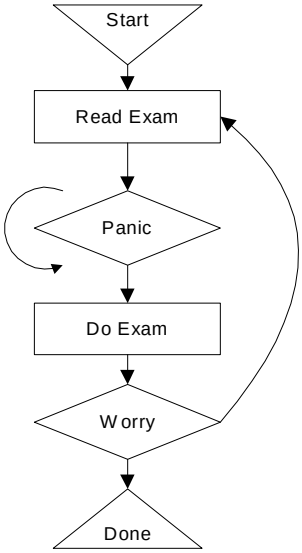
- Safe transportation
- Avoid unnecessary complexity in the control system

This page left intentionally blank

- THE EXAM STARTS BELOW -

1. Draw a Use Case diagram of the <Exam Problem> system (10pt)
   (Hint: Identify Use Cases, Actors, relationships between them, system boundary, etc.)
2. Identify Classes in the <Exam Problem> system (5pt)
   (Hint: for each use case find a set of collaborating objects/classes)
3. Identify the structural relations (association, generalization) among the classes and draw the diagram (5pt)
4. Choose a use case and draw a sequence diagram (5pt)
5. Create a state diagram for the overall system or part of it (5pt)

6. Kernels (18pts total)
NOTE: NO FAULT TOLERANCE OR REMOTE-CONTROL FEATURES ARE NEEDED FOR THIS QUESTION



6.1. 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 as a:

6.1.1. polling system (5pt)

6.1.2. interrupt based system (5pt)

6.1.3. process-based system (5pt)

6.2. Which of the above is best suited to implement the control system according to the goals listed in the beginning? Explain why? (5pt)

7. How could the above control system be made more fault-tolerant? (20pts total)
NOTE: NO REMOTE-CONTROL FEATURES ARE NEEDED FOR THIS QUESTION

7.1. Define fault-tolerance in general (5pt)

7.2. Briefly describe what changes are necessary to the system described on the first page and the system to ensure a basic level fault tolerance in normal operation. (10pt)

7.3. Which of the types of systems in Question 6 *is best suited for these modifications? Describe and justify. (5pt)*

8. Fault tolerance and prevention (20pts total)
Answer the following questions briefly in the context of fault tolerance and fault prevention.

8.1. What is the role of testing in fault tolerance and prevention? (4pt)

8.2. How do sanity checks work? (4pt)

8.3. Explain the differences between Mechanical and Software Interlocks (4pt)

8.4. What is meant by safe start-up and shutdown of an embedded system(4pt)

8.5. What is a watchdog? (4pt)

9. Answer the following with **BRIEF** explanations: (20pts total)

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

9.2. Why are control system methods (such as PI, PD, PID) useful? (5pt)

9.3. Explain what went wrong with the Therac-25? (5pt)

9.4. The requirements change again. What control system or related changes are needed to add remote diagnostics ability to the system in questions 6&7 (the physical method of remote controlling has been accomplished for you by unspecified means, ie. You have a black box)? How does that affect your choice in question 7.3? (5pt)

10. Any feedback about this exam or course? (this does not affect your grade)