

4 December 2015

INFO-0064 Embedded systems

Extra exercise session

Exam questions

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Question 2 - August 2015

[8 points] A portable audio player is equipped with a microcontroller that has to react to user actions, display messages on a small screen, and send audio data to an MP3 decoder.

The function of the MP3 decoder is to convert audio data into analog signals. This decoder is connected to a dedicated digital input of the microcontroller, on which it signals whether it is ready or not to receive data.

The microcontroller needs to run the following tasks:

- A task τ_1 checking the state of the keyboard 25 times per second. Its execution time is negligible.
- A task τ_2 sending a fixed number of characters to the screen, at most 25 times per second. This task requires 3 *ms* to complete.
- A task τ_3 sending audio data to the MP3 decoder whenever it is ready to receive it. Sending data can take up to 80 *ms*. In the worst case, this operation might be requested 10 times per second. The microcontroller is the master of the transaction; it can pause the data transfer in order to perform other tasks, provided that the duration of this pause does not exceed 10 *ms*.

Note: The input of the microcontroller connected to the decoder can be configured to trigger interrupts.

1. What is the best software architecture for this system ? Justify.
2. Using pseudocode, give the global structure of this software.

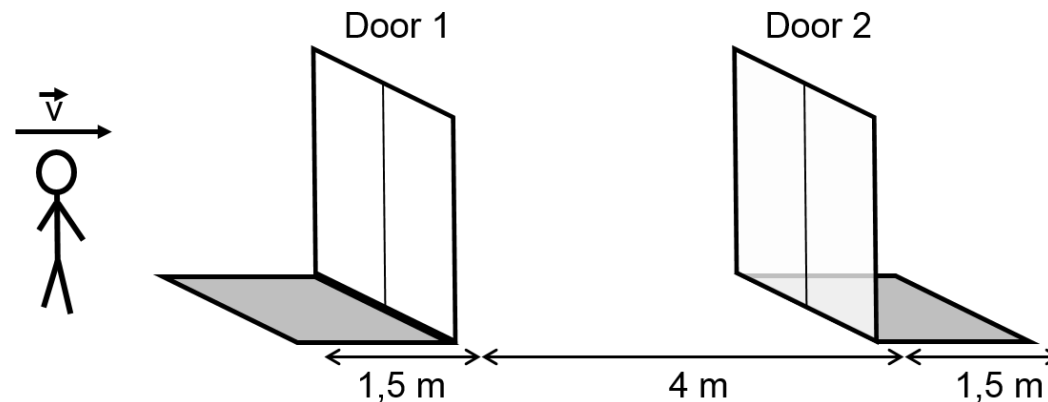
Question 4 - June 2015

[7 points] A microcontroller controls two security doors at the entrance of a bank, located 4 meters apart. Both doors are equipped with a sensor that is able to detect people. The range of the sensors is depicted in Figure 1.

It is assumed that people always move from left to right, i.e., that they first go through door 1 and then through door 2.

The microcontroller controls the doors as follows:

- Door 1 opens as soon as its sensor detects someone, at a rate of 67% per second (in other words, it takes about 1.5 s for it to become fully open). It closes, at a rate of 50% per second, when the sensor of door 2 picks up someone.
- Door 2 starts to open, at a rate of 50% per second, exactly 2 seconds after the sensor of door 1 has detected someone. It closes, at the same rate, when the sensor of door 2 stops sensing.



A person can pass through a door only if it is at least 50% open. Otherwise, he/she waits for the door to open enough. It is assumed that at most one person can use the doors at any time, in other words, a new person may approach door 1 only after the previous one has left the sensing area of door 2.

1. Describe a hybrid system modelling this situation.
2. Give the first 3 steps of the space-state exploration of this system, in the case of a person moving at a speed of 1.75 m/s.

