Final Assignment - Pedestrian Crossing

This assignment contributes 64% towards ACS335

Aim

The aim of this final assignment is to allow you to demonstrate the knowledge and skills that you have developed by designing and implementing an embedded system to meet a provided system specification.

Structure of the Assignment

Date assignment is available from: 2359 (11.59pm) on Monday 21st November

Date of assignment submission: 2359 (11.59pm) on Monday 12th December

Marks awarded: This assignment is marked out of 100

Submission

Submission of your work will be through MOLE. You will be required to submit the following files/documents. ***Failure to submit all of these documents will lead to a mark of zero for the assignment***. The reason for this is that the the assessor will not be able to build your project and test its functionality.

To the Turn-it-In submission link:

1. A text document (.doc, .docx or .rtf - not a pdf) divided into two parts, as follows:

   Part I: This section should explain the overall functionality of your code and how it implements each level of the required specification in part A. It is restricted to a maximum of 2 pages, size 12 font, single line spacing. ***A submission with part A greater than 2 pages will get zero for the assignment***.

   Part II: This section should contain all of your ".c" and ".h" source files that you created for your project (e.g. main, my_headers and Thread files) copied and pasted in as text (***A submission where the code is pasted as an image will get zero for the assignment***). Please make sure that each file starts on a new page and is clearly labelled.

To the standard MOLE submission link, the following files:

2. The Keil µVision project file for your design (this is the "UVPROJX File" that can be found in the directory of the project that you create).
3. All of your individual ".c" and ".h" source files that you created for your project (e.g. main, my_headers and Thread files).
4. Your "system_stm32f4xx.c" file (this can be found in your project directory in the sub folder RTE->Device->STM32F407VGTx).
5. Your "RTX_Conf_CM.c" file if you use the CMSIS-RTOS RTX in your solution (this can be found in your project directory in the sub folder RTE->CMSIS).
6. The .hex file produced by the compiler. ***You will need to open the "Options for Target 'Target 1'" window, select the Output tab and select the "Create HEX File" option. The "Name_of_your_project.hex" file will be created in the Objects sub-folder of your main project folder.*** It is the .hex file that will be run to test the

functionality of your code – make sure that you run "build" before submission to ensure that you upload the latest version that matches your submitted project.

Standard penalties for late submission apply (https://www.sheffield.ac.uk/acse/worksub)

Restrictions

All code should be developed using Keil µVision and the HAL drivers for the STM32F4. Worked submitted using other software and components will not be assessed.

Assessment and Feedback process

IMPORTANT*:* Your final code should include ***your own original comments*** to fully explain its operation. ***It is not acceptable to copy and paste any comments provided in the teaching material (it is ok to include comments automatically generated by Keil in template files, such as Thread.c)***. If your code does not contain sufficiently detailed comments for the assessor to understand its operation (code where comments are copied from the teaching material will be classed as not commented) you will only be awarded 50% of the marks for that part of the specification, compared to what you could have been awarded if your code was correctly commented. This is because you will be deemed to have not been able to sufficiently explain your answer.

You will be marked on a number of factors, including how well your code meets the required specification, its efficiency and how will it is documented (see the previous statement about comments and part I of document 1 in the list of submitted documents).

You will receive written feedback on your work within 3 university working weeks of its submission.

Unfair Means

The lab should be completed individually. ***You should not discuss any aspect of it with other students and should not work together in completing the lab***. The lab must be wholly your own work. Any suspicions of the use of unfair means will be investigated and may lead to penalties. See http://www.shef.ac.uk/ssid/exams/plagiarism for more information. In addition to your Turn-it-In submission, your code will also be submitted to MOSS, which is a specialist service focused solely on detecting plagiarism and collusion in code.

Special Circumstances

If you have medical or personal circumstances which cause you to be unable to complete this lab on time or that may have affected your performance, please complete and submit a special circumstances form along with documentary evidence of the circumstances. See http://www.shef.ac.uk/ssid/forms/special, particularly noting point 6 (Medical Circumstances affecting Examinations/Assessment).

Support

If you have any problems with the equipment please contact Dr S A Pope immediately using the contact details provided below. ***These inquiries should only relate to problems with the equipment, such as suspected faults***. Any inquiry should include a clear description of the problem. For example "It isn't working" would not be an acceptable inquiry on its own.

Contact details: Dr S A Pope, Email: s.a.pope@sheffield.ac.uk, Room: C07d AJB

Please turn to the next page for the assignment briefing

Assignment Briefing

Pedestrian Crossing

Your task is to design and implement a prototype pedestrian crossing that allows pedestrians to safely cross a busy road. Your design is required to meet the following specification. There are four levels to this specification, with each increasing the level of functionality and complexity of the system and therefore the marks that can be gained.

Specification - Level 1

By completing this level you can achieve a maximum mark of 40. It is expected that all students who are of pass grade will complete this part of the specification.

A. During normal/idle operation the green user LED stays on so the traffic can proceed along the road and the blue LED stays on to indicate that pedestrians shouldn't cross the road.
B. When a pedestrian would like to cross the road they press the blue user button.
C. When the button is pressed the following happens:

    If the crossing has not previously completed a ***crossing sequence*** within the last 15 seconds, then the ***crossing sequence*** starts straightaway. If a ***crossing sequence*** was completed within the last 15 seconds the system waits until 15 seconds has elapsed since the last crossing sequence has completed and then starts the ***crossing sequence***.

D. The ***crossing sequence*** should adhere to the following sequence:

    I. The green LED should turn off and the orange LED should turn on. The crossing should remain in this state for 2 seconds.
    II. After 2 seconds the orange LED should turn off and the red LED should come on. When the red LED comes on there should be a 1 second delay and then the blue LED should change from permanently on to blinking on and off at 0.1 second intervals to indicate that it is safe for the pedestrians to cross. The crossing should remain in this state for 25 seconds.
    III. After the blue LED has been blinking for 25 seconds the red LED should turn off and the orange LED should blink on and off at 0.3 second intervals (the blue LED should remain blinking). This indicates that pedestrians should not start attempting to cross. The crossing should remain in this state for 5 seconds.
    IV. After the orange LED has been blinking for 5 seconds the orange and blue LED's should stop blinking. The orange LED should turn off and the blue and green LED's should turn on permanently to indicate that pedestrians shouldn't cross and vehicles can continue.

In summary: The red, orange and green LED's are used to signal to the vehicles the state of the crossing. The blue LED is used to signal to the pedestrians the state of the crossing and the blue user button is used by the pedestrians to initiate the crossing sequence.

Please turn over the page for the rest of the assignment

Specification - Level 2

By completing this level specification in addition to level 1, you can achieve a maximum mark of 50. It is expected that all students who are of third class level will complete this part of the specification.

E. The embedded system will use the CMSIS-RTOS RTX to implement an appropriate multi-thread real-time operating system solution for the pedestrian crossing.

Specification - level 3

By completing this level specification in addition to levels 1-2, you can achieve a maximum mark of 70. It is expected that students who are deemed of 2:2 or 2:1 level will be able to complete this part of the specification.

In addition to the level 1 and 2 specification, the crossing system should also implement the following functionality to prevent large queues of vehicles waiting at the crossing:

F. Many pedestrian crossings have a sensor in the road to indicate that vehicles are waiting while pedestrians cross. The accelerometer can be used in a similar manner. An acceleration resulting from a quick tap on the board will be measured by the accelerometer and indicate that a car is waiting at the crossing. If this happens while the crossing is in state D.II of the basic specification and has been in this state for less than 15 seconds (i.e. a vehicle arrives at the crossing within the first 15 seconds of pedestrians being allowed to cross), then the crossing sequence should reduce the maximum time spend in state D.II to 15 seconds before it advances to part D.III, otherwise the time spent in state D.II should remain at 25 seconds.

Specification - level 4

By completing this level specification in addition to levels 1-3, you can achieve a maximum mark of 100. It is expected that only first class level students will be able to complete this part of the specification.

In addition to levels 1-3 of the specification, the crossing system should also implement the following functionality to audibly indicate to pedestrians that it is safe to cross:

G. The STM32F4Discovery incorporates a “CS43L22, audio DAC with integrated class D speaker driver”. You have not directly used this peripheral thus far, but you have covered all of the techniques that you will need to use it. This device can be used to provide an audio output when either headphones or speakers are connected to the audio jack on the STM32F4Discovery. This component should be used to provide the desired audible output through a set of headphones, to indicate, in addition to the flashing blue LED, that it is safe for pedestrians to cross while the crossing is in state D.II of the basic specification. It is your decision what sound that the pedestrian crossing makes.

   The data sheet for the “CS43L22, audio DAC with integrated class D speaker driver” is provided on MOLE in the same folder as the assignment briefing sheet.