CS25710 Assignment 2011

March 11th 2011

This assignment requires you to create a design for a device that will be used by the Equine Studies department to carry out research on abnormal horse behaviour. The scientists aim is to investigate behaviour and analyse possible causes such as stress, boredom, anxiety, anticipation or management, and they have asked Computer Science to help in the capture of data to assist in the research.

Introduction

The proposal is to build a device that can be attached to an animal and can capture data relating to movement. The basic parameters of abnormal behaviours can then be objectively established and can be used by the scientists in their investigations. More background to the application is provided in the scenario section below.

You are required to carry out a paper based design study for the hardware and software that will be required for the device to satisfy the requirements of the scenario, and establish the important parameters (e.g mass, performance, outline cost) of a feasible system. You are not required to produce the details of the electrical design and you are also not required to code the software. However you *are required* to research and identify in detail the major components of the system ensuring that your design is sound and feasible. The design should not contain any 'show stoppers' that would require a significant redesign of your concept system before implementation. Any aspects of the design that you cannot complete should be documented with the issues that need to be resolved and expertise required to complete the details.

In order to score well on this project you will need to research in detail the capabilities of the devices, software libraries and tools available for the hardware that you have chosen. This will involve reading parts of data sheets and other documentation and using this information to ensure a coherent and workable design is created, and that its important parameters are calculated.

Please notice there is no single 'correct' design since there are a wide variety of components available and the specifications allow for considerable variations in design. You must therefore make and document reasonable assumptions where necessary, and justify the design decisions you make.

The scenario details

Horses exhibit two characteristic types of behaviour to be investigated (you will find many example videos of these behaviours on 'YouTube' and I will put links on Blackboard):

Weaving: the animal moves its head and neck from side to side in a repetitive manner, possibly for an extended duration.

Crib Biting/Cribbing/Windsucking: the animal will bite down on an object (e.g. fence), tense its neck and suck air while making a sharp jerking movement. (Apparently this is potentially bad for the lungs and can cause other health problems such as colic)

Ultimately the information the scientists need to find out is how frequently the animal has an episode of the behaviour, when it happens during the day, how long it persists for, what the repetition rate is for these repetitive behaviours. Experiments can then be carried out to test various hypotheses regarding the cause and possible solutions for the behaviour by capturing new sets of objective data from the sensor device.

The proposal is to use accelerometer type sensor(s) in a small device that can be attached to the animals head-collar combined with inexpensive flash memory devices to store the data, although you are free to propose alternatives and discuss the pros and cons. For practical reasons maintenance (such as changing batteries) can be carried out once per day. Initially the proposal is to capture and store the data so that the time and severity of head movements can be extracted from the data at a later date (and processed on a standard PC) bearing in mind the data storage capabilities of your design.

Hardware design

The hardware design that you are to produce is *not intended* to be a complete circuit diagram or circuit board, but should include at least the following (marks available for each aspect shown in brackets):

1. A list of major active components including the microcontroller/ microprocessor, sensor device(s), storage or communication device(s) and any others you need to complete the application. You should explain the role and features of each and also include justifications for the selections that you make, and mention any significant or relevant alternatives that are available. For example, how much storage is required by the application? You will need to think carefully and decide what data is to be stored and how often and in what format. This will then impact on your software design also. [20% of the total marks for the assignment]

2. A detailed description of the interconnections between the devices including the communication mechanisms and protocols used. Include also any connections to external devices. You should also give detailed justifications for the choices you have made. [5%]

3. The power supply requirements of the major components. What voltages and maximum power requirements are involved? Therefore are any power regulation devices required? Detailed solutions are not required but you should document the requirements so that an electronics engineer could design the relevant circuitry. [5%]

4. An energy budget for the hardware, taking in to account the anticipated operating modes of the devices. The type and capacity of power source(s) to be used should also be discussed. [10%]

5. An estimated size and weight of the device. You should *not* design a detailed circuit board however you should consider the size and weight of the major components and sketch how they could be physically placed on a single sided prototype circuit board to get an idea of the expected overall size of your device. Don't forget to include the weight of the power source ! [5%]

6. A rough estimate of the overall cost of the main components of the project for example will it be nearer £10, £50 £100, or £500... An exact cost would require more details than you will have and would anyway depend on the volumes of components purchased. However, just guessing a number with no justification is not enough - you should itemise the costs of all the major components and produce a Bill Of Materials (BOM). Nowadays the websites of most component distributors provide online pricing information. [5%]

   Since you are not producing a complete electrical design I am not expecting details of the minor electrical components or circuit board and these are typically fairly inexpensive anyway.

Control algorithm and software

The design of the control algorithm is the key part of this assignment. Your algorithm should be designed to perform at a rate suitable for the application and should take into account the way in which the data is to be collected, stored and/or transmitted. The algorithm must also be designed *in conjunction with the hardware that you selected* to ensure the hardware is initialised and controlled in an appropriate way and uses an appropriate amount of power. For instance you should consider whether your application could use an interrupt driven or polling mechanism for data collection.

You should present your control algorithm as follows:

1. A state chart depicting the major operating modes of your software. A flow-chart (activity diagram) or set of flow-charts as necessary, depicting the main algorithm(s) or tasks of your application. You may need to think carefully about how you represent the use of interrupts in your program (if your application requires them). [15%]

2. Detailed descriptions of what each part of your program does and why it does it. This could be a list of the components/functions, the parameters required and operations performed in each. Think about the following issues. How you are exploiting the power-saving features of the hardware that you selected? How you are exploiting the input and output capabilities of the hardware that you selected? How you will ensure that the timing and synchronization issues inherent in your application are addressed in your implementation? Why have you broken the problem up the way that you have and how the various components/functions are synchronized and triggered? In order to do this you will need to list and describe any timers and interrupts that are used and how they will interact with each other and with the application environment. [15%]

3. What is the procedure for using the device in the field? Are there any user configurations required for your software? If so, you need a description of these including how they will be stored and how will the user select or change them?[5%]

4. How you will develop your implementation in terms of the software and hardware tools required and how you would set about test, debug, and refinement of the implementation. [5%]

5. You should provide *estimates* of how many lines of code and how much memory are likely to be required for each of the parts of your software and rationalise this with the amount of program memory available. Please *do not* write the actual code it will be too much work and there are no marks for it and besides there is no way of testing it without the hardware ! Just estimate based on your experience how many

lines might be required for each task is it closer to 10, 100, 1000 or 10000 for example. You may use the empirical examples from the lectures to make estimates, or you might write some test code in MPLAB during a practical and view the memory usage. [5%]

6. Do you require any library code for your application? What would these libraries be used for? [5%]

Write-up and hand-in

This is an individual assignment and I will expect each student to produce their own design. Of course you may discuss possibilities with your peers, however there are so many estimates, assumptions and choices to make that any identical reports will not be considered in a favourable light.

You should not write more than 4000 words for this assignment although you may use as many diagrams as you wish to help you explain the design. You must put all the material you hand in in a single folder and it must be possible to read and write on all sheets that you hand in without having to remove them from the folder. In particular, you must not hand in loose sheets in a bag, or put everything in a single plastic pocket of a folder. The "folder" does not need to be a commercially made folder, indeed, I'm happy to accept sheets neatly stapled together as a "leaflet".

Keep the text concise and to the point! Rambling incoherent descriptions waste your time and mine. You may also wish to comment upon possible design options that you chose to reject in order to highlight why you believe the design that you selected is good; again keep to the main issues. Remember, stick to the requirements - don't get carried away and create an unnecessarily complex design.

This work should be handed in using the normal departmental hand-in procedure (drop box) on Wed 4th May between 9am and 4pm. This assignment will make up 50% of the module marks.

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