3rd Year Project, 2024

SF4
USB Data Logger
Project Guide and Instructions

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SF4 Datalogger/Embedded Systems Project

SUMMARY

The aim of the 3rd Year Datalogger Project is to teach students how to develop a modern embedded system including hardware and firmware/software components. The overall project time is 4 weeks, whereby students summarise design specifications in an interim report after 2 weeks, and demonstrate a full working system after 4 weeks, followed by the submission of a final report.

The project uses an Arduino UNO microcontroller board which is based on the ATmega328P microcontroller unit (MCU). There are 4 main parts which require design in this project. Firstly, the students have to design circuitry for taking the input signal(s) and interfacing it with the MCU. Next, students will have to write firmware (in C) to control the MCU and to handle input from the circuitry. Then, there are the 'Communications' and 'Software' aspects, which are in essence the protocol or format with which data or commands are sent between the MCU and the Windows PC. For their overall system, students will have to develop a "product identity" in the form of a marketing datasheet to create an awareness of the commercial market in the target area. To create cost awareness, the students will have a budget of £15 available to purchase hardware components that are not available in the teaching lab.

Students will start by going through an introductory handout on the operation of the Arduino. Additional reading material will also be provided on more advanced features of the microcontroller board which the students might choose to incorporate in their designs.

1.0 INTRODUCTION

The purpose of this project is to develop an embedded system, including the required analogue/digital hardware, and firmware/software. The application for the embedded system and product identity, i.e. what it does, is left for each group to decide - the more imaginative the better! However, all projects should be based around the basic "datalogger" architecture such that a hardware element (e.g. analogue sensors) provides some input to the microcontroller, and may be controlled by it, while communication between the MCU and PC is demonstrated. This two-way communication should allow a user to control the system and see feedback/output from it.

The project uses the Arduino Uno microcontroller board. The Arduino is powered, programmed and debugged from a PC over a USB connection. Communication with the PC is via a serial connection. Application hardware can be powered from the development board's 5V supplies, providing the current requirements are small (<20mA, above 40mA would permanently damage the board). Resettable fuses must be connected in series with these power supplies to reduce the likelihood of accidental damage to the PC/USB port.

The starting point for all of the projects is an introductory handout that demonstrates various basic functionalities of the Arduino. Additional reading material is also provided on more advanced capabilities.

All relevant software and drivers can be downloaded from the internet, as explained in the introductory handout, and the students can also make use of their own PC to operate the Arduino.

Also, note that we accept no responsibility whatsoever for any damage to your own PC!

Students are encouraged to go onto the internet and search for code or designs that others have already been done. Please do not "re-invent the wheel" – if someone has some nice code/circuit for download, use it! ***However, students must reference it in their design and/or report and state the full link with the originator.***

2.0 PROJECT SCHEDULE AND ASSESMENT

The project starts on Friday 10 May 2024 and ends on 4 June 2024 (4 weeks). After an introductory talk at 11 am on Fri 10 May at LR5, all the project sessions are in the EIETL lab scheduled for:

Fridays 11am-1pm and **Tuesdays 9-11am & 2-4.00pm**

You are expected to attend all of these sessions, at which demonstrators will be available to assist you, and attendance will be recorded. There are mark penalties for lateness and/or absence from these scheduled sessions. **Do not arrange anything which will clash with these sessions.**
You may also have access to the PC's and lab equipment at other times, although priority will be given to other scheduled projects.
There are 3 milestones for this project. The project is marked out of 80 (positive credit).

Milestone	**When and what happens**	**What is required**
Specification and design – **Interim Report**	Date: 21 May 2024 by 11am (submitted via Moodle) Report feedback for 10 mins, in pairs, on 24 May Worth: **10 marks**	**1 set of paperwork per pair** containing (2 pages, excl. appendices): analogue circuit design, parts list for purchasing, block diagrams for comms., firmware/software design. Plus: **Who's doing which bit?** IIA project cover sheet
Demonstration	Date: 4 June 2024 (2-4.00pm) Students (in pairs) demonstrate their system with the assessor for 15 minutes Worth: **30 marks**	Working hardware/firmware/software
Final Report	Date: 7 June 2024, 4pm (submitted via Moodle) Students must **individually** write up and submit their report. Each will be assessed on its own merits. Worth: **40 marks**	**1 marketing datasheet** from each student [1 piece of A4 (2-sides) max] **1 independent report** from each student (10 sides of A4 max, excluding appendices, as outlined in THIRD YEAR PROJECT GUIDE*; add interim report as appendix). IIA project cover sheet and **Signed declaration** that student is submitting own work.

* for guidance on report writing, you are referred to the online Writing Skills documents on the Teaching Webpages: https://www.vle.cam.ac.uk/course/view.php?id=72251

Each project will be evaluated based on:

- Design creativity and functionality
- Arduino features exploited and sampling speed achieved.
- 2-way communication between MCU and computer.
- Analogue circuitry including appropriate conditioning (eg. DC offset removal, anti-aliasing, automatic gain control etc if appropriate)
- Level of signal processing (e.g. Fourier transforms, scaling, averaging etc.)
- Robust demonstration of whole system
- Clear presentation and effective communication of system design and its features in the interim and final reports as well as in the datasheet.

Please note the following (see also Y3 project guide):

- For non-attendance at a timetabled session, the penalty is 1 mark per hour or part hour missed.
- For late submission of interim reports, the penalty is 3 marks per day.
- No reports will be accepted after the submission date for the final report.
- The marks for different projects may be moderated after the conclusion of the project to even out any significant differences in mark distributions.