4B25. Final Project Report.

Nathan Day, nd368@cam.ac.uk.

Project title: **Development of a pedometer using the FRDM-KL03Z board.**

Report summary.

This report details the final state of the developed pedometer, as well as key design decisions and the development methodology behind the product. This is done via addressing the points stated in the Grading Rubric for this coursework item.

The problem solved. (1).

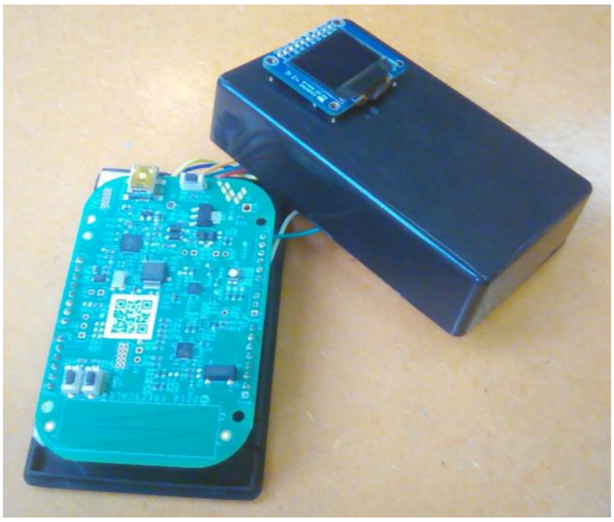
A pedometer has been created using the FRDM-KL03Z board.

Who cares if the problem is solved. (1).

Given suitable market adaptations, that would exploit benefits of this particular design and develop a marketable advantage, then end-users would receive a device better in this criteria, and parties involved in development and sales of the device would receive benefit from this.

The current state of the art. (5).

The device consists of the FRDM-KL03Z board (with built-in accelerometer) attached to an OLED to display the number of steps registered, fitted with a coin-cell battery and packaged within an enclosure. These features are shown in the image below.



Due to problems arising with the interfacing to the on-board accelerometer, the logic pertaining to the identification of steps could not be implemented as effectively as initially desired. The product met specifications in all other regards.

The approach. (10).

The approach centred around achieving a minimally viable solution followed by layered development and optimization on top of this. The most-value adding parts of the system were to receive the most attention during this optimization process.

An in-depth view of this approach is outlined in the figure below, with corresponding division of tasks partitioned into project stages.

Project stages.

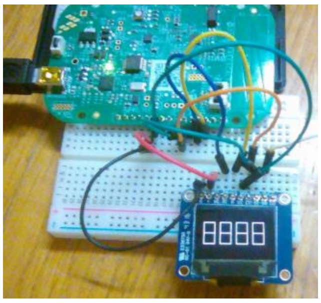
1. Preliminary.
    1.1. Preliminary overview and implementation reading of required components available on the FRKL03 development board.
2. Feasibility.
    2.1. Individual subsystem test programs deployed.
        2.1.1. Base program (hello world supplied).
        2.1.2. Accelerometer.
        2.1.3. OLED display.
        2.1.4. Storage.
    2.2. Combined system basic test program.
3. Development to minimally viable system for data analytics.
    3.1. Optimization of combined system program for recording acceleration data in a suitable format that can be exported for analysis.
    3.2. Brief review / formalization of this program.
    3.3. Hardware setup.
        3.3.1. Coin-cell battery.
        3.3.2. Enclosure / fixings / protection measures.
        3.3.3. Punch out necessary holes in enclosure.
4. Analysis.
    4.1. Pedometer algorithms researched.
    4.2. Pedometer user-step data analysed.
    4.3. Initial understanding / matching up of observations in the recorded data with user 'step/walk' physical events.
    4.4. From initial findings, perform further experimentation to isolate the key patterns + events, and gain more detailed understanding of them.
5. Implementation + continued analysis.
    5.1. Combine knowledge of key patterns, events, and existing algorithms, to develop an algorithm that will acceptably satisfy project minimum requirements.
    5.2. Implement algorithm + perform iterative development to ensure the minimum project requirements are met.

IF AND ONLY IF THE MINIMUMALLY VIABLE SYSTEM FOR THE PROJECT HAS BEEN DEVELOPED, THE FOLLOWING MODIFICATIONS MAY BE ADDED.

6. Additional modifications.
    6.1. Optimisation of step-recognition algorithm to increase recognition rate, and reduce false positive rate.
    6.2. Research into optimal location pedometer can be positioned on a person, and modify the device such that it can be wearable / positioned optimally.

The results. (10).

The developmental success of each sub-unit within the system is detailed below, followed by a statement pertaining to the operational success of the system as a whole.



Coin-cell battery: Fitted successfully. Device self-sufficient in power requirement.

OLED: Fitted successfully. Can display any number 0-9999. Code produced in an extensible manner, allowing for fast implementation of further digits if necessary.

Accelerometer: Interfaced successfully. Initial problems arose since Kinetis system demo program originally modified instead of the demo version used in previous coursework. This led to several problems, the most notable of which was insufficient baud-rate leading to the accelerometer unit returning various error messages (overrun and underrun errors). The problems were identified and resolved successfully.

MCU unit: A program was developed to control the operation of the pedometer, including the interfacing of its sub-units. Due to the earlier-stated problems with the accelerometer interfacing, time limitations prevented the step-recognition function within the program from being developed to the effectiveness initially desired. The program operated successfully and met specification in all other regards.

The overall successfulness of the project was limited by unforeseen problems encountered during the development process, notably with accelerometer-MCU interfacing difficulties. The effects of this substantiated most significantly in the latter parts of the system to be developed, notably in the logic pertaining to step recognition; residual effects of lesser significance manifested system-wide. Despite the encountered difficulties, several system components were developed successfully and met system specification, and these were integrated to form a final system of reduced functionality.