A Low-cost Sensor Module for In-Building Monitoring and Threat Detection

Project proposal for 4B25 Embedded Systems

1 Introduction

1.1 Overview

Nowadays, with the rise of Internet-of-Things (IoT), sophisticated hardware systems for environment and security monitoring purposes have begun to transform towards systems that are with *better intelligence*, *lower-cost* and *less power consumption*. In-building monitoring systems that integrate more functionalities should have begun to emerge, in the hope to replace the traditional systems which targets to only a limited number of aspects, e.g. smoke detection, environment monitoring, etc., unfortunately, to-date there are few such highly-integrated low-cost monitoring systems available in market. This proposed project is an early-stage attempt to bring such a system prototype into real-life.

1.2 The aim and objectives

The aim of this project is to develop a low-cost hardware system, which is capable of providing environment monitoring, safety sensing and security threat detection functionalities, suitable for in-building deployment.

In order to achieve the aim, the following objectives are identified:

- To design a hardware prototype to provide temperature, humidity, light density, gas concentration, sound and motion sensing data.
- To develop an *in-situ* low-cost means to display and report the sensed data and important messages to end-users.
- To test and evaluate the system in a building at the University of Cambridge, Cambridge, UK.

2 Market potential

This proposed system would eventually benefit people working in areas such as estates, building management and security. More importantly, it would provide a wider use-case for ordinary households who are expecting low-cost monitoring systems, which could provide security threat detection, gas safety monitoring and environmental sensing capabilities within a single small and compact design, to be deployed at homes.

3 The proposed approach

Due to the limited time available, the system at its initial stage will be powered by wire, and will utilize wired communication. The system will be based on a Cortex M0+ hardware platform (FRDM-KL03Z, NXP Semiconductors, Eindhoven, The Netherlands) with necessary break-out designs to implement sensors for monitoring and measurement purposes. The sensed data will be displayed and reported to end-users *in-situ* using an organic light-emitting-diode (OLED) display and a buzzer alarm. The mechanical design consists of a 3D-printed system module enclosure and a user-friendly wired breakout board for user interaction. The entire system will be running a modified firmware based on the open-source *Warp-firmware* source code. As for mechanical design the module will be enclosed within a 3D-printed enclosure that could provide ease of installation as well as mechanical protection for the system when deployed in buildings.

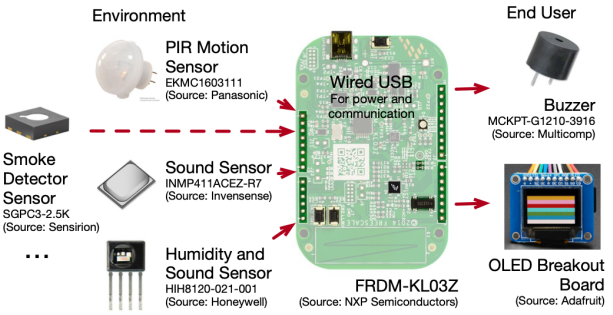

Figure 1: The system diagram showing the hardware setups. Sensors that captures humidity, smoke, PIR movement and sound data will be implemented using break-out configuration.

4 Project timeline

The Gantt chart for this project is shown below.

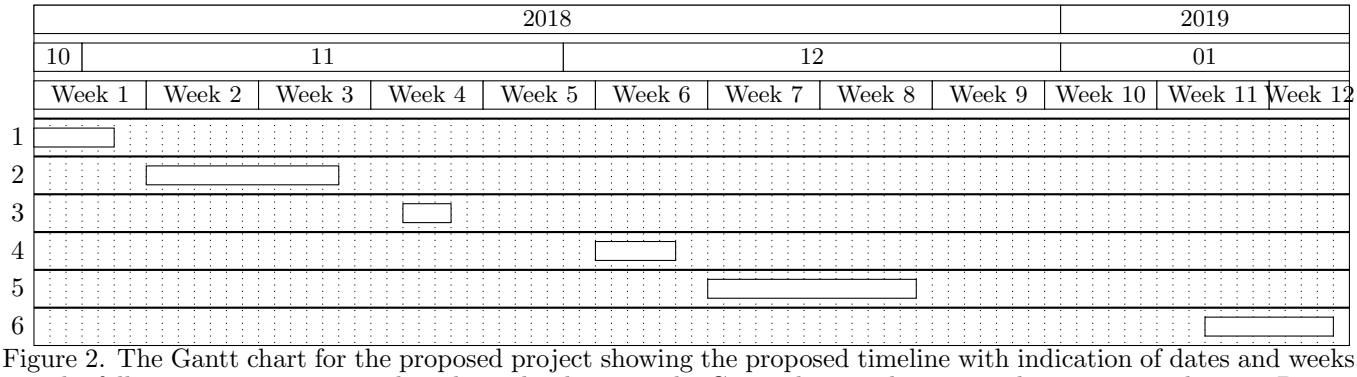

Figure 2. The Gantt chart for the proposed project showing the proposed timeline with indication of dates and weeks.

The following items correspond to the tasks shown in the Gantt chart with estimated time to complete. 1: Project proposal writing and components selection (3 hrs). 2: Firmware development using Warp platform resources (6 hrs). 3: Interim report writing (3 hrs). 4: Breakout board and mechanical design (6 hrs). 5: System construction, both hardware and software (10 hrs). 6: Final report writing and demo preparation (5 hrs).

The project will be carried out throughout the months, with an estimated working time of 22 hours without considering the time that will be spent on producing reports.

5 Feasibility analysis

Given the availability of the *FRDM-KL03Z* hardware platform and the open-source firmware developed by *Physical Computation Laboratory*, it becomes possible within the limited 20 hours time frame to design and write-up the firmware for the monitoring system based on the *Warp* configuration, without having the need to design a printed circuit board (PCB) from scratch. Commercial off-the-shelf (COTS) sensors and devices will be implemented, therefore the focus will be mainly towards firmware development.