School of Engineering

ER1731/EL1242 Embedded C Assignment
A Primary Smart Home System

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Module Learning Outcomes:

2. Explain the operation of a basic microprocessor/microcontroller system, and interpret software used in such a system.

3. Write and test simple programs using a modern programming language and an appropriate set of development tools or environment, including use of libraries, debug tools etc.

4. Develop digital systems and programs for basic engineering applications.

5. Design hardware and software to meet the specification for a simple processor-based system.

Brief

Smart home devices are a part of the larger concept of home automation. Large smart home systems utilize a main hub or controller to provide users with a central control for all of their devices. These devices can include lighting, heating and air conditioning and security system. The other key application of smart home is to provide assistance for disabled and elderly individuals. For example, they can be equipped with additional safety features which include sensors that monitor for medical emergencies such as falls or seizures. Smart home technology can provide users with more freedom and a higher quality of life.

Your task is to implement a primary smart home system which can automatically control the heating and lighting system, detect people's falls, and provide readings of environmental parameters, e.g. temperature, ambient light levels.

Specific requirements of the systems are as follows:

1. You will use the Nucleo STM32f303RE ARM board and specially made sensor board, an application shield, shown in Figure 1.
2. **Automatic heating control**. This is about a design of a thermostat. The state of the thermostat controller is represented by a servo. When the temperature is greater than or equal to 25 °C, the servo should be at a position of 0° degree, which means the controller is 'off'. When the temperature is below 25 °C, the servo should be at a position of 135° degree, which means the thermostat controller is 'on'.
3. **Automatic lighting control**. Use the four red leds as lighting devices. There are five required levels of lighting, 1, 2, 3, 4 and off. The lighting level is controlled by the lightness/darkness detected by the LDR sensor, for example when it is very light, all the leds will be off, and

when it is very dark all the four leds will be on. All the 5 levels of lighting will be corresponded to the evenly distributed 'ReadIn' value from the LDR.

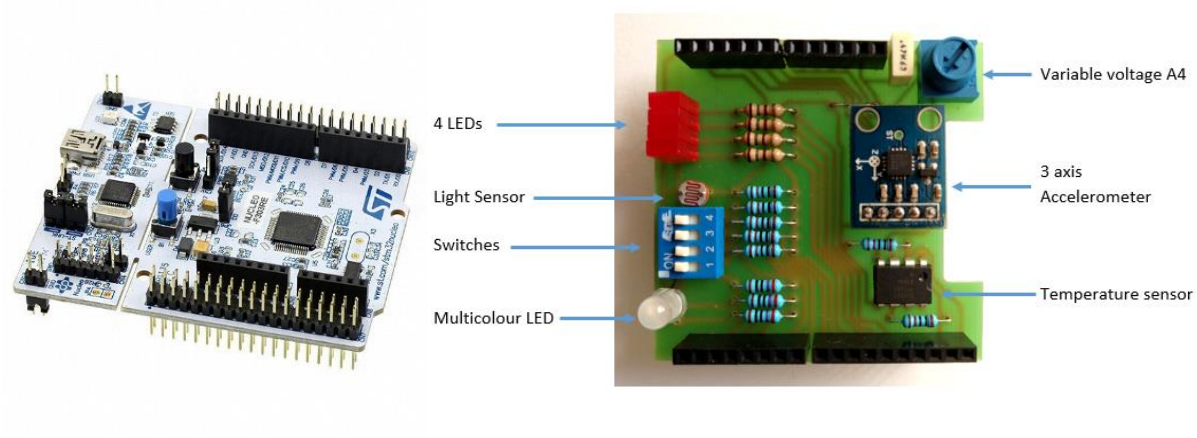

Figure 1. Nucleo STM32f303RE ARM board and the specially made sensor board.

4. **Detecting falls**. Use the 3 axis (X, Y, Z) accelerometer to detect fall and the three colour led to represent an alarm. Assume that when people fall, the value of acceleration is greater than 2g or less than -2g in any direction of X, Y and Z. When a fall happens, light up 3 colour leds in turn and each colour duration time is 0.2s.
5. **Environmental parameter readings**. Use the blue User Button and switches to control the content of readings. When the blue user button is pressed, and the switch position is '0001', display the temperature on the PC screen through the on board serial port. When the blue user button is pressed, and the switch position is '0010', display the ambient light levels with a pattern of number of '*' on the PC screen. When the blue user button is pressed, and the switch position is '0100', display the values of acceleration of 3 directions on the PC screen. When the blue user button is pressed, and the switch position is '1000', display the output voltage value from the potential meter. When the switch value is others, display a message of 'invalid switch value' on the PC screen. The summary of readings is as below,

State of Blue User Button	Value of Switch	Content to Display on PC
Pressed	0001	Temperature (°C)
Pressed	0010	Ambient light levels as a pattern of number of '*'
Pressed	0100	Values of acceleration of 3 directions
Pressed	1000	Output voltage value from the potential meter
Pressed	Other values	'Invalid switch value'
Not pressed	Do not care	Keep previous display

Marking Scheme

This assignment contributes up to 30% of the mark for the module.

It is recognised that not everyone will be able to meet all of the specifications given overleaf, so the assessment scheme is designed to measure how much of the specification you can meet. You will be

required to write a short evaluative report and give a demonstration of your system by taking a 20 second selfie video. All the program with inline comments you made should be included in the report. Marks will be awarded as follows:

Item	Possible Mark %
Automatic heating control	20
Automatic lighting control	20
Fall detection	20
Environmental parameter readings	20
A 20 second video demonstrating your working system	20

Appendix: Details of devices on the specially designed shield.

Device	Nucleo/Arduino Pin(s)	ARM Pins	Comment
4 LEDs	D10–D13	PB6, PA7, 6, 5	Can output 4 bits, 1 'hex' digit Nucleo Board 'LED1' is D13
4 switches	D6-D9	PB10, PA8, PA9, PC7	Can input 4 bits, one 'hex' digit
Push Switch	USER_BUTTON	PC13	Interrupt, Polling
PWM	Any digital output pin, except D6, ARM PB10 [we use this for input on our system]		Brightness of LEDs, speeds of motors, angular position of Servos can all be controller with PWM
Multi-coloured LED	D2 = Red D3 = Blue D4 = Green	PA10 PB3 PB5	3 colour LED, allowing (almost) any colour to be produced by addition
Potentiometer	A4	PC1	Adjustable Analogue input
Light dep. Resistor	A5	PC0	Voltage Vin varies inversely with light level
Analogue Accelerometer	A0 = X A1 = Y A2 = Z	PA0 PA1 PA4	ADX335 3 axis analogue accelerometer Axes are marked on module
I^2C sensor	D14 = SDA D15 = SCL	PB9 PB8	DS1621 temperature sensor