Design Problem:
Smart Home Security System

I. Introduction

Design an embedded system to realize a simple smart home security system with the following design criteria.

1. System Mode:

MODE	Description
Normal Mode (NORM_MODE)	Pressing MODE_button (B1 of MCU_1) toggles from NORM_mode ←→SECUR _mode
Security Mode (SECUR_MODE):	Pressing STOP_button (B1 of MCU_2) resets from SIREN_mode to SECUR_mode.
SIREN Mode (SIREN_MODE):	Turns on the siren after 5 seconds from SIREN_TRG trigger generation.

2. Window Security System:

MODE	Description
Normal Mode (NORM_MODE)	During the daytime: - Automatically opens the curtain. During the night time: - Closes the curtain. Does not generates SIREN _TRG trigger.
Security Mode (SECUR_MODE):	If the window is opened or the glass is chattered unexpectively: - Opens the curtain and generates the SIREN _TRG trigger

3. Front Door:

MODE	Description
Normal Mode (NORM_MODE)	When a person is detected within the given distance from the door(outside): - Keep turning on the door light as long as the person is present. When a person is detected inside the house nearby the door: - Turn on the door light for given period of time and does not generates the SIREN _TRG trigger.
Security Mode (SECUR_MODE):	When a person is detected within the given distance from the door(outside): - Keep turning on the door light as long as the person is present and sends the VISITOR_LOG message to the server. When a person is detected inside the house nearby the door: - Keep turning on the door light and generates the SIREN _TRG trigger.

Embedded Controller

Hardware

- MCU: NUCLEO -F411RE x 2

- Analog Sensor: IR reflective optical sensor(TCRT5000) x1
                          Ultrasonic distance sensor(HC-SR04) x1
                          Sound sensor (SZH-EK033) x1
- Digital Sensor: Light intensity sensor(MSE004LSM) x1

                          PIR motion sensor

- Actuator: Stepper Motor(28BYJ-48) , Motor driver(ULN2003)

- Display: LED, 7-segment display(S-5101ASR)

- Communication:Zigbee module (XB24CZ7WIT-004) x2, Zigbee Shield(DFR0015) x2, Bluetooth Module(HC-06)x1

Software

Keil uVision IDE, CMSIS, EC_HAL

II. Problem Description

The system is consisted of a server, a sensor unit and an actuation unit.
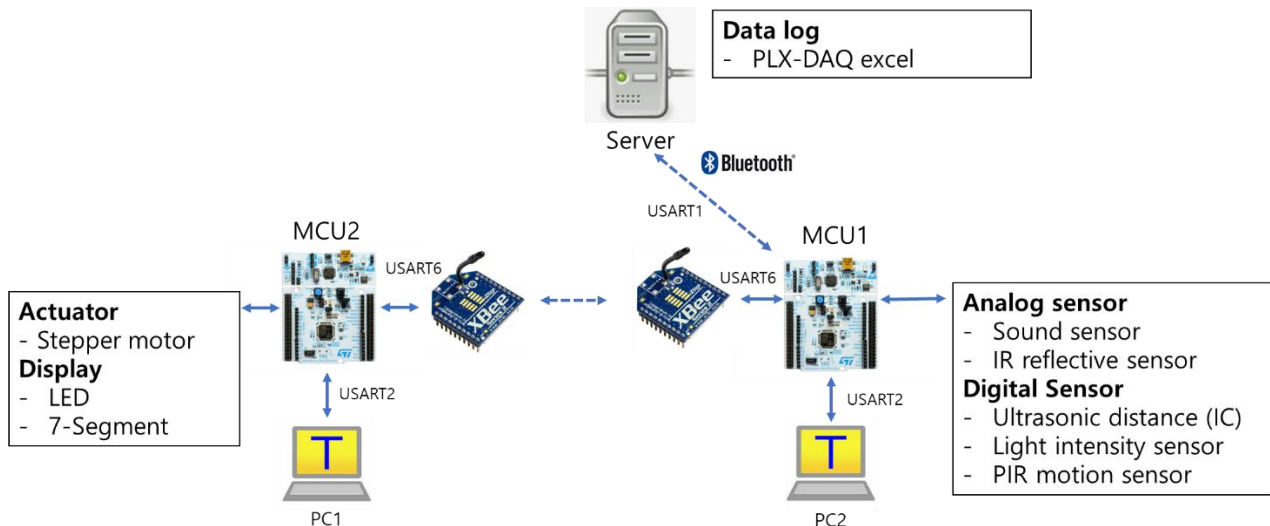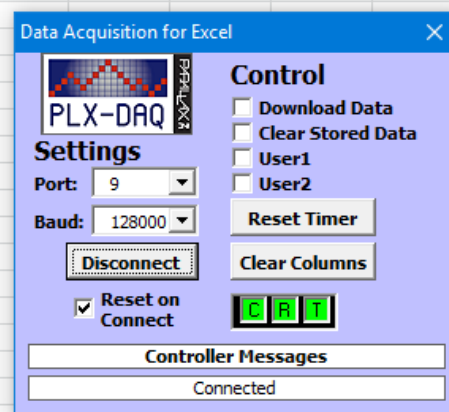

Server

Receives each sensor values and necessary status from the Sensor Unit MCU, every 1 second

You can decide what needs to be transmitted to the server.

For this design problem, we will use PLX-DAQ for excel as the data logging.

https://www.parallax.com/package/plx-daq/

Embedded Controller

Sensor Unit: MCU_1

Function	Sensor	Type	Configuration	Comments
Door Person detect (front)	Ultrasonic distance sensor	Input Capture	Sampling 0.1 sec Check object presence within 30cm Generates PERSON_OUTSIDE flag	Need to check for outlier measurements (at least 7/10 Postive) VISITOR_LOG under SECUR_MODE
Door Person detect (inside)	PIR motion sensor	Digital	Edge trigger Generates PERSON_INSIDE flag	
Glass breaking detect	Sound sensor	Analog	Choose sampling Set a threshold value for breaking Generates WIN_BREAK flag	
Window open detect	IR reflective sensor	Analog	Choose sampling Set a threshold value for open WIN_OPEN flag	Need to check for outlier measurements (at least 7/10 Postive)
Daylight intensity	Light Intensity sensor	Digital	Edge trigger Generates CURTAIN_OPEN Flag	Check for false data. Need to maintain Bright or Dark condition for 2 secs
MODE switch	Button B1	Digital	Edge trigger Toggles SECUR_MODE to NORM_MODE	

Actuator/Display Unit: MCU_2

Function	Actuator	Conditions	Action	Comment
Curtain	Stepper motor	CURTAIN_OPEN=0 CURTAIN_OPEN=1	10 rev CW. Generates CUR_OPENED=1 flag 10 rev CCW. Generates CUR_OPENED=0 flag	Should give complete_flag to MCU1 Open/close only once. Cannot open when it is already opened
Door Light	LED	DLIGHT_ON=1	Turns on light	
MODE Display	7-segment	NORM MODE SECUR MODE	Display '1' Display '5'	
SIREN Countdown	7-segment	SIREN _TRG=1	Count 5 to 0 with 1 sec rate. Go to SIREN_ON	
SIREN_ON	7-segment	SIREN_ON=1 If 'Stop' button is not pressed in this mode	7-segment blinking with number '0' at rate of 1 sec	
SIREN_STOP	B1 of MCU2 (Input)	Under SECUR_MODE	Edge trigger Turns off SIREN Dısplay '5'	Reset to SECUR MODE

B. MCU Configuration [10pt]

You are free to select appropriate configurations for the design problem. Create a configuration table to list all the necessary setup.

MUST condition: Use at least one timer interrupt, at least one polling process in main().

Example:

Functions	Register	PORT_PIN	Configuration
System Clock	RCC		PLL 84MHz
delay_ms	SysTick		
	Digital Out		
RS-232 USB cable(ST-LINK)	USART2		No Parity, 8-bit Data, 1-bit Stop bit 38400 baud-rate
Bluetooth	USART1	TXD: PA9 RXD: PA10	No Parity, 8-bit Data, 1-bit Stop bit 9600 baud-rate
Zigbee	USART6		
	….		
TIMER	TIMER1		
	TIMER2		
	TIMER3		
	….		

C. MCU wiring connection [10pt]

MUST condition: Show the wiring of each sensor/actuator component to MCUs.

DO NOT draw by hand.

III. Algorithm

A. Algorithm Overview [30pt]

For the algorithm overview, you need to explain <u>concisely </u>how your system works. Recomend explain with tables or state diagram. Also you should use explain by

- Listing all necessary states (states, input, output etc) to implement this design problem.

- Listing all necessary conditional FLAGS (WIN_BREAK etc) for programming.

- Explaining additional conditions/configurations that were not explained in Introduction.

B. Flow Chart [30pt]

Draw a flow chart or state diagram to show the flow of your system

IV. Demonstration [100pt]

In class demonstration. Score table will be announced.

V. Appendix [20pt]

A. source code: main.c

Score table will be announced.

B. source code: others

Header files created for this design problem