University of Balamand - Faculty of Engineering

Embedded Controllers Lab Project – Fall 2017

Embedded Controllers Lab
CPEN 309

2017

Name : _____

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Due Date: 7 December 2017

Introduction:

This project is an embedded device for acquisition and control on the Nucleo STM32F401RE development board. The project consists of an LM35 temperature sensor, A PWM out (fan control), resistors, LEDs, keypad and an LCD. The purpose of this project is to set up an acquisition and control system which monitors the current temperature and operates the LEDs and PWM accordingly. Furthermore a 4x4 keypad is used to input required minimum and maximum allowable temperature values and an LCD to display the menu option and alert messages including the current temperature, and the PWM duty cycle values.

Design:

Set up a data acquisition and control program to convert the acquired voltage to temperature in Celsius and control the relevant devices (LEDs, PWM).
Your design should operate as follows and is divided into two states (initialize, monitoring and control, emergency):

- **Using RTOS and Threading greatly affects the grading system.**
- **State machine design is a MUST (If RTOS is not used)**

1) Upon power up or reset the device should enter into "initialization mode" and should prompt the user to either input temperature limiting variables for comparison (TempLow, TempMid, and TempMax) or use default values in the program.
    a. If the user chooses to input new data he should use the keypad to input the required parameters guided by the LCD prompts. The newly input parameters are then saved in the program overwriting previously available data.
    b. If the user chooses to read previously available values the system should fetch the data from memory and display them for confirmation.
        i. If the user declines the values the system will revert to input new data from the user and proceeds to the next state "initialize".
        ii. If the user confirms the read data the system will go to the second state "control and monitoring" and will use the loaded values.

2) Read the temperature sensors voltage and convert it to degree C. and display the current temperature. Computer the running average for 10 temperature samples.

3) Use the PWM output to control a connected LED.

4) Set up an LED control circuit using the board digital IO. Show all calculations and list the LED voltage, current specification to operate the needed. You will have to include 3 LEDs in your design (Yellow, Green, and Red) to indicate different temperature levels.

5) The system should provide logging data and state messages using the UART terminal.

6) Control your indicators (PWM, LEDs and LCD) using the chosen three threshold points: TempMin, TempMid, TempMax.

    a. **Case 1**: IF (Temperature<TempMin) output a 0% PWM signal to turn off/keep the fan off. Turn on the Yellow LED only. Display current status and current temperature ("T"), Average temperature ("TA") on LCD and UART use "**Cold**" state to define this case status.
    b. **Case 2**: IF (TempMin<Temperature<TempMid) output a 30% PWM signal and operate the fan. Turn on the Yellow and Green LED only. Display current status and current temperature ("T"), Average temperature ("TA") on LCD and UART use "**Stable**" state to define this case status.
    c. **Case 3**: IF (TempMid<Temperature<TempMax) output a 60% PWM signal and operate the fan. Turn on the Green and Red LEDs only. Display current status and current temperature ("T"), Average temperature ("TA") on LCD and UART use "**High**" state to define this case status.
    d. **Case 4**: IF (Temperature> TempMax) output a 100% PWM signal and operate the fan. Turn on the Red LED only. Display current status and current temperature ("T"), Average temperature ("TA") on LCD and UART use "**Heated**" state to define this case status.

The system should be able to provide an asynchronous reset option as a user emergency button, when an emergency event (interrupt) is introduced (user inputs a specific keypad character) the system should transit to the emergency state and operate the PWM at 0 (0% duty cycle) while turning off all LEDs for 3 seconds. The LCD should display a flashing emergency sign on one line and a decrementing number showing the remaining time in seconds to revert back to the "monitoring and control" state.

Challenges:

1) Include a device lock password for startup, parameters change and emergency timer value (in the initialize state).

2) Use the mbed systems real time clock to include log time.

3) Include a keyboard driven interrupt/event. A keyboard character from the UART to allow the user to go to the emergency state and do the previous operation and another character to allow the user to access a remote menu (**transit to a new state called "remote" and turn off all outputs until user terminates the session. Use this state to acquire UART data and modify variables**) the system should return to "monitoring and control" after session termination.

    a. The menu items should include the initialize states parameters modifications are as follows.
        i. Modify Systems Startup Password.
        ii. Modify Temperature Limit Parameters.
        iii. Modify Emergency Timer Value.
        iv. Terminate Session.

4) Connect an SD Card Controller and log monitoring values including systems real time clock and state transitions.

It is Mandatory to do at least one of the listed challenges to a complete project. Additional challenges will result in bonus grades on previous experiments.