**EGR 326 Embedded System Design and Build Project**

**Fall 2022**

**Project Description:**

Goal: to design and build an embedded system that employs most of the concepts discussed in class and serves a useful purpose. This is an exercise in translating a set of customer requirements into the design of an embedded system and working prototype to demonstrate desired and enhanced features. A similar process will be followed during your senior project capstone experience, so this exercise will help prepare you.

The design and build project this term is an embedded musical instrument. The heart of your system is your TI MSP432 Launchpad microcontroller board. It interfaces with a real time clock IC and several sensors that comprise the system. The primary method of generating music is via the proximity sensor. Other creative options to control pitch, volume or note length can be controlled using pushbutton switches, analog sensors, two stepper motors, and a rotary encoder. You will design and build a prototype to evaluate usability and feasibility of desired features described below.

The microcontroller collects input from a rotary encoder and pushbutton switches, formats the display for time and status information, and continuous sensory input. Time and note value are displayed at all times on the LCD display

REQUIREMENT SPECIFICATION:

The customer has expressed a desire for a low cost, futuristic electronic musical instrument

1. A bit mapped graphic liquid crystal display (LCD) shows the time, and the last note broadcast. As the notes change, so does the display color. A matching LED color will illuminate the display. The color varies from red-cyan-green-aqua-blue-violet and back to red…
2. A relationship between user distance (with a user’s hand) will establish which note is generated. This must be implemented vertically (ie- waving a hand at different heights produces different tones)
3. A stepper motor will indicate the volume on a graduated scale. Volume is adjustable.
4. The system has a rotary encoder for providing input into the system for setting the clock.
5. A menu on the display guides the user to enter information to set the time of the day, and date. If the entry mode has been idle for more than 1 minute, the action is cancelled, and the system returns to the time of day display.
6. The embedded system must retain clock time/day/date and preset system information when power is removed and returned.
7. The system may be powered by an AC-DC switching power supply from a USB wall plug charging unit. A voltage regulator circuit on the microcontroller board provides power to the MCU, the RTC, and sensors The USB 5V is provided to the motor circuit and other sensors that require 5V
8. A fixture must hold all components including the microcontroller board, connector board, display, LEDs, switches, keypad, cable attachments, etc… attractively and securely. This fixture must be open on at least one side, so that the circuits are visible.
9. A PCB will be constructed to interface with the MSP432 port pins, RTC, proximity sensor and hall effect transistor.

**Design constraints:**

1. The system must be autonomous so it can operate without a connection to code composer.
2. User interface must be clear and easy to use
3. The system must use the TI MSP432 microcontroller on your TI MSP432 launchpad development board as the embedded controller.
4. Any components that can be interfaced by a human must be safe.
5. The built-in watchdog timer on the TI MSP432 must be employed to confirm that the program is operating as designed and must be verified without CCS.
6. All parts that satisfy the project requirements are contained in the course lab kit or provided by your instructor. Additional parts may be purchased to enhance your design; however, cost of such parts must be limited to $50 per team.

Extra features (some ideas to choose from):

* Major: Design and create an attractive faceplate for the prototype
* Major: A rotating magnet/hall effect sensor can create a drum beat with configurable frequency.
* Major: Incorporate the SPI- 6-digit display in a creative way.
* Minor: Enhance the display to provide a scrolling date/time/temperature movement across the screen
* Major: User recorded sounds to speak the time of day, day of the week, and date when a button is pressed
* Minor: Add a remote temperature sensor to affect sound if the sensor changes temperature.
* Minor: All I2C modules (if more than 1) incorporated on same port.
* Propose other additional features to your EGR326 instructor for approval.

Note: 2 “Minor” extra features is equivalent to one major feature

**Grading**

To receive a grade in the “C” range on the project, your dashboard prototype must demonstrate all the customer functional requirements described above within the design constraints. They must be properly identified in your specifications document and fully described in your design document and validation plan.

To receive a grade in the “B” range, two of the extra major features described above must be successfully implemented and described in your design document.

To receive a grade in the “A” range, four extra major features must be successfully implemented and described in your design document.

The top 5 projects of all lab sections will be chosen by ballot and are eligible for extra credit if presented (with an accompanying poster) during Project Day. Any project selected must meet at least the requirements for a “C” grade.

Due Dates:

Oct 21 – Specifications document submitted to Blackboard

Nov 18 – Design document submitted to Blackboard

Dec 7 – Project demonstrations during final class session

Dec 9– Final project validation walkthrough in lab (scheduled times)

Dec 12 – Final revised design document submitted to blackboard