	ECGR 4101/5101 LAB 9 Report	12/05/2023
Nahush D. Tambe		**ntambe@charlotte.edu**
Bharat Kumar Duraisamy Krishnamoorthi		**bduraisa@charlotte.edu**

Lab Objective:

The objective of this lab was to add to the complexity of the previous labs by incorporating another Ultrasonic sensor to work in coordination with the original SparkFun Quad-Digit display, original Ultra Sonic Sensor and a 3.3V buzzer. The goal was to first program an application to measure the distance of an object in the range of 0 to 400 cm using the Ultrasonic Sensors and increment or decrement if a person enters a room or leaves the room. Next, the entire circuit was to be soldered together on a perf board while taking out the msp435g2253 IC and using the carrier board for programming and power. In addition, a buzzer was to be used that would alert at varying frequencies using a Pulse Width Modulator based off of the direction of the person entering or leaving measured by the Ultrasonic Sensor. This was expected to be achieved with an efficient and concise code, keeping the number of executable lines minimum, thus ensuring optimized application.

Lab Figures/Tables:

Table 1: Board 1 PIN Mappings

Hardware Peripheral	Purpose
Port 2.1 (Pin # 9)	TRIGGER (For Ultrasonic Sensor 1)
Port 2.0 (Pin # 8)	ECHO (For Ultrasonic Sensor 1)
5.0 V	VCC (For Ultrasonic Sensor 1)
GND	GND (For Ultrasonic Sensor 1)
Port 2.4 (Pin # 12)	TRIGGER (For Ultrasonic Sensor 2)
Port 2.3 (Pin # 11)	ECHO (For Ultrasonic Sensor 2)
5.0 V	VCC (For Ultrasonic Sensor 2)
GND	GND (For Ultrasonic Sensor 2)
PORT 2.6 (Pin # 19)	PWM (For Buzzer)
GND	GND (For Buzzer)
5.0 V	VCC (For SparkFun Display)
GND	GND (For SparkFun Display)
Port 1.2 (Tx) (Pin # 4)	Rx (For SparkFun Display)

For the Sparkfun Quad-Digit Display, 3 connections were made to VCC (5V), GND, and between the Receiver (Rx) of the display and the Transmitter (Tx) of the MSP430 board. For the Buzzer, PWM was connected to the board along with a connection to GND. To connect both the Ultrasonic Sensors to the board, 8 connections were made including GND and VCC to 5.0 V. PORT 2.0, 2.1, 2.3, & 2.4 were connected to the Echo and Trigger to send out a wave and calculate the echo wave's length to further calculate the detect an object from the sensor. Table 1 shows the connections that were made between MSP430 Board, Ultrasonic sensor, Buzzer, and the SparkFun Quad-Digit display.

Apart from these connections, the TEST PIN of the IC was connected to the TEST PIN of the carrier board. Next, the RST (Reset) of the IC was connected to the RST of the carrier board and a 47k Ohm resistor was also connected between the Reset and the Chip's VCC. Finally, all the VCCs and GNDs were connected together.

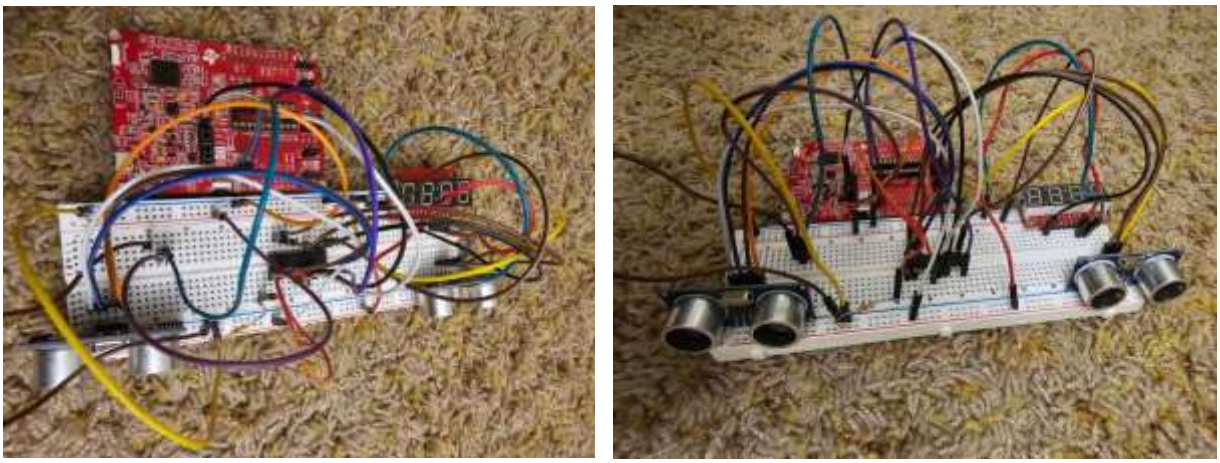

Figure 1: Connections made between the MSP430 Board and the Breadboard with SparkFun Quad-Digit Display, Ultrasonic Sensor, and Buzzer

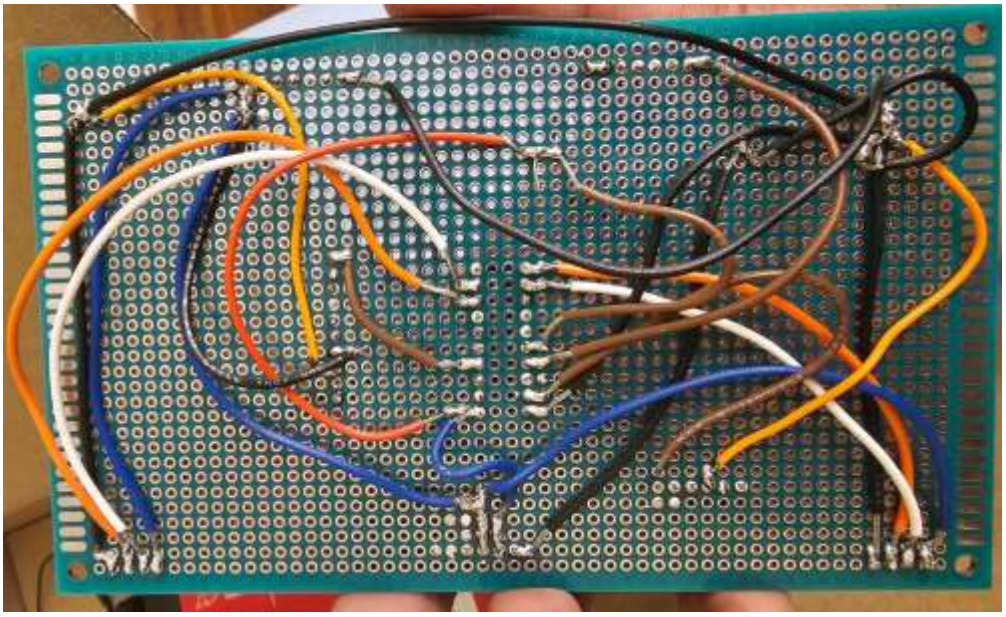

Figure 2: Soldered PCB Board with all the Connections Made

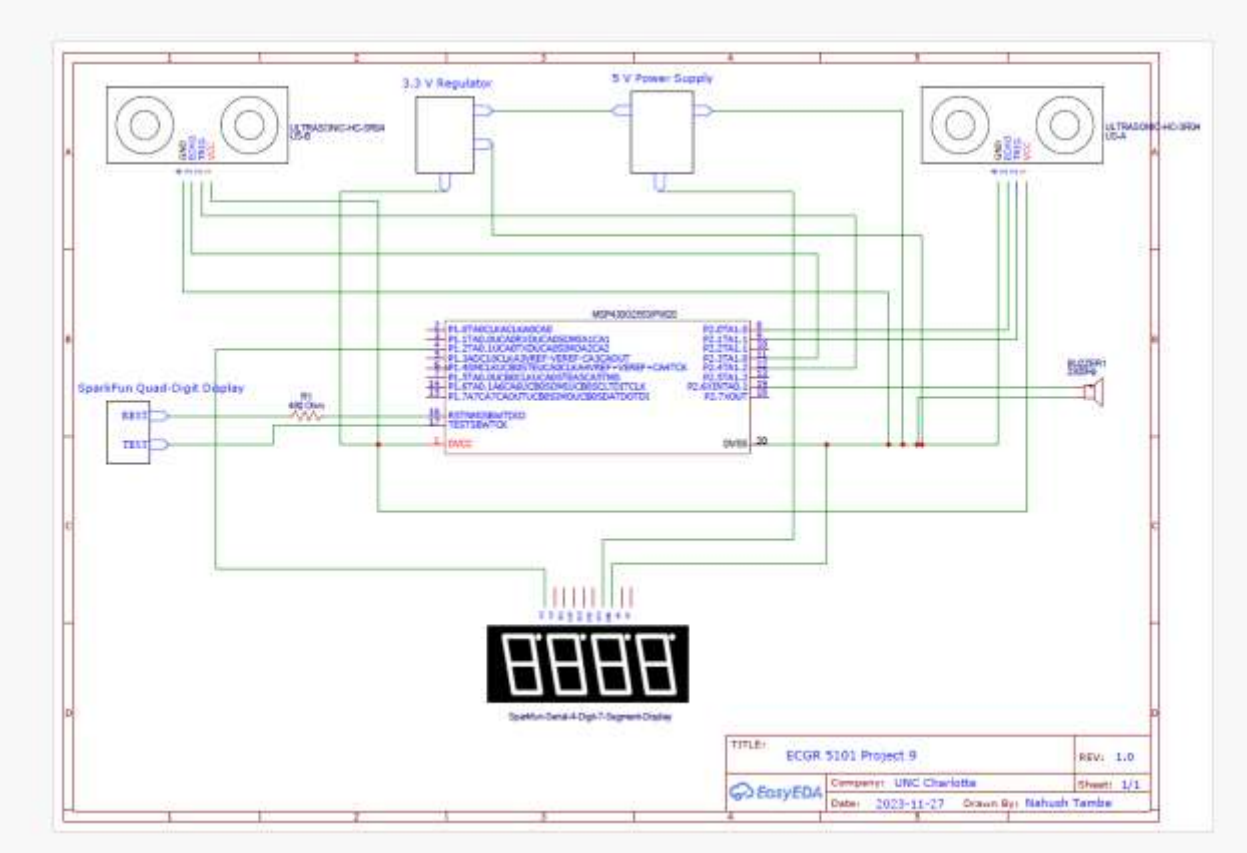

Figure 3: Original Circuit Diagram made in EasyEDA to Build the Circuit Upon and Solder the Components

https://youtube.com/shorts/ShMHyIvkjSE?si=PsF-EJYb5VCHq40n

Given above is the link to the YouTube video of the circuit working exactly as expected on a breadboard. If a person or an object enters from right to left, the counter increments and the value is shown on the display and if the person or the object comes from left to right, the counter decrements. When an object is in front of both the sensors, the value displayed is stable, and if an object is in front of any one US sensor without moving, the counter increments or decrements continuously. If the counter is zero and the Ultrasonic sensor that is responsible for decrementing detects an object, it does not go below zero.

Commentary and Conclusion:

For lab 9, along with the original Ultrasonic Sensor, another Ultrasonic sensor was used to detect a person entering or leaving a room. With this as the only change, for this lab a PCB was also expected to be designed and all the connections soldered. With that, the task was to provide both 3.3 and 5.0 Volts to the components. The way this was expected to be accomplished by using a voltage regulator, which when fed with a % Volts supply, would provide 5 Volts as is to the Display, and the two sensors. Next, the 5 Volts was fed to the voltage regulator as an input and the output was 3.3 Volts. This 3.3 Volts was then supplied to the VCC of the 2553 IC.

Another task that needed to be done was take out the IC from the carrier board and use the TEST and RST connections to first program the chip, and then run the entire application using external power source.

To successfully run the entire lab, the first thing done was the code from lab 8 was adjusted accordingly to incorporate another Ultrasonic sensor. With that part working, the entire circuit was made and tested on a breadboard with the IC removed and used on its own. The last part was to solder all the components to the perf board and test the entire circuit.

During the lab, a few major challenges were encountered, and with some code changes and physical testing, some were resolved. In the end, one major problem that remained unsolved was the soldered PCB did not show the accurate display and always displayed a “0”. The way to fix this was first to check if the required voltages were reaching the spots where they were needed. With that tested, the continuity test was carried out using a multimeter. With that test also working, but the problem unsolved, the soldering was done again entirely from scratch on another perf board. But when that board was tested, the same problem was seen. The reason for this can be either soldering issues, or loose connections because when the same code was used with the bread board circuit, it was working simply as expected.
Another minor problem that came up was the application was working correctly when the Buzzer’s PWM was connected to PIN 2.2 or PIN 2.4, but not when connected to 2.6. The requirement was that the PWM pin be connected to 2.6. To tackle this, first the pins were tested using an oscilloscope with varying frequencies. One that was working, the software aspect, in this case, the code was tested and adjusted accordingly. It took a while, but the Buzzer was running and hence was soldered directly to the perf board along with the voltage regulator. This resulted in them being useless with the circuit board as they were unable to be desoldered.