**ENEL 387**

**Project Write Up**

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**Abstract:**

With increasing concern on the health and obesity problems, more and more attentions have been attracted on how to know their body mass index (as known as BMI). The BMI is a obvious sign of obesity. This indicator will calculate the BMI and show if your body were in good situation.

**Background and Description of Problem:**

In the modern society, people’s pace of life become faster. In most times, people do not pay attention on their body’s condition. When their body got some problems, the rehabilitation process maybe is late. This indicator is easy to use. People just provide their weight and height; the indicator will calculate and give you the result efficiently. People can know their body’s working condition in the first place.

**Equipment:**

* STM32VL Discovery Board
* Keil uVision4
* ZFLEX A201-100 (Pressure Sensor – 100lb)
* GP2Y0A02YK0F (Infrared Proximity Sensor, 0.5 to 1.5 m)
* GDM2004D (20x4 LCD Display)
* Breadboard Power Supply (5v/3.3v)
* 1M and 1.5K Resisters
* 10μF Capacitor
* LEDs (Red, Blue, Yellow)
* Wires
* Breadboard

**Description and Operation:**

1. Ideal: The pressure plate (build by four flexiforce ZFLEX A201-100 pressure sensors and one flat plate) is used to measure the user’s weight in lb unit in a certain range (depends on the sensor, maximum capacity is 400 lb). Then, I will transfer the result in lb unit to kg unit (1lb is about 0.45kg). The actual weight = 0.45 x 4 x the sensor’s result.

Demo: For now, I use only one pressure sensor to build the prototype and demonstrate the functionality. The flexiforce sensor ranges its resistance between near infinite when not being touched, to under 25K ohms when you approach its weight limit. When barely touching it, it has a resistance of around 10M ohms. We can measure that change using ADC. But to do that, we need a fixed resistor (not changing) that we can use for that comparison (We are using a 1M resistor). This is called a voltage divider and divides the 5v between the flexiforce and the resistor. During the coding, I cannot find a way to represent the decimal fraction by hex number. The largest voltage is 3.3V because of the Discovery board, so the maximum value we can get is 36kg, according to the datasheet. Then, my value is adc\_value/114. The 114 is computed by 4096/36, which is how many percent per kilogram. Because it is not calculated by the equation, so the result is not accurate. For the connection, I connect the output pin with PA7 on board.

1. Ideal: The GP2Y0A02YK0F IR sensor is used to calculate the user’s height. It will be placed at the top of a long bar or a wall in the lab, which is 2.5 meter high. With my consideration, this range of height could cover the most people. The actual height = 2.5m – the sensor’s result. For reducing the noise, I use a 10μF capacitor to stabilize the signal.

Demo: During building the project prototype, I realize that this Infrared sensor is not good for my project, because the output is not linear. That’s the reason why I hard coded a series of sub functions (I picked 19 points from the output characteristic, once the adc\_value comes to a certain range, the corresponding sub function would return a predefined result) to determine the height. I didn’t find a way to convert the equation I found online into assembly language. The range of prototype is from 185cm to 140cm (The base is 200cm). For the connection, I connect the output pin with PA1 on board.

1. Ideal: The weight and height will be passed into the calculator, our ARM Cortex-M3 on the discovery board. The M3 will do the computation and give user their BMI and some advices.

Demo: Because I didn’t figure out how to process the decimal fraction during the BMI calculation in the assembly language, the height in cm would always become 1 after convert to height in m by divided by 100. This causes that the result is not accurate.

1. The LCD screen is used to show the height, weight, BMI and advices. The connection between LCD and discovery board is the same as we did in lab.
2. The three LEDs (Red, Green, and Yellow) will indicate your body condition based on the BMI. Between LEDs and board GND, I use 1.5K resister to limit the current for protection. For the connection, I connect the blue LED with PA10 on board; the yellow LED with PA9 on board; the red LED with PA8 on board.

In the first time, I used the PB7 to PB9 to connect with my LEDs. When I ran the code, the advice cannot display on the LCD, after discussed with my classmates, I realised that the ports for LEDs maybe conflict with the ports for LCD. Then, I changed the ports to PA8 to PA10.

1. BMI Table for the condition of LED changing:

|  |  |  |
| --- | --- | --- |
| **BMI** | **Weight Status** | **LED and LCD Display** |
| Below 18.5 | Underweight | Yellow is ON; “Please Eat More!” |
| 18.5 – 24.9 | Normal | Blue is ON; “Keep It This Way!” |
| 25.0 – 29.9 | Overweight | Yellow is ON; “You Need Exercise!” |
| 30 and above | Obese | Red is ON; “Go to Gym, NOW!” |

1. Physical Block Diagram:
2. State Diagram:
3. Schematic: please see the diagram in Appendix section
4. Safety Issues:

When I solder the components like resistors on the circuit board, the solder iron may scald my hand. I should be carefully to avoid this condition. And, the sharp objects will scratch the skin such as the pins of the amplifier. The static electricity also should be avoided because it may destroy my M3 ship with no obvious sign on the surface of the chip.

**Conclusion:**

In this project, I used one ZFLEX A201-100 pressure sensor to measure weight and one Sharp GP2Y0A02YK0F infrared sensor to measure height (actual height = 200cm – IR sensor result). After converted by the analog to digital converter, the two results would be passed to the ARM Cortex M3 on Discovery Board. Then, the BMI would be calculated by the M3, and the BMI value and the values of height and weight would be displayed on the GDM2004D 20x4 LCD. Also, the corresponding advice and LED for the BMI would be displayed on the LCD.

**Demonstration:**

Ideal: Anyone could be my user to use the BMI indicator to calculate their BMI. I need flat place to set my pressure plate and a wall or bar with enough height to set the IR sensor. For demo day, only one pressure sensor will be used to just show the functionality.

Demo: We can use the finger to pressure the pressure sensor, and the result could represent the weight. Using hand to cover the Infrared sensor, and the result could represent the height.

**Reference:**

BMI table: <http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#Interpreted>

Pound and Kilogram Conversion (U.S. Department of Commerce, National Bureau of Standards. p. 13):

<http://books.google.ca/books?id=4aWN-VRV1AoC&pg=PA13&redir_esc=y#v=onepage&q&f=false>

Information about Pressure Sensor: (The characteristic of pressure sensor output)

<http://www.advanticsys.com/wiki/index.php?title=Tekscan%C2%AE_A201-100>

<http://bildr.org/2012/11/flexiforce-arduino/>

<https://www.sparkfun.com/tutorials/389>

Information about Infrared Sensor: (The equation of output)

<http://arduino.cc/forum/index.php/topic,16786.0.html>

<http://arduinomega.blogspot.ca/2011/05/infrared-long-range-sensor-gift-of.html>

Information about LCD:

<http://homepage.hispeed.ch/peterfleury/avr-lcd44780.html>

<http://arduino.cc/forum/index.php?PHPSESSID=d1b28998e557a4e1576f38caa9d2daca&topic=9592.0>

<https://forum.sparkfun.com/viewtopic.php?t=9300>

Hexadecimal (Hex) to Decimal Lookup Table:

<http://www.cambiaresearch.com/articles/43/hexadecimal-hex-to-decimal-lookup-table>

**Appendix:**

Datasheets and Schematics