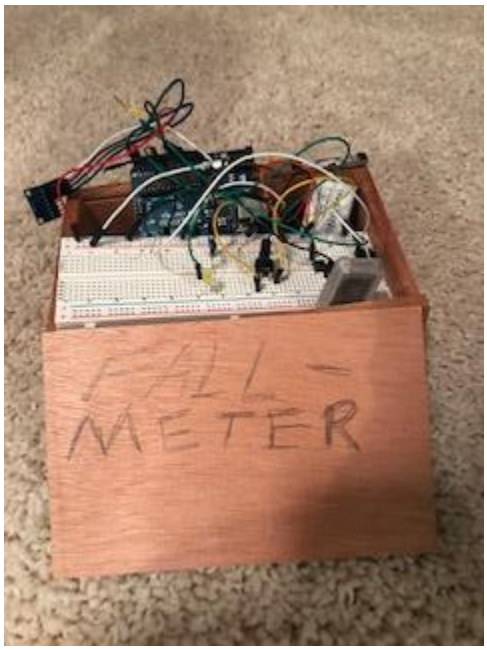
FIRST QUARTER DESIGN PROJECT - FINAL REPORT

BOUNCE BACK FALL DETECTION



EE 111/151 - Fall 2020

Design Engineer: ***Jacqueline Radding***

EE 111/151 – First Quarter Design Project

Project Design - Final Specification

Project Name: Bounce Back

Project Goal:

The Bounce Back Fall Detection system wirelessly alerts senior center workers when a patient falls. Elderly patients can fall and be unable to press a fall button if they have a medical emergency. The Bounce Back is a wireless, Bluetooth solution that protects the elderly and alerts staff if medical attention is needed to a main computer or tablet. Senior centers are understaffed due to COVID-19 and need to ensure the safety of their patients with reduced contact. The Bounce Back alerts staff on the main tablet when they are online. If a patient falls, an alert will be sent to the staff and a sound will be played on a buzzer (which can be changed by a potentiometer), and a bright LED will turn on to confirm the device is in emergency mode. A patient can also click an emergency button on the Bounce Back to also alert the main computer.

Intended Customer / User:

Senior centers will provide their patients with the Bounce Back. Bounce Back will be used by individuals aged sixty and up.

Product Use Environment:

Indoor use in a senior center or hospital.

Temperature Range: 50 °F – 85 °F

Market Research:

Similar Products:

-Fall necklaces such as Bay Alarm Medical cost approximately 20 dollars

-Apple watches with fall detection that start at 300 dollars

Customer Needs: Features and Functions

- **Bluetooth/wireless fall detection**
- **Bluetooth alert interface on a tablet**
- **Buzzer alert with a pitch that can be altered by a potentiometer**
- **An emergency button that sends an alert**
- **Acceleration calibration**
- **LED fall indicator**
- **Vigorous acceleration/fall alert and lighter fall counter**

Performance Requirements?

Specification	Requirement	Units
Fall Detection Response Time	Under 3 seconds to send alert	Seconds

User Interface:

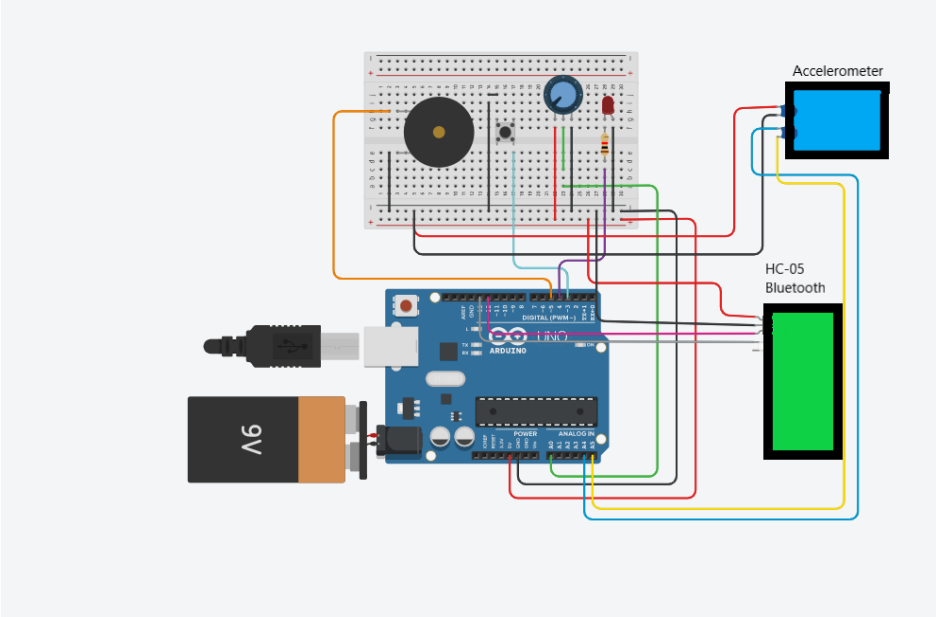
Inputs:

- **X,Y, and Z Acceleration/ Acceleration Magnitude, Potentiometer Resistance(to control sound output), Emergency button**

Outputs:

- **LED On, Fall Counter, Buzzer frequency, calibrated acceleration, Bluetooth Fall Alert**

Hardware Design



Software Design

```
//FALLMETER

//BY JACQUELINE RADDING

/* FALLMETER is a wireless device that detects a fall or pressed emergency button and sends the recent fall alert and data to a bluetooth connected device. */

#include <SoftwareSerial.h> // Bluetooth serial reading
```

```
SoftwareSerial BTserial(10, 11); // RX | TX for Bluetooth

#include <Wire.h> // library to help read acceleration data

#include <MPU6050.h> // library for acceleration sensor

MPU6050 mpu; // this is the accelerometer



#include <Wire.h>

const int MPU_addr = 0x68; // I2C address of the MPU-6050

int16_t AX, AY, AZ, Tmp, GyX, GyY, GyZ; // the gathered accel and other data, I am only using the Ax Ay AZ

float ax = 0, ay = 0, az = 0, gx = 0, gy = 0, gz = 0; // the calculated accel

int ledpin = 5;

int recentf = 0; // this variable will indicate a recent fall, and is set to zero b/c a fall has not occurred

boolean fall = false; //stores if a fall has occurred

int emerg = 0; //indicates if button was pressed

int potpin = A0; // this will detect the PWM on the potentiometer

int beeper = 4; // this is the beeper pin that will go off when fall occurs

int val; // this will be the analog pot value that will decide tone of beeper

int fallcount = 0; // this will be the time/ fall counter

int button1 = 3; // emergency button


void setup() {

 pinMode(ledpin, OUTPUT); //led pin is an output if device is on

 pinMode(button1, INPUT_PULLUP); //sets to button input pullup

 Wire.begin(); // begins the MPU

 Wire.beginTransmission(MPU_addr); // gets ready to receive data

 Wire.write(0x6B);  // PWR_MGMT_1 register
```

```
  Wire.write(0);    // set to zero to start accel

  Wire.endTransmission(true); // wireless transmission just in case

  Serial.begin(9600); // for debug

  BTserial.begin(9600); // for Bluetooth device

  attachInterrupt(digitalPinToInterrupt(button1), button, LOW); // interrupt button 1 and sends emergency fall alert infinitely

  // button interrupt for emergency fall button

}



void loop() {

  //digitalWrite(13,HIGH); // turns on transmitter

  mpu_read(); // reads accel

  mpu_val(); // computes accel



  // calculating Acceleration magnitude vector for 3 axis

  float Raw_Amag = pow(pow(ax, 2) + pow(ay, 2) + pow(az, 2), 0.5); // this is the total magnitude of acceleration

  int Amag = (Raw_Amag * 10) - 2; // get this value to the four values I want for my switch case (2,4,8,16)



  switch (AM) // determines the severity of the fall

  {

          case 16:          Serial.println("16 g"); fall = true; break; //this is the fall threshold of the magnitude of acceleration send fall

          case 8:           Serial.println("8 g"); fall = false; break; // this value is not enough to be considered a hard fall

          case 4:           Serial.println("4 g"); fall = false; break; // this value is not enough to be considered a hard fall

          case 2:           Serial.println("2 g"); fall = false; break;// this value is not enough to be considered a hard fall
```

```
}


if (fall == true) {
        for (int i = 0; i < 3; i++) { // counting loop makes sure person does or does not get up
        int newax = ax; // new value has a greater acceleration on the x-axis
   mpu_read(); // reads accel
   mpu_val(); // calc accel
   digitalWrite(ledpin, HIGH); // led indicates fall movement
        if (newax > ax) { // if person does get up
    fallcount = fallcount + 1; // counts the acceleration threshold hits
    digitalWrite(ledpin, LOW); //turns off LED if no fall is detected
        // sendfall();
    delay(200); // fall data within .2 seconds so they have time to get up


   }
        if (fallcount == 3) { // if person does not get up
        int var = analogRead(potpin); // reading the potentiometer to determine frequency of buzzer
        int tonemap = map(var, 0, 1023, 40, 100); // mapped frequency is based on the potentiometer so it can
if there is a fall
    sendfall(); // sends Bluetooth fall alert to tablet
    tone(beeper, tonemap, 100); // sends a tone
    recentf = recentf + 1; // adds to recent falls
        }
        }
}
```

```
  else {
    digitalWrite(ledpin, LOW); //turns off LED if no fall is detected
            // turns off beeper once fall stops
            fallcount = 0;  // resets fall counter
    sendonline(); // if no recent fall, send fall-free status
    noTone(beeper); // turns off beeper once fall stops
    digitalWrite(ledpin, LOW); //turns off LED if no fall is detected
  }

  while (recentf >= 10) { // if the 10 less severe fall counter threshold is exceeded, infinitely send emergency
reading
    sendfall();

  }
  delay(100);
}

void sendfall() { // sends fall alert
  // recentf = 1; // this variable will tell the user if there has been a fall that was missed
  BTserial.print("1234"); // this is the device #
  BTserial.print(",");
  BTserial.print("FALL"); // indicates fall
  BTserial.print(",");
  BTserial.print("EMERG"); // indicates fall
```

```
  BTserial.print(",");
  BTserial.print(recentf); // fall count that has happened
  BTserial.print(";");
  //fallcount = fallcount +1; - not using this
  delay(20);
}

void sendonline() { // sends fall alert
  // recentf = 1; // this variable will tell the user if there has been a fall that was missed
  BTserial.print("1234"); // this is the device #
  BTserial.print(",");
  BTserial.print("NORMAL"); // indicates fall
  BTserial.print(",");
  BTserial.print("NORMAL"); // indicates fall
  BTserial.print(",");
  BTserial.print(recentf); // fall has happened
  BTserial.print(";");
  //fallcount = fallcount +1;
  //message to the receiving device

  delay(20);
}

void button() { // button action
  BTserial.print("1234"); // this is the device #
  BTserial.print(",");
```

```
  BTserial.print("FALL"); // indicates fall

  BTserial.print(",");

  BTserial.print("EMERG"); // indicates fall

  BTserial.print(",");

  BTserial.print("BUTTON"); // fall has happened

  BTserial.print(";");

  //fallcount = fallcount +1;

  //message to the receiving device

  tone(beeper, 275 , 500); // sends a tone

  delay(20);


}

void mpu_read() { // this reads the acceleration values

  Wire.beginTransmission(MPU_addr);

  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)

  Wire.endTransmission(false);

  Wire.requestFrom(MPU_addr, 14, true); // request a total of 14 registers

  AX = Wire.read() << 8 | Wire.read(); // 0x3B (ACCEL_XOUT_H) & 0x3C (ACCEL_XOUT_L) // reads acceleration
on x axis

  AY = Wire.read() << 8 | Wire.read(); // 0x3D (ACCEL_YOUT_H) & 0x3E (ACCEL_YOUT_L) // accel on y

  AX = Wire.read() << 8 | Wire.read(); // 0x3F (ACCEL_ZOUT_H) & 0x40 (ACCEL_ZOUT_L)// accel on z

}

int mpu_val() { // this calculates acceleration values

  ax = (AX - 16588) / 16384.00; // calibrations of acceleration I got to fit my accelerometer to make values 0 at
start

  ay = (AY + 4) / 16384.00;

  az = (AZ + 1988) / 16384.00;
```

```
}
```

Cost Accounting Spreadsheet

Project Name:	FallMeter	**EE 151 Section:**	online
Designer Name:	Jacqueline Radding		

MATERIAL COSTS:

PROTOTYPE MATERIAL COSTS:

(Not including the Arduino Kit)

(Including materials for verification testing.)

	Item	Cost
11	Motion Detectors (11 Pack)	$ 6.99
2)	Accelerometer (3 Pack)	$ 3.99
3)	HC-05 Bluetooth Module	$ 7.99
4)	433 Mhz transmitter/ receiver	$ 5.00

TOTAL PROTOTYPE MATL. COST: ***$23.97***

Co st

FINAL PRODUCT MATERIAL COST ESTIMATES:

(Including any parts from the Arduino Kit Used)

	Item	Cost
1)	Arduino Uno	$ 10.99
2)	9V Battery	$ 1.99
3)	PCB Board	$ 0.99
4)	Potentiometer	$ 1.50
5)	Wires/Solder x 14 and wood shell	$ 0.35
6)	Push Button	$0.15

7)	HC-05 Bluetooth Module	$ 6.99
8)	Yellow LED	$ 0.06
9)	Accelerometer	$ 1.50
10)	Piezo Buzzer	$ 1.00

TOTAL PRODUCT MATERIAL COST ESTIMATE: $25.47

Overcoming Problems:

I was originally going to use a 433 MHz receiver and transmitter on two different arduinos, but I could not get the receiver to communicate. I had a HC-05 Bluetooth module, and I decided to use that instead. I adapted my code and libraries to send the fall alert via Bluetooth to an android tablet.

Project References (tutorials, websites, etc.):

1. https://www.instructables.com/How-to-Receive-Arduino-Sensor-Data-on-Your-Android/

2. https://github.com/jarzebski/Arduino-MPU6050/blob/master/MPU6050_free_fall/MPU6050_free_fall.ino

3. https://www.hackster.io/ashshaks/diy-iot-fall-detection-using-nodemcu-9f18c9