**Fall Detection Based Alert System (FDBAS) for the Elderly.**

**I. Selected Nature of work:**

Novel solution/ indigenous design to a problem/ challenge

**II. Rationale:**

The detection of falls is a significant concern in the public healthcare sector, especially for the elderly due to the deterioration in their physical fitness. To reduce the detrimental impacts of falls, early and effective surveillance is required. According to the World Health Organization's 2018 report, there are approximately 646 000 fatal falls worldwide each year, the majority of which involve adults over the age of 65. This places it second behind road traffic injuries in terms of unintentional injury deaths. It goes without saying that the injuries that older people sustain from falls have a significant negative impact on not just their families but also the healthcare systems and society at large. Falling can result in a variety of injuries, including head trauma, bone fractures, joint dislocations, and tissue injuries. If quick aid is not provided in time, a person's lack of movement following a fall may result in serious health issues and may even result in death. This problem calls for an immediate need for a solution to save the lives of the many unlucky elderly.

The existing fall detection technology is either a Wearable Sensor Device (WSD) or an Ambient Sensor Device. In an ASD, Video cameras are carefully positioned throughout a person's home using ambient sensing devices to monitor their movements. The monitoring service contacts the individual over a speaker in the home when the ambient sensors identify a fall. The monitoring service representative notifies the person's emergency contact if the person admits to falling. When the individual who has fallen does not respond or provide input, their emergency contact is automatically informed. However, the main drawback of ASD is that they cannot be used in private settings and that they cannot detect falls that occur outside of the camera's field of view. Given that WSD is wearable, compact, and not area-specific, it is the only practical and logical solution in this situation.

On the market, WSD with integrated sensor-based fall detection systems already exists. They are typically discovered imbedded in a watch, pendant, belt, or clip-on accessory. However, they are just out of touch for the majority of those in need and too expensive. Nobody wants to spend thousands of rupees on an accelerometer for their wearable technology just so it can recognize a fall. Even though the technology is affordable, corporate companies increase the selling price of their products by integrating fall detection alert systems into their wearable gadgets and marketing it as a premium and necessary add-on that only they provide.

Therefore, with this issue in mind, we set out to develop a prototype of a Fall Detection Band with Integrated Alert System (FDBAS) for the Elderly.

**III. Scientific Principle(s)/ Concepts:** Specify the Science concept used/ explored

* Linear Motion
* Angular Motion
* Gravitation and Magnetism
* Dynamic Acceleration
* Vectors in a 3D plane
* Angular velocity

**IV. Materials Used:**

 List of materials that are used for developing the exhibit.

1. Mini Breadboard

2. NodeMCU ESP8266

3. MPU6050

4. Connecting Wires

5. 9 Volt Battery with Connector

6. Box Board

 Measuring instruments/ equipment/ tools required for operating the exhibit.

1. USB-B Connecting Wire

2. Laptop with Internet Connectivity

3. Arduino Application with Wire’s and ESP8266.h libraries

5. Glue Gun

6. Wire Stripper

**V. Procedure/ Description:**

Part 1 - Setting up Hardware for Fall Detector

The MPU6050 sensor module has an accelerometer and a gyroscope. The accelerometer offers data on the angular parameter, such as the three-axis data, while the gyroscope is utilized to detect orientation. We will contrast the amplitude of the acceleration with the threshold value to identify the fall. The device developed will notify the concerned individual through SMS if the fall is detected. Here, a microcontroller NodeMCU is used to connect to IFTTT and send SMS messages.

The MPU6050 works on the I2C protocol, so we only need two wires to interface NodeMCU and MPU6050.The SCL and SDA pins of MPU6050 should be connected to D1 and D2 pins of NodeMCU, while VCC and GND pins of MPU6050 are connected to 3.3V and GND of NodeMCU.

The MPU6050 sensor module is a full 6-axis Micro-Electro-Mechanical Systems (MEMS) device that can monitor acceleration, velocity, orientation, displacement, and a variety of other motion-related characteristics. In addition to this, it features a separate temperature sensor built inside the chip. The MPU6050 module is compact, uses little power, has a high repetition rate, is shock-tolerant, and is inexpensive for end users. With its I2C bus and auxiliary I2C bus interface, the MPU6050 can easily interface the operation of other sensors like magnetometers and microcontrollers.

Part 2 - IFTTT Setup for Fall Detector

Using the web-based service IFTTT (If This Then That), building applets takes place, which are collections of conditional expressions. We can send emails, tweets, and Facebook notifications using these applets. IFTTT is being used in this project to send SMS notifications whenever the device senses a fall. The following steps needs to be executed for the successful set up of IFTTT.

Step 1 - Sign in to your IFTTT account, if you don't already have one, register one to utilize the IFTTT platform.

Step 2 - Now look for "Webhooks" and choose Webhooks from the Services list.

Step 3 - To obtain the private key, click "Documentation" in the Webhooks window's upper right corner.

Step 4 - Copy this key because this key will be used in our code.

Step 5 - After getting the private key, now create an applet using Webhooks and Email services. To create an applet, click on your profile and then click on ‘Create.’

Step 6 - Now select the "This" icon in the next window.

Step 7- Click on "Webhooks" after searching for "Webhooks" in the search section.

Step 8 - Click on "That" to construct a response to the fall detect event to finish the applet.

Here, we are sending a message in response to the fall detect event. To do this,

Step 9 - type "Android device" into the search bar and select "Android SMS."

You will now be asked to enter the message body and phone number. To finish the procedure,

Step 10 - enter the Mobile Number and the message body, and then click "create action."

Part 3 - Coding for Fall Detector

Before starting to code we set our platform so that the microcontroller’s WIFI module connects to the world wide web and is accessible by the software. For that we start by opening the Arduino application and then by clicking on files then preferences and add “http://arduino.esp8266.com/stable/package\_esp8266com\_index.json” to the additional Boards Manager URLs. Now click on tools then board and then board manager and download the esp8266 package.

Now the actual coding part starts where we split our code into 8 different segments.

As usual, start the code by including all the required libraries. The Wire.h library allows you to communicate with I2C / TWI devices while ESP8266.h library provides NodeMCU specific Wi-Fi routines that we are calling to connect to the network. And this part is integrated into segment 1. In segment 2 we initialize and set the default values. In segment 3 we enter the Wi-Fi Name and password and IFTTT account credentials. In segment 4, Inside the void setup (), initialize the baud rate, the wire library, and the data transmission through the power management register. In segment 5 inside the void loop (), read the MPU6050 sensor data. 2050, 77, 1947 are values for calibration of an accelerometer. Same for gyroscope, add the calibration values in the original values. In segment 5.1 after getting the accelerometer and gyroscope values, calculate the amplitude vector of the accelerometer values. Then is segment 6 we program so that it first checks if the accelerometer values exceed the lower threshold, if yes, then it waits for 0.5seconds and checks for the higher threshold. If the accelerometer values exceed the higher threshold, then it checks for the gyroscope values to calculate the change in orientation. If there is a sudden change in orientation, then it waits for 10 seconds and checks if the orientation remains the same. If yes, then it activates the Fall Detector alarm. Then in segment 7.1 Inside the mpu\_read loop (), read all the six registers for the X, Y, and Z axes of Accelerometer and Gyroscope. Finally in segment 8 we make the code in such a way that it uses WIFI Client class to create TCP connections and so that creation of a URL for the request takes place; and finally, this will send the request to the server to send the message.

Part 4 – Final Touch Up

To finish the final development process of the prototype, we make a cuboid-like structure as per the dimensions of the device. Outline the cut out in the box board as per the measured dimensions and fold the box like a piece of origami and assemble it. The next step is to slide the device into the structured box. Now to power the device connects the positive terminal of the 9-volt battery to the Vin pin of the NodeMCU and the negative terminal to the GND pin which is adjacent Vin pin.

Part 5 - Testing

Upload the code as soon as your hardware is prepared. To test the project, hold the MPU6050 in your hands and pretend to be strolling slowly before suddenly falling to the ground by tripping over a ledge. The gadget will trigger the fall detection alarm and send a message to the registered number if the magnitude is greater than the threshold value.

**VI. References**

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