IOT BASED FALL DETECTION SYSTEM FOR THE ELDERLY PEOPLE

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Abstract. Given the prevalence of older people living alone, it might be challenging for them to get assistance in times of need. Falling is the most frequent reason for needing medical attention for elderly adults. Elderly people hurt themselves more frequently by falling, especially when they live alone. In order to lower the risk of the person after a fall, immediate medical attention is required. The intent of our project is to confect a fall detection sensor system which helps in cautioning the relatives of the injured person by sending SOS. The Internet of things concept is applied here to give a holistic approach. We have made use of sensors and a buzzer which are incorporated on the bread board for creating an effective detection system. Moreover, in our experimentation we have developed Mobile App using Kodular. This app is capable of accessing Person Status tag value from Google Firebase database (cloud environment). The tag value is updated in Realtime in cloud with the accelerometer sensor using Node MCU(ESP8266-12). In the app we created a button and whenever the fall is detected we will get a audio response as person has fallen.

Keywords. fall detection, buzzer, IOT, SOS, Kodular, Google Firebase.

INTRODUCTION

Elderly people are major part of our society. The number of elderlies in the world population is rising. After road traffic accidents, the second biggest cause of accidental injury fatality is fall. Elder people are more prone to fall because they suffer from muscle weakness, vision loss, and low blood pressure which can lead to dizziness. Fall became a serious problem worldwide. Every year, nearly 36million falls are reported among elder persons. And falls results in some major injuries such as hip fractures, and head injuries etc. Every year falls result in more than 32,000 deaths worldwide. The Fear of falling magnify the post-fall ramifications and decrease the patient's courage. So, to reduce the number of deaths caused by falls medical attention needs to be provided quickly to the particular person. So, people around the world introduced fall detection systems. Various fall detection systems were built around the world using different technologies such as Artificial Intelligence, Edge computing-based systems and Internet of Things. These different technologies have yielded different levels of accuracy. Our fall detection system is based on IoT. IoT also known as Internet of Things is a technology which aids communication between devices and cloud, and between devices themselves. IoT is a rapidly expanding aspect of modern technology. The Internet of Things (IoT) has expanded over time into a comprehensive system utilizing numerous technologies ranging from the Internet to wireless communication in the form of advanced embedded systems. This is a new technology with a large amount of potential for building a fall detection system. This advanced technology can also provide data processing, and smart sensors for the advancement of fall detection systems. Using IOT, we developed a fall detection system to send a SoS (which is a signal for help) whenever a fall is detected. This system is useful to provide immediate medical assistance to the elderly who are prone to fall. The MPU6050 sensor used in this system to calculate the velocity, acceleration and motion related parameters such as displacement, orientation of a person.

The message will be sent using an app called IFTTT (If This Then That). Along with the sensor the system consists of a buzzer which will be activated when fall takes place. Additionally, we developed an app using Kodular creator and Google Firebase. Kodular is a code free environment and support development of Mobile App. It contains variety of blocks (event blocks, procedure blocks) which allows the data extraction from google firebase RealTime database. The Firebase Realtime Database allows us to build collaborative applications and Firebase allows us to securely access the database directly from client-side code. This built-in system can be placed around waist or can be placed in wrist watches.

LITERATURE REVIEW

[1] Devansh Kumar Garg and Gauri Rao collaborated on the publication of an "IoT-based fall detection system." Their major goal was to provide critical help by developing a device that detects falls using a number of sensors. The tool primarily assesses the individual's speed, weight, gender, and orientation. A system for measuring degrees, a rotating mechanism, and a load detecting element, a Wi-Fi module, and a microprocessor are all utilized, and any change in the original data in terms of speed, direction, or weight is gathered, sent, and monitored in order to be documented as a fall. [2] Hazem Ibrahim, Omar Reyad and Mohamed Esmail published an "IoT-Based Fall Detection for Aiding Elderly Care: Sensors, Methods, Challenges and Future Trends." The purpose of their article is to evaluate new research on AI algorithms and methodologies for fall detection systems (FDS) in the IoT context. Their research presented novel techniques and opportunities for accurate fall detection in the elderly, such as lightweight deep models, as one of the approaches and possibilities of future smart IoT-enabled devices. [3] IoT Based Fall Detection Monitoring and Alarm System for Elderly: A proposed system by Akash Gupta, Rohini Srivastava, Himanshu Gupta, and Basant Kumar. Their main aim is to develop a system that detects falls and alerts medical specialists about occurrences of discomfort. The acceleration data of the elderly patient is continuously collected by a sensor and saved on a cloud server using an IoT board in the recommended system for falling detection. An android application was created for the medical expert to examine the fall in the elderly patient and, if required, supply the appropriate assistance in order to retrieve the stored data. a threshold-based technique for fall detection was adopted to get sensor data and to set the threshold on accelerometer readings. [4] Osvaldo, Luis and Vale presented an IoT-Based Human Fall Detection System. They proposed a non-wearable approach which was non-intrusive and used in homes, hospitals, rehabilitation centers, and nursing homes. The system utilized a three-tiered computing architecture with components from the edge, fog, and cloud. For human fall categorization, a mathematical model based on the Morlet wavelet and an artificial intelligence model based on artificial neural networks are utilised; the two methodologies are compared. [5] Tuan Nguyen Gia,Igor Tcarenko published IoT-based fall detection system with energy efficient sensor nodes. The primary goal of this research is to investigate the energy consumption of sensor nodes in an IoT-based fall detection system and to propose a design for a customized sensor node in this work. They compared their customized sensor node with additional sensor nodes that were constructed using general purpose development boards. [6] Fall detection system for elderly using Internet of Things and ensemble machine learning algorithm: Jara Suárezde and Pulau Carlos. This system detects the fall of elderly people in indoor environments. This system 3D-axis accelerometer integrated into a wearable 6LowPAN device and is in charge of gathering data from elderly people movements in real-time. At the network's edge, acceleration data are processed and analyzed using an ensemble-based prediction model that has been identified as the best predictor for fall detection. [7] Chandra, N. Sivakumar, Chandra Babu.G & P. Parthasarathy proposed a IoT based fall detection and ambient assisted system for the elderly. They presented a fall detection system that uses a tri-axis accelerometer to identify four types of positions: falling forward, falling backward, leaping, and sitting quickly. This system used accelerometer and gyroscope sensors, which are used to accurately forecast the fall, and to decrease false positives and negatives, and to improve accuracy. They used acceleration and velocity to determine kind of fall. [8] IoT Based Fall Detection System for Elderly Healthcare by Ahsen Tahir, Taylor, Ahmad Taha. They delineated about an elderly-centric IoT-based fall detection system for smart homes and care facilities, with a focus on the IoT layers at the edge, fog, and cloud. Machine and deep learning algorithms are addressed for identifying fall events from 1D and 2D data, as well as numerous deployment strategies in the context of edge or cloud IoT layers.

TABLE1: Summary Table of Literature Table

Year	Author Names	Remarks
2019	S.M Turkane, Swapnil J.Vikhe	The proposed system is sensor and vision-based in nature. The proposed system can identify the body fall automatically using this method. The accelerometer is utilized to measure direction and angular velocity, and the GLCM technique is used to extract features. For classification, the SVM approach was utilized. [9]
2021	Jyothi Wadmare Deep Shah Chintan Diwakar Viren Bhanushali	They created a vision-based fall detection system in this study. This system is implemented using a basic UR fall dataset. A MOG2 algorithm is used to concentrate just on the individual while disregarding the environment. A Shi Tomsai algorithm is used to locate interesting points. The optical flow approach is used to track these interesting points. In the case of a fall, the system recognizes a human in the environment, follows the person, and calculates the optical flow. If the fall exceeds a certain threshold, an alert is delivered.[10]
2019	Biao Ye Lasheng Yu	The goal of this work was to examine human fall behavior and create a fall detection system. This system made use of the BiLSTM neural network. A bionic experiment data set that simulates a fall was used to identify and analyze the system. The experimental findings showed that the fall detection accuracy was enhanced. The precision was 90.47%. [11]
2017	Abdul Waheed, Abdul Khadeer	They demonstrated a fall detection system based on IOT and algorithms such as Motion History Image and C-Motion. They utilized a low-cost Pi Camera to detect falls. The device will monitor the target person for falls and sudden motion changes. If the motion changes unexpectedly, the suggested system will treat it as a fall. If the alert was false, that is, if the individual did not fall, the system will give you 5 seconds to deactivate the alarm. If the user does not push the stop button within the allotted time, the system will consider it a fall and will notify the proper person. [12]

METHODOLOGY

Hardware Requirements

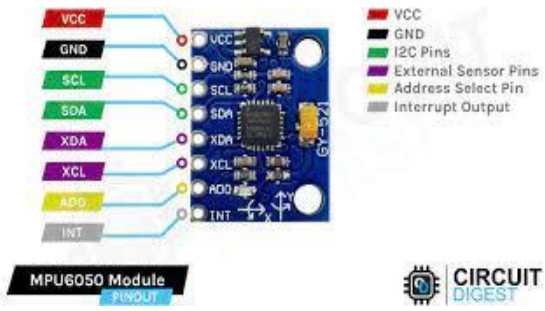

Figure2. MPU6050

Figure2 is a sensor module that consists of 3-axis accelerometer and a 3-axis gyroscope. This enables us to measure an object's acceleration, velocity, direction, displacement, and a range of other motion-related properties. This sensor module also consists of Auxiliary I2C bus for interacting with other sensor devices.

- 3-axis Accelerometer: - Used to detect angle along x, y and z axis.
- 3-axis Gyroscope: - It determines rotational velocity along the x, y, and z axis.

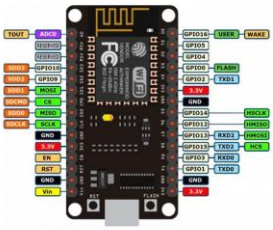

Figure3. NodeMCU

Figure3 is a self-contained, ESP8266-12e-based microcontroller that is ideal for IoT applications. The NodeMCU is a low-cost SoC with an open-source software and hardware development environment. NodeMCU has only one analogue pin and relatively restricted GPIO pins. We used this board in our system to send SoS to mobile phones because it has an inbuilt Wifi chip (ESP8266).

Figure4. Jumper Wires

Figure4 is an electrical line with connectors on both ends. It is commonly used to connect the components of a breadboard or other prototype.

Figure5. Buzzer

Figure5 a Piezoelectric buzzer. A piezo buzzer is a sort of electrical device that produces a tone, alert, or sound.

Model Architecture

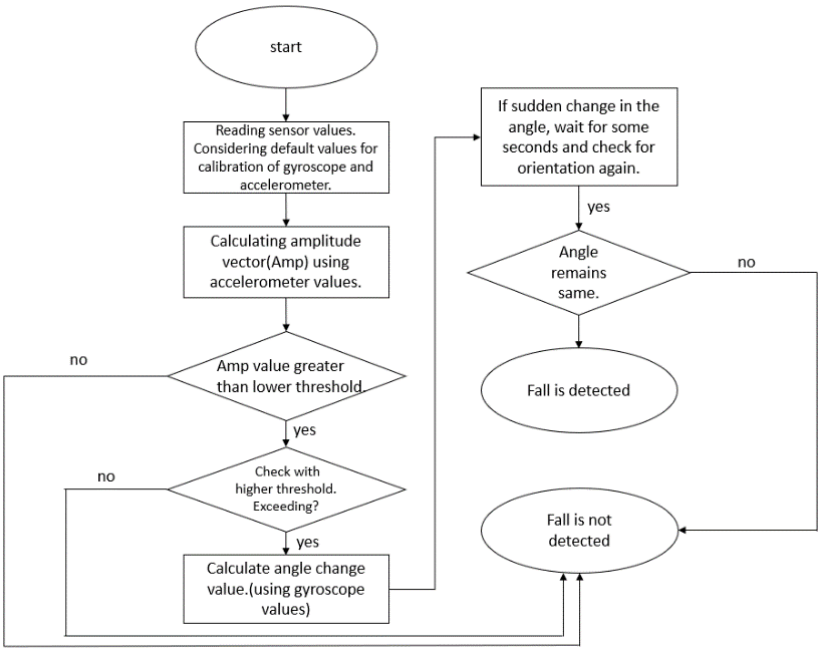

Figure6. Model Architecture Flowchart

The above flowchart depicts the process of our proposed system. Our proposed system is based on MPU6050 sensor and NodeMCU applications. For sending an emergency alert to the concerned person, we created an applet using the IFTTT app. IFTTT is a web-based tool that enables us to construct "applets", using this we can send mails, messages, and notifications. While creating an applet, IFTTT provides us with a private key, and we use this private key in our code. We will select the Android SMS option while creating the applet and enter the phone number of the concerned person and the message body (whatever message we have typed in this field will be reflected on the mobile phone when a fall is detected). There are some essential libraries such as Wire.h and ESP8266WiFi.h used in the project. Wire.h provides the connection with I2C/ TWI devices and ESP8266WiFi.h allows us to connect with the network using some NodeMCU-specific Wi-Fi functions. We provide a Wi-fi SSID and password to connect.
First, we check the default values for calibrating the accelerometer and gyroscope values. The default values for the accelerometer are 2050, 77, and 1947, and the default values for the gyroscope are 270, 351, and 136. After obtaining accelerometer values, we calculate an amplitude vector using the accelerometer values. We consider two values as our lower and higher thresholds. Then, we compare our accelerometer value with a lower threshold and if the value exceeds the lower threshold, we will check it with a higher threshold. If the value exceeds the higher threshold, we will calculate the angle change (orientation) for gyroscope values.
If the direction suddenly changes, the system will wait for some seconds and check whether the orientation is the same or not. If it is the same, then a "fall detected" message will be sent to the concerned person, and at the same time, the buzzer will be activated.

Moreover, we have extended the project by using Google Firebase and Kodular creator, we created a tag value called Person_Status. When firebase project is created it provide project specific URL and database security key. This information is needed while developing Mobile App.

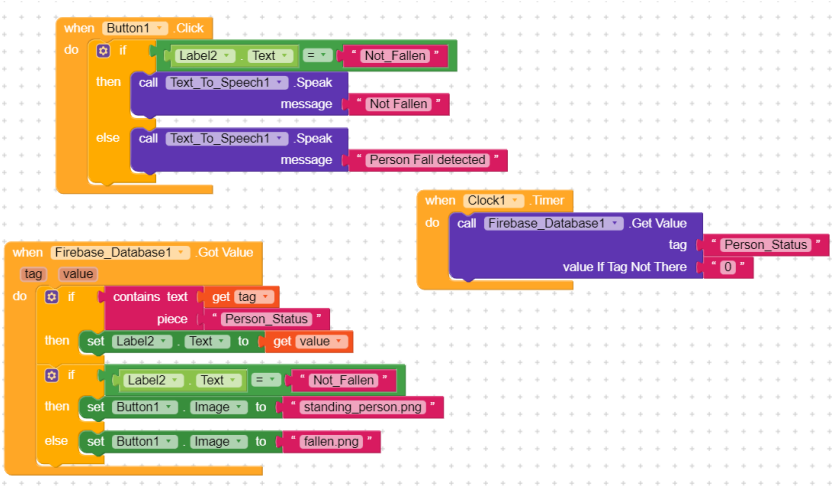

Figure7

The above figure depicts the blocks we used in Kodular Creator to develop a button in the app. Whenever the tag value will be updated (value will be extracted from firebase) in the cloud with accelerometer sensor using Node MCU, the button will be clicked and we will get an audio has 'person has fallen'. Further, the developed project in turn extracted using QR code and installed App permanently on android mobile.

RESULTS

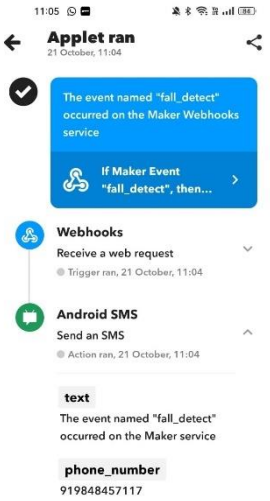

Figure8. The SOS received

This is the message that will be received to the concerned person whenever fall is detected. At the same time the buzzer will be activated.

Figure9.Button Not Fallen

The above picture depicts the result we have obtained while creating the app. Whenever the tag value is Not_Fallen and we click on the button, we will get the audio response as “person has Not Fallen”.

Figure10. Button Fallen

Figure 10 depicts the result we have obtained while creating the app. Whenever the tag value is Fallen and when we click on the button, we will get the audio response has “person has Fallen”.

CONCLUSION

The project “IoT based fall detection system” was developed using NodeMCU and MPU6050 sensor. Using MPU6050 sensor we can track the orientation and motion of the target person. This system will trigger an alert message whenever fall is detected. This system can be used in the real world by embedding it into a watch or belt.
This proposed system will be further enhanced by creating watch or a waist belt.

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