Parkinson’s Fall Detection System using IOT

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ABSTRACT
Parkinson's disease (PD) is one of the long-term regressive disorders of the central nervous system that primarily affects humans' nerve systems, causing frequent falls that can even result in fatalities or put sufferers in dangerous situations. To address this problem, we have put forth a concept that tracks patient falls and alerts the caregiver or family member using a message, call, or alarm to prevent deaths. The wearable fall-detection system for Parkinson's disease sufferers built on a wi-fi module is the main goal of our research and development efforts. The results of an accelerometer, oximeter, and pressure sensor that are uploaded to the Blynk cloud through NodeMCU-ESP32 were used to properly track patient falls.

Keywords
Parkinson’s disease, fall-detection, Blynk cloud.

1. INTRODUCTION
The leading cause of injury for elderly individuals is falls. According to estimates, 4% of people over 60 have Parkinson's disease that was first diagnosed before and at the age of 50. Up to 1 million Americans may have Parkinson's disease overall, and each year, 60,000 Americans report having the condition. A fall detection system for the elderly is thus a technological advancement that is crucial for an ageing society. The majority of persons with Parkinson's disease will frequently and repeatedly fall. Falls can have severe, wide-ranging, and expensive effects. Parkinson's disease symptoms include tremor, tight muscles, pain in limbs, gait impairment, freezing of gait, slowness of movement, stumble walking, and cognitive impairment. People with Parkinson's disease most frequently report a decrease in bodily balance.

People with Parkinson's disease may experience frequent falls and seizures that result in injuries, including fractured bones (PD). The central nervous system infirmity Parkinson's disease (PD) principally affects the human kinetic system. Dopamine is a neurotransmitter that aids in the brain's performance of key activities including managing kinetic processes, as well as potential mood- and emotion-related processes. PD is caused by damage to or reduction in the number of brain cells that produce dopamine. About 50% of PD patients experience recurrent falls, accounting for about 68% of all falls. From the observation of 100 patients, it was shown that 13% of them experience a fall once, twice, or more than once every week. According to studies, [1] patients have falls 577 times in 20 weeks, or around 1,500 times a year. These records require that information be communicated to caregivers and family members as soon as they see the first signs of Parkinson's disease in order to stop the patient from falling.

As a result, fall-detection systems provide an excellent remedy by minimizing the following detrimental effects of hazardous falls. The direction of the fall event can show freezing and gait impairment in people with Parkinson's disease in addition to fall detection. Fall direction has been introduced in numerous studies. The calculation of the direction of fall incidents, however, is still mostly unreliable.

This study proposes a wearable fall-detection system (WFDS) for elderly PD patients. [3] By sending out warnings, this WFDS aids in the wireless rapid reporting of such unpleasant situations to medical staff or family members so that they may seek medical attention as soon as possible. This WFDS automatically detects fall events. Additionally, this help is beneficial for enhancing senior patients' feelings of security and lowering their fear of falling, especially for those who live alone.

2. LITERATURE SURVEY
Allen et.al [1] addressed PD patients who experienced 577 falls in 20 weeks, which equates to around 1,500 falls per year. These findings point to the necessity of regularly monitoring the fall events of Parkinson's disease (PD) patients at their residences or medical facilities in order to alert their member families or caregivers as soon as possible of the occurrence by identifying the signals of fall detection. As a result, fall-detection system provides a valuable solution by reducing the adverse effects of hazardous falls, such as sudden death from cardiac arrest or stroke, hip fracture, or other injuries.

Wan-Jung Chang et.al [2] has put forward assistive system that consists of a smart walking stick, wearable smart glass, a mobile app, and a cloud-based information management platform. In order to achieve the goals of fall detection and aerial obstacle avoidance, a smart assistive system based on wearable smart glass and a smart walking stick is designed for blind people. The suggested intelligent walking stick and smart eyewear can help people with vision impairments recognize aerial obstacles and roadside falls. The suggested smart walking stick can vibrate as well to assist persons who are visually impaired in avoiding accidents with moving objects in the air. According to testing results, the recommended system can identify aerial obstructions within 3 meters, and its average fall detection accuracy canreach 98.3%.

Wu et.al [3] proposed a wearable device using a single tri-axial accelerometer. The wearable gadget is worn around the person's waist. The gadget sends a message together with the user's position information and employs acceleration analysis to identify falls. The user can also choose to cancel an alert using the system.

An SMS notification informing the user of their safety will be sent if they deactivate the alert. Since the method does not require the accelerometer's axes to be positioned precisely, no specific mounting is necessary for this system. The suggested approach attained 98.3% specificity and 97.1% sensitivity. The system might issue erroneous alarms since falling and normal resting haverotations that are similar.

Liu et.al [4] created a fall detection device for geriatric healthcare. Three delicate PIR sensors are used in the system, and they are mounted at various heights on a wall. The device responds to temperature variations brought on by movement of people in order to identify the fall event. The optical flow approach was also utilized to record and examine the motions that the head, lower limbs, and upper limbs were each responsible for. 92.5% sensitivity and 93.7% specificity were reached by the system.

Aguiar et.al [5] has put forward an unobtrusive smartphone-based fall detection system The device continually checks the accelerometer data while a mobile is carried in the user's pocket or on their belt. The output of the smartphone's accelerometer is computed by the system, and a total of 14 distinct signal components (x, y, and z projections, magnitude value, and angles with the x, y, and z-axes of the phone) are then passed toa Butterworth digital filter. The programmed then uses a decision tree to obtain the crucial thresholds and properties. This data is used in a state machine algorithm to detect falls and send an SMS with the user's location to caregivers. For both use positions, the system's sensitivity and specificity are close to 97% and 99%, respectively (belt or pocket). The usage of gyroscopes for sensing rotation and barometers for estimating altitude in the system may be included in future works. Battery utilization of the smartphone is an issue because the system screens the accelerometer data continually.

J S Navya et.al [6] proposed a fall detection system that offer PD patients with an ambulatory gait analysis system to avoid falls and protect them from further physical deterioration and harm from falls. Additionally, this technology can make it easier to monitor motor irregularities over time in PD patients while they go about their daily lives. As soon as the technology detects abnormal gaits, auditory alerts are transmitted to PD patients and the caregivers at their sides, assisting patients in avoiding falls while going about their everyday lives. This article discusses a Single Gyroscope with Standard Deviation Algorithm using data from a single gyroscope attached to the body's shank in order to identify and prevent falls in Parkinson's disease (PD) patients. The sensor MPU6050 of the system detects motion. It is a motion sensor with a gyroscope and an accelerometer, and one of its benefits is that it is very portable. Phuong Cao et.al [7] proposed Postural instability and freezingof gait can both contribute to falls in PD patients. In order tocollect data for this experiment, only one motion sensor is used.Only fall occurrences resulting from festinating gait factors, orsituations where the patient abruptly takes smaller, quicker steps, may be done and examined. The acceleration mode of themotion sensor provides data that may be used to determine howswiftly moving objects are. The data that the sensor hascollected will be analyzed using basic analytical techniques andmachine learning techniques.

This study focuses on analyzing gaits before a fall actually occurs in order to predict falls. Researchers can develop extra protective devices to lower the incidence of fall-related injuries in PD patients as well as older persons if falls can be predicted. Priya Sharma et.al [8] proposed an attempt that was made to fully use the capabilities of the cloud-based mobile app Blynk, which was created expressly for Internet of Things applications. An Internet of Things (IoT) system based on Node MCU was created for this purpose. It allows for real-time monitoring of the measured outputs from numerous sensors and also gives the user the ability to regulate the electrical load that is linked to it. It uses the Wi-Fi local hotspot network in accordance with the SSID and password credentials entered by the user in the firmware itself because it is a wireless multiple sensor network. The carefully thought-out hardware, real-time monitoring of measured sensor outputs, relay on/off state monitored via the Blynk App, and real-time relay management validated the work Gia, Tuan Nguyen, et al [9] proposed an Energy efficient sensor node for IOT based fall detection system. The system architecture of wearable sensor nodes, a gateway and a black-end system. Acquiring the data and transmitting the data was done by the sensor node system via wireless communication protocol to a smart gateway. As this work majorly focuses onthe energy efficiency, evaluation of energy consumption of wearable sensor nodes in different scenarios to find optimal solutions for improving energy efficiency. The hardware and software factors or techniques impacting on the life-time of the sensor node are investigated. Comparison of wearable devices with different devices proposed by others. The results from conducted experiments conclude that the sensor node used can operate around 76h with a 1000mAh battery in a tough condition. Saad Aalah Al-Barrak [10] proposed a wearable, inexpensive fall detection and warning system for elderly people the number of false-positive fall alarms has been decreased using this innovative strategy. In order to identify the user's orientation in different output formats, an advanced orientation detection module was employed to monitor user movements. In the event that the user's orientation data values are abnormal, the system will send an alert message and notify the caregiver through Wi- Fi and GSM. A simple, low-cost, and power-efficient design is considered in the system design. A GSM module, two orientation-detection modules, and a Wi-Fi-based microcontroller make up the system. The device is designed tobe attached with a waist belt and worn around the user's waist. The device is powered by a pin-type lithium-ion rechargeable battery.

3. PROPOSED METHOD

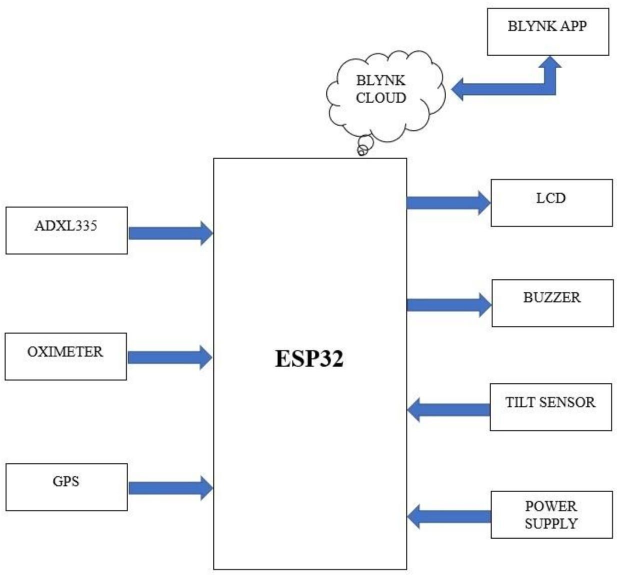

Fig 1: Block diagram of Fall detection system

The suggested system's two essential components are the sensor board and the monitoring system. The first significant component is the sensor board, often known as a fall detection device. This gadget is composed of the NodeMCU-ESP32 and the nine axes of the numerous Sensor modules (GY-85) that make up this device include. The three-axis gyroscope, the triaxial accelerometer (ADXL335), and the three-axis magnetic field. This is used to extract the kinematics signal from the daily activities of older persons. As a result, the ESP32 serves as the administrator to send the kinematics signal that the ADXL335 detected to Blynk Cloud.

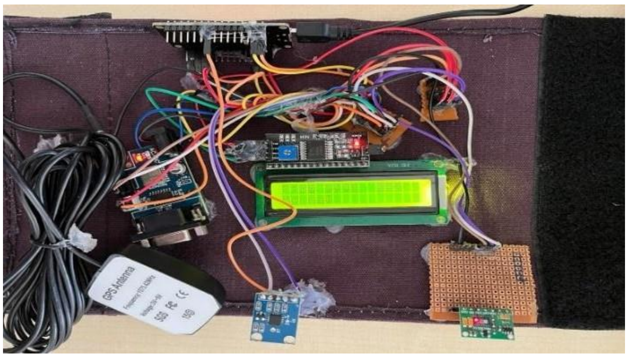

Fig.2. Working Model of Fall Detection System

Fig 2 depicts the complete functional model of the circuit. The wrist band that holds the circuit makes it portable and easy for the user to wear. In the microcontroller, a led light turns on to signal when the system starts. A notification message stating "Fall detected" is sent to the caregiver's mobile phone when the person has fallen down using the Blynk application. [8] The Blynk application also displays the user's location in terms of GPS-tracked latitude and longitude coordinates. Similar to this, the Blynk program indicates this circumstance by displaying a notification that says "Normal" if no fall has been observed. Fig 4 depicts the Blynk program window with the proper messages in two scenarios: a normal condition anda scenario after an accident. The user location's obtained latitude and longitude are 13.119 degrees and 77.661 degrees, respectively.

4. FLOWCHART OF PROPOSED MODEL

The Fig 3 shows the flowchart of the proposed design. Body position and unexpected sounds are two examples of the parameters that the sensors (accelerometer and sound sensor) sense. To control the outputs sensed from the sensors, the interface circuit sends the sensed values to the NodeMCU Esp32 microcontroller. The measured output from the sensors is compared with the threshold values defined for each sensorin the microcontroller. Accelerometer detects whether or not the user has fallen. In the event of an accident, the sound sensor will pick up any form of sound. The Blynk application immediately sends a notification to the carer with the relevant message and the user's precise position in the event that the user has fallen or if a loud sound is heard. All the sensor datais sent to the Blynk cloud storage through Esp32 Wi-Fi.

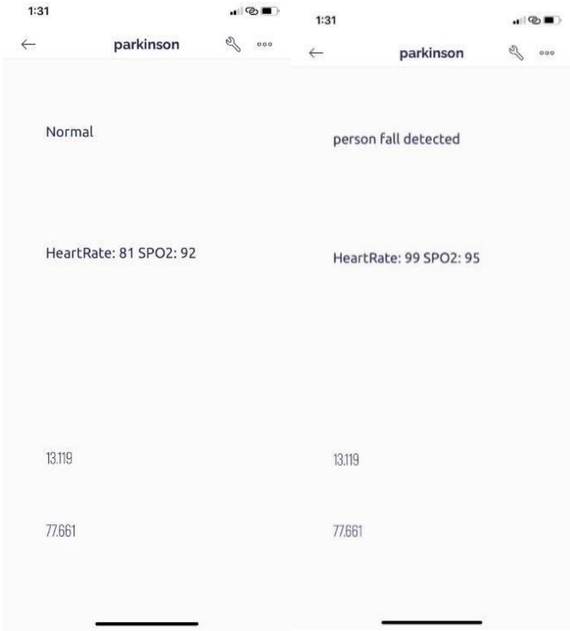

Fig.4. Blynk application window under normal condition (left) and when accident has occurred (right)

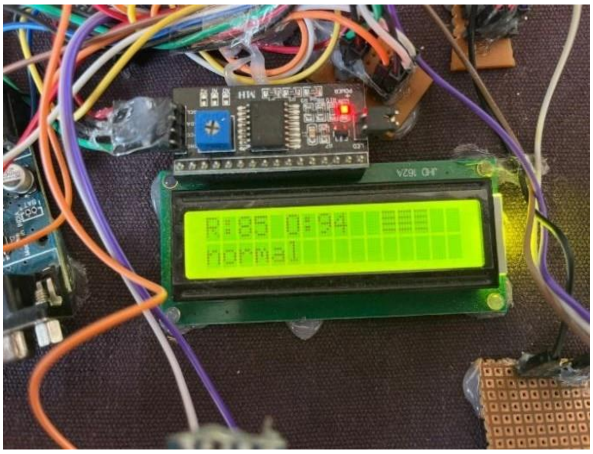

Fig 5. Blynk application window under normal condition

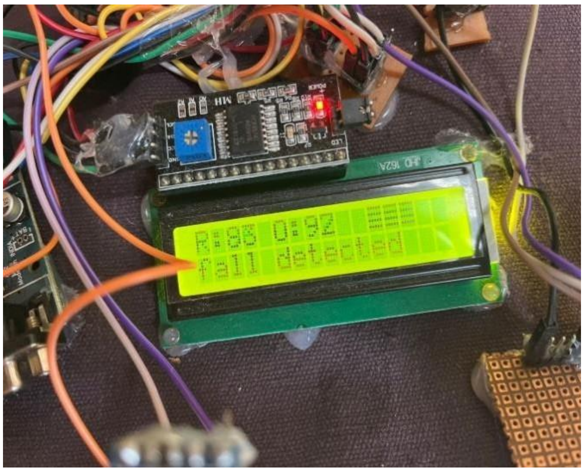

Fig 6. Blynk application window when accident has occurred

5. CONCLUSION AND FUTURE SCOPE

An overall view can be concluded as to develop an intelligent device for detecting fall using the IoT pattern of Parkinson's patients and we achieved that using this proposed system. The different directions of patient's were detected using accelerometersensor (ADXL335) and ESP32 provides the real-time monitoring of Firebase cloud. The data uploaded to the Blynk server can be used for medical research. The real-time location update of patients and direction of fall is the most important facility of our system which helps caretakers and family to reach the patients immediately.

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