نظام مدمج منخفض التكلفة للكشف عن السقوط وتنبيه الطوارئ باستخدام إنترنت الأشياء لكبار السن

Low-cost Embeded Fall Detection Fall and Emergency Alesrt System Using IoT for the Elderly

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الملخص:

كثيرًا ما يواجه كبار السن مشكلات كبيرة تتعلق بالسقوط، مما يؤدي إلى حدوث إصابات وفقدان الحرية. في هذا البحث، نقترح نظام إنترنت الأشياء المدمج وغير المكلف لاكتشاف حالات السقوط لكبار السن وتنبيهات الطوارئ. ووفقا لمنظمة الصحة العالمية، فإن السقوط هو السبب العالمي الثاني الأكثر شيوعا للوفيات الناجمة عن الإصابات غير المقصودة أو العرضية، وهو ما يمثل ما يقدر بنحو 646 ألف حالة وفاة سنويا. بالإضافة إلى الإصابات القاتلة، يمكن أن يؤدي السقوط إلى إصابات غير مميتة بما في ذلك كسور الورك، والتي يمكن أن تقلل بشكل كبير من القدرة على الحركة والحرية. يتكون النظام من جهاز سهل اللصق وقابل للفصل ويمكن ارتداؤه على الحزام أو في جيب القميص. مكونات هذه الأداة: مودم SIM800L GSM، ومستشعر جيروسكوبي MPU9250 ذو 9 محاور، ووحدة GPS، وزر الذعر، وبطارية قابلة لإعادة الشحن. يتم اكتشاف السقوط بواسطة مستشعر MPU9250، ويمكن إرسال تحذير للطوارئ عن طريق الضغط على زر الذعر. حيث تم تصميم النظام ليكون غير مكلف، وسهل التشغيل، ويمكن الاعتماد عليه، مما يجعله مناسبًا للتطبيق على نطاق واسع في رعاية المسنين. ووفقا للنتائج الأولية، يمكن للنظام تحديد السقوط بشكل موثوق وإصدار إنذارات الطوارئ، مما يثبت قدرته على زيادة سلامة ورفاهية كبار السن.

الكلمات المفتاحية: MPU9250 جيروسكوبي ذو 9 محاور، اكتشاف السقوط، تنبيه الطوارئ، إنترنت الأشياء، رعاية المسنين.

Abstract:

Elderly people frequently experience major problems with falls that lead to injuries and loss of freedom. In this research, we suggest an inexpensive embedded IoT system for senior fall detection and emergency alerts. According to the World Health Organization, falls are the second most common global cause of unintended or accidental injury deaths, accounting for an estimated 646,000 fatalities annually. In addition to deadly injuries, falls can result in non-fatal injuries including hip fractures, which can significantly reduce mobility and freedom. The system comprises of an easily-adhesive detachable device that can be worn on the belt or in a shirt pocket. A SIM800L GSM modem, an MPU9250 9-axis gyro sensor, a GPS module, a panic button, and a rechargeable battery are all components of the gadget. Falls are detected by the MPU9250 sensor, and an emergency

warning can be sent by pressing the panic button. The system is made to be inexpensive, simple to operate, and dependable, making it appropriate for wide-spread application in geriatric care. According to preliminary findings, the system can reliably identify falls and issue emergency alarms, proving its potential to increase elderly people's safety and wellbeing.

Keywords: MPU9250 9-axis gyro, Fall detection, Emergency alert, Internet of Things, Elderly care.

Introduction :

As falls are a frequent and serious problem for the elderly population, extensive research has been done in recent years on fall detection and emergency alert systems. Every year, one in three elderly people fall, which can cause serious injuries, hospital stays, and even death [1], impairing their functionality and reducing their mobility, independence, and quality of life [2]. To lessen false-negative and false-positive mistakes, fall detection systems' accuracy must be increased [3]. Several fall detection and emergency warning systems have been created to solve this issue, and they automatically notify the necessary care groups when a fall is detected [4] [5]. Many of these systems, nevertheless, are pricy, large, and need a lot of user input, which prevents their general adoption. In order to minimize the discomfort that comes with wearing wearable technology, wearable technology eliminates the need for older individuals to wear sensors on their body [6] [7].

Review Of Literature

Fall detection systems that are wearable and ambient can be loosely split into two categories. Wearable systems use sensors that are affixed to the body of the elderly person, such as a wristband or pendant, and can identify falls based on the person's movement and orientation. Contrarily, ambient

systems rely on environmental sensors, like cameras or floor sensors, to detect falls.

Various wearable technology-based fall detection systems have been proposed in numerous research. For instance, one study concentrated on creating a module that uses accelerometers and gyroscopes to detect falls. With the aid of the "Intel Galileo Gen I" development board, this module was integrated into a bigger daily elderly control system. When a fall is detected, the technology is intended to notify caretakers [8].

An alternative solution is an IoT-based tri-axis accelerometer fall detection and ambient aid system. When a fall is detected, this technology is intended to alert caregivers [9] [10]. In a different study, to identify falls in older patients, a wearable sensor continuously collects acceleration data from them and records it on a cloud server using an IoT board. When a fall is detected, this technology also alerts caretakers [11] [12].

The Fall Detection device based on Internet of Things (FallDS-IoT) created a wearable gadget that uses accelerometer and gyroscope sensors to detect falls in older people [13]. A device that employs a passive RFID sensor tag with the RFMicron Magnus S chip and can track pressure in addition to RSSI was suggested by another study. This device can recognize falls and notify caregivers when one is discovered [14] [15]. According to these research, wearable technology holds a lot of promise for reducing elderly citizen fall risk. By promptly warning caregivers in the case of a fall, these gadgets can help elderly people live better lives and prevent major injuries.

Block Diagram

Four primary blocks make up the fall detection and emergency warning system (Fog. 1). The MPU9250 9-axis gyro sensor is part of the sensor block, which is the initial block. This sensor can detect abrupt changes in

these values, which indicate a fall, by measuring the device's angular velocity and acceleration. The processing block, the second block, has an STM32 microcontroller that processes the sensor block's data [16] and runs the fall detection algorithm. The program detects falls and issues emergency alarms using angular velocity and acceleration data.

The communication block, which is the third block, consists of a SIM800L GSM modem and a GPS module. While the GPS module determines the device's location, the GSM modem transmits the emergency alert message to the specified emergency contact. Using the cellular network, this block sends the emergency alert message and the emergency contact's position information. The power block also has a rechargeable battery, which powers the gadget. Utilizing a USB cord, the battery can be charged while the device is in use [17].
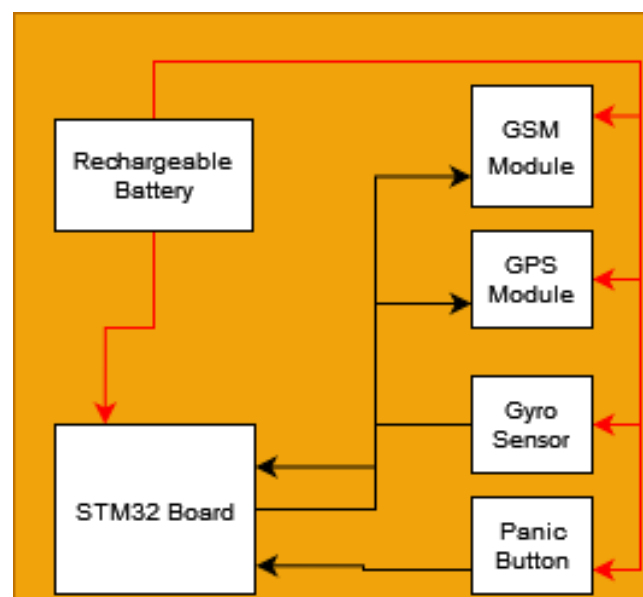
In conclusion, the block diagram demonstrates how the system is created to be reliable, efficient, and small. The system's sensor, processor, communication [18], and power blocks work together to reliably detect falls, send out emergency alarms [19], and give the selected emergency contact location data. The system's overall goal is to give older people who need fall detection and emergency alerts a low-cost, embedded solution.

Hardware Development

The hardware connectors for the Fall Detector Device is as follows (Fig. 3):

- The SIM800L module's Vcc and GND pins are linked to the battery's 5V and GND pins. The STM32 Board's pins 14 and 13 are used to link the Rx and Tx pins of the SIM800L GSM modem.

- The 5V and GND pins of the battery are connected to the Vcc and GND pins of the GPS Neo module. The 21 and 22 no pins on the STM32 board are linked to the RX and TX pins of the GPS Neo.

- The 25 no pin on the STM32 board is connected to one side of the panic button's pin, which is connected to GND on the board.

- The battery's 5V and GND pins are connected to the Vcc and GND pins of the Gyr>

- o sensor. The 28 and 27 no pins of the STM32 board were linked to the SCL and SDA pins of the Gyro sensor
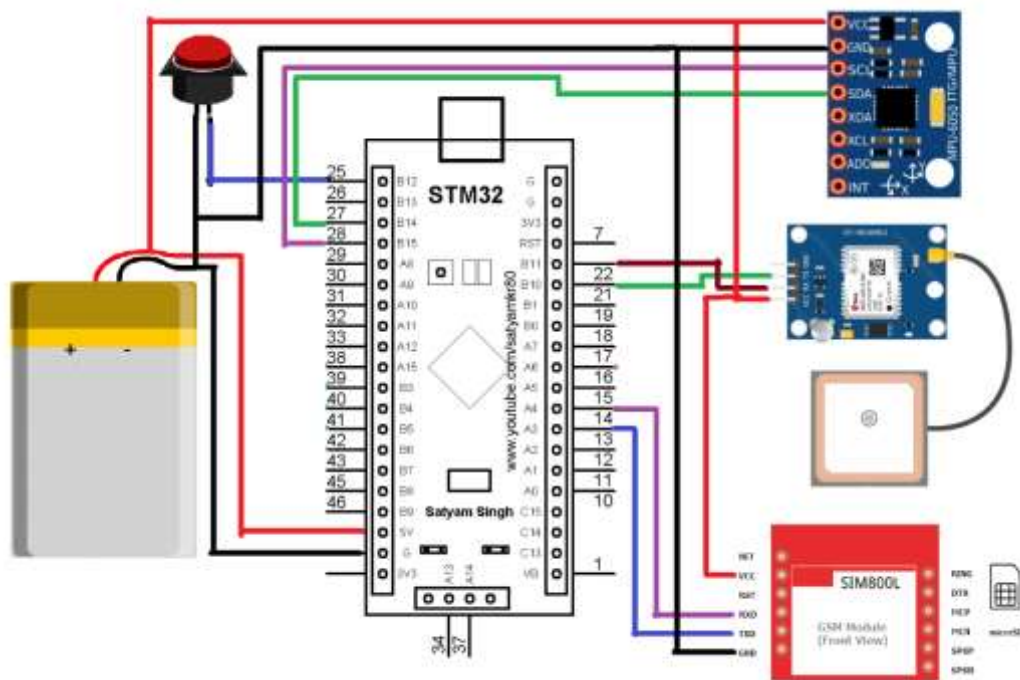
Fig 1 Block diagram of the Device

Fig. 2. Connection diagram of Device

Implementation of the system

The fall detection system is launched when the sensor, processor, communication, and power blocks have been configured. The system continuously collects sensor data, such as angular velocity and acceleration, using the MPU9250 9-axis gyro sensor. The sensor is calibrated prior to data collection to ensure precise results.

The acceleration has a defined threshold value; when it is exceeded, a fall has happened (Fig. 3). The sensor data is used to identify the device's orientation as well. To ensure that the angular velocity data [20] is compatible with a fall, it is compared to a specified range. If the acceleration exceeds the threshold value, the emergency alert system is triggered.

The system sends an emergency alert message via the SIM800L GSM modem whenever the angular velocity data falls within the predetermined range. The GPS module's location information is included in the message, enabling the emergency contact to follow the fall victim's progress.

Finally, the system records sensor data until it is turned off, allowing for analysis and, if necessary, troubleshooting. Overall, this system offers a reliable method of spotting falls and rapidly alerting emergency contacts, which is crucial for older or disabled people.

A flexible sensor with precise acceleration and angular velocity values is the MPU9250 9-axis gyro sensor. The data from the sensor can be used to create a very accurate fall detection system.

The particular needs of the system and the context in which it will be utilized will determine how the fall detection algorithm is implemented. The algorithm might need to take into consideration variations in body types, movements, and activities, for instance. Additionally, it could have to adapt to various settings and floor types.

Fig. 3. Fall Detection Device
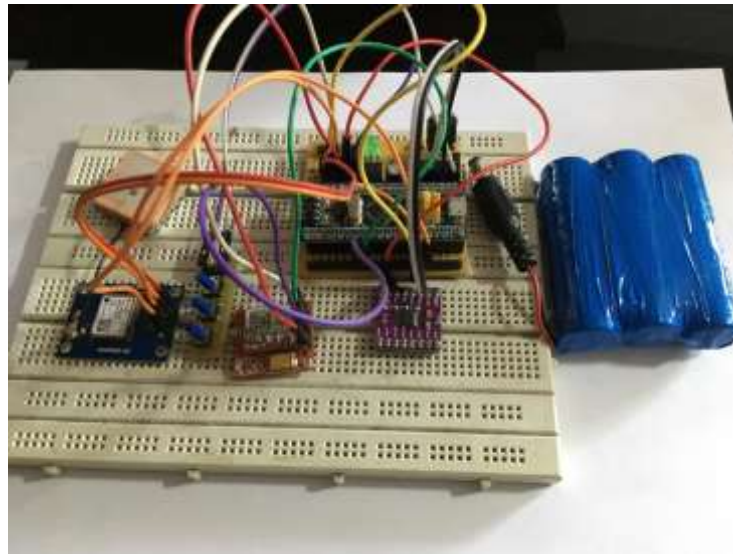
No of the specifics of implementation, the fall detection algorithm is a crucial part of the system. It examines the sensor data [21] to determine when a fall will occur, and when one happens, it activates an emergency alert system. This makes sure that, in the event of a fall, emergency personnel are swiftly alerted, which could, in some circumstances, save a life [22].

Overall, the MPU9250 9-axis gyro sensor-based fall detection and emergency warning system offers a low-cost, embedded solution to satisfy the demands of elders and other people who may be at risk of falling. It can help them feel safer and more at ease while still preserving their independence.

When a fall is detected, Fig. 4 shows the emergency alert on the IoT mobile app.

Fig. 5. Fall Alert Detection Blynk2.0 IoT Mobile App

Conclusion

In conclusion, a possible solution to the growing demand for fall detection and emergency alert systems in an aging population is the low-cost embedded fall detection and emergency alert system using IoT for the elderly. With an MPU9250 9-axis gyro sensor to detect falls, an STM32 microcontroller to analyze the sensor data, a SIM800L GSM modem to deliver the emergency alarm message, and a GPS module to provide position data, the system is made to be small, effective, and dependable. For individuals and families searching for a dependable and economical solution to their fall detection and emergency alarm needs, the system is an appealing alternative because to its low cost and simplicity of use.

The system has the potential to significantly enhance the quality of life for older individuals and their families by reliably and effectively detecting falls and sending out emergency notifications. The technology can also

speed up emergency reaction times, which can be crucial in stopping further harm and raising the likelihood of a successful outcome.

Overall, A promising technology that has the potential to dramatically better the lives of elderly individuals and their families is the IoT-based low-cost embedded fall detection and emergency alert system for the elderly. More research and development in this field is therefore necessary.

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