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Detection of Abnormal Movements of Elderly People Using Arduino

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ABSTRACT –

Maintaining the safety and well-being of elderly people, especially those who live independently, is a major challenge. In this paper, a fall detection and emergency alert system based on IoT is proposed for elderly people, with a focus on detecting abnormal movement. The proposed system combines an MPU6050 gyroscope, a GSM module, and an Arduino microcontroller to constantly monitor the pattern of motion. Upon detecting a serious abnormality in movement, the system triggers a buzzer and LED for local instant alerts while automatically sending an SMS alert to a previously defined emergency contact. The real-time information is displayed on an LCD display, keeping it transparent and user-friendly. The cost-effectiveness, simplicity of implementation, and reliability of the system make it an excellent solution for improving elderly care and emergency response systems.

Keywords: Motion Detection, MPU6050, GSM Module, Arduino, Fall Detection, IoT-Based Healthcare.

1. INTRODUCTION

Growing population of elderly requires the development of high-tech monitoring systems for their safety. Falls and acute physical instability in elderly individuals are among the common causes of injury, disability, and death. Conventional monitoring systems depend on direct supervision, which is not possible for solo-living individuals. proposed system employs IoT technology to monitor movement at all times, identify anomalies, and trigger alarms in the event of emergencies. MPU6050 sensor measures acceleration and angular velocity on three axes to enable precise identification of abnormal movement. Integration of a GSM module enables real-time communication with caregivers to necessitate timely intervention.

2. LITERATURE REVIEW

Some research has investigated sensor-based motion detection systems for elderly care. Traditional monitoring systems include wearable sensors, floor pressure sensors, and vision-based monitoring systems. These systems have limitations regarding user comfort, privacy, and low-light reliability. IoT-based systems, particularly those utilizing accelerometers and gyroscopes, are an efficient and affordable solution. Earlier research has included stepper motor-based movement detection, RFID-based tracking, and facial recognition for access control. This research contributes to earlier literature by including a real-time fall detection system with automatic alert mechanisms for improved responsiveness and accuracy.

3. METHODOLOGY

Some research has investigated sensor-based motion detection systems for elderly care. Traditional monitoring systems include wearable sensors, floor pressure sensors, and vision-based monitoring systems. These systems have limitations regarding user comfort, privacy, and low-light reliability. IoT-based systems, particularly those utilizing accelerometers and gyroscopes, are an efficient and affordable solution. Earlier research has included stepper motor-based movement detection, RFID-based tracking, and facial recognition for access control. This research contributes to earlier literature by including a real-time fall detection system with automatic alert mechanisms for improved responsiveness and accuracy.

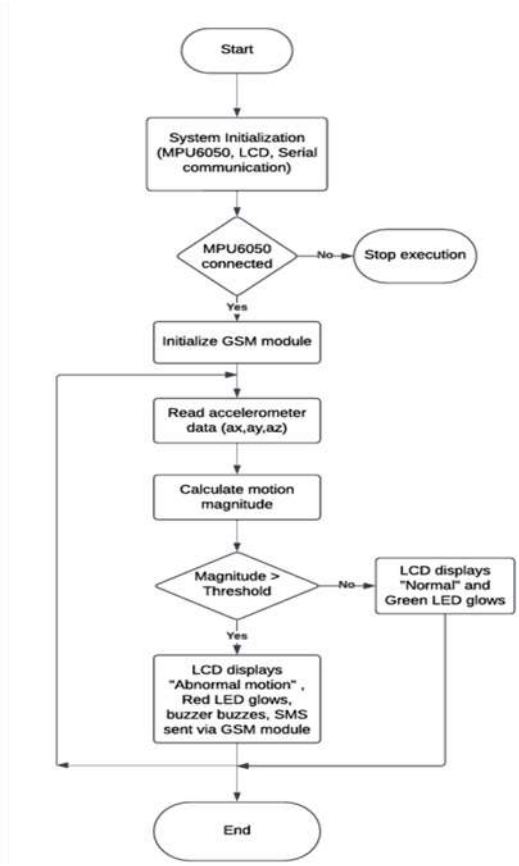

Figure1: Flow chart of working mechanism

As evident from Figure 1, After initialization the system keeps on reading acceleration on x, y, and z axes from the MPU6050 sensor. Then the motion magnitude is calculated based on acceleration to find the intensity of motion. The system checks the calculated motion magnitude for a predetermined threshold to classify

movement as normal or abnormal. When the intensity crosses the threshold, the system identifies it as abnormal movement and triggers an alert. The alert system includes various response actions: the LCD shows "Abnormal Motion," a red LED lights up, a buzzer beeps, and an SMS alert is produced to emergency numbers via the GSM module. When the motion falls within the threshold, the system shows a "Normal" message on the LCD, and a green LED lights up, marking safe movement.

The entire process operates under a constant monitoring loop, enabling real-time detection and response. The process formalized enhances the efficiency, accuracy, and reliability of the system to detect abnormal movement among the elderly, ensuring timely interventions and improved safety measures.

4. HARDWARE

- **MPU6050 Motion Sensor** – A 6-axis motion sensor that includes a 3-axis accelerometer and a 3-axis gyroscope. It senses acceleration and angular velocity, allowing for precise detection of abnormal or sudden movement.
- **Arduino Uno** – It is the processing unit, where it processes data inputs from sensors, calculates magnitudes of movements, and activates the alert systems.
- **GSM Module (SIM800L)** – Offers real-time communication in the form of sending SMS to emergency contacts in the event of suspicious movement.
- **LCD Display (16x2)** – Displays real- time status updates, indicating whether the detected movement is normal or abnormal
- **Buzzer** – Beeps when an abnormal movement is sensed, to get instant attention.
- **LED Lights (Red and Green)** – The red LED light gives an indication of abnormal movement, and the green LED gives an indication of normal movement.
- **Power Supply** – Supplies voltage and current as required to drive the system effectively.

5. SOFTWARE

- **Arduino IDE** – Used for writing, compiling, and uploading the code into the Arduino microcontroller.
- **MPU6050 and Wire Libraries** – Allows for data transfer between the Arduino board and the motion sensor and can capture proper data.
- **GSM Library** – Enables you to communicate with the GSM module to send SMS notifications.
- **Serial Communication Protocol** – Enables data exchange between different modules to support real-time monitoring and processing.
- **Embedded C Programming** – C is used for the embedded logic, which includes data capture, processing, and generation of alarms.

6. DESIGN

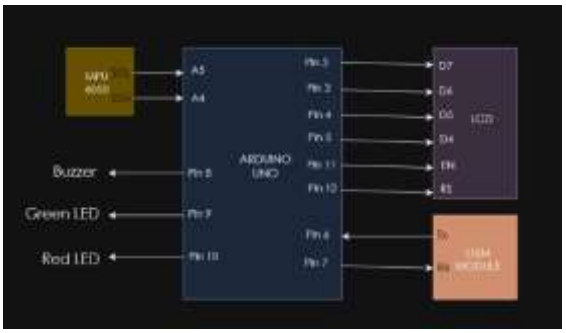

Figure 2: Block diagram

As is clear from Figure 2, The block diagram shows the hardware configuration of the Elderly Abnormal Movement Detection System, with the interfaces between various components and the Arduino Uno microcontroller. The system includes input, processing, and output units, all functioning together to sense abnormal motion and initiate alarms. MPU6050 motion sensor is the input unit, communicating with the Arduino via A4 (SDA) and A5 (SCL) pins to supply real-time acceleration and gyroscopic data. The processing is done by the Arduino Uno, which calculates the magnitude of the motion and whether it crosses a pre-set threshold. Depending on the outcome, the system initiates different output units. A 16x2 LCD display, communicated via digital pins 2, 3, 4, 5, 11, and 12, supplies real-time status. A buzzer, communicated via Pin 8, generates a sound alarm when abnormal movement is detected. Two LED indicators are also part of the system, with a green LED (Pin 9) indicating normal movement and a red LED (Pin 10) indicating abnormal movement. A GSM module (SIM800L) is also integrated via Pin 6 (Tx) and Pin 7 (Rx) to send emergency SMS alerts when abnormal movement is detected. This organized integration of units facilitates effective real-time monitoring and timely alarms, improving the safety of the elderly.

7. RESULTS AND DISCUSSION

The system was tested under various movement conditions to validate its effectiveness.

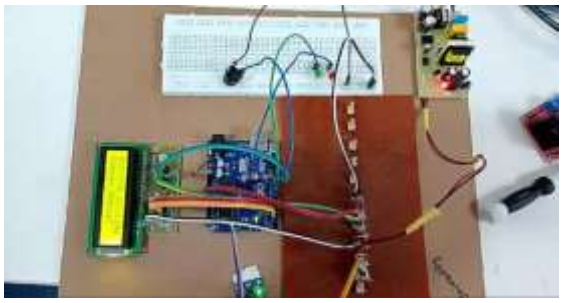

Figure 3: Arduino based abnormal motion detection system

1. **Normal Movements:** Walking and slow

body movements generated motion values within threshold, which prompted no alarms.

Figure 4: Output during normal motion detection

2. **Abnormal Movements:** Sudden jerks or falls crossed the threshold, which activated an alarm system.

Figure 5: Output during abnormal motion detection

3. **Alert System Performance:** The GSM module delivered emergency SMS messages within a 2– 5 second response time. The LCD display provided real- time motion values precisely.
4. **Challenges & Limitations:** Certain normal behaviors, including rapid turns, caused alarms. Network Dependency - GSM functionality was interrupted in low-signal regions.

8. CONCLUSION

This paper presents a low-cost and feasible IoT-based solution for abnormal movement detection in the elderly. The system effectively incorporates motion sensors, an alarm mechanism, and real-time communication for enhanced emergency response time. Future development involves enhancing motion classification algorithms, incorporating AI-based learning for higher accuracy, and incorporating features like two-way communication with caregivers.

9. FUTURE SCOPE

In the future, the system can further be improved with the addition of IoT (Internet of Things) technology, which allows real-time monitoring and remote control through cloud-based interfaces. Addition of AI and machine learning algorithms can also enhance the precision of motion detection by differentiating between various forms of movements, minimizing false alarms. Further, GPS integration can allow tracking of the location of the elderly person in case of an emergency, such that the caregivers or medical personnel can respond quicker. The system can also be made more wearable and portable, such as incorporating the technology into a smartwatch or smart band for ease of handling and convenience. Future improvements can also include wireless communication with healthcare providers and voice notifications for enhanced interaction with the user. Moreover, the efficiency of the system can be enhanced with low-power microcontrollers and power-efficient power management schemes, making the system more reliable for long-term usage. All these advancements will make the system more intuitive, reliable, and flexible in application to various healthcare and elderly care monitoring applications.

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