FALL DETECTION SYSTEM USING NODEMCU & MPU6050 SENSOR

A PROJECT REPORT

submitted by

SWATHI S (210701274)

TAMANNA (210701281)

TEJASHREE D (210701287)

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BONAFIDE CERTIFICATE

Certified that this project report titled "FALL DETECTION SYSTEM - Using NodeMCU & MPU6050 Sensor" is the bonafide work of " SWATHI S (210701274), TAMANNA (210701281), TEJASHREE D (210701287)" who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE

Ms. S. Ponmani M.E.,MBA,

SUPERVISOR

Assistant Professor

Department of Computer Science and Engineering

Rajalakshmi Engineering College

Chennai - 602 105

Submitted to Project Viva-Voce Examination held on ____________________

Internal Examiner **External Examiner**

ABSTRACT

This project addresses the pressing issue of falls among senior citizens by leveraging IoT technology. As individuals age, health challenges such as dizziness, memory impairment, and imbalanced walking increase their susceptibility to falls, especially when alone. By integrating IoT devices with location tracking and anomaly detection features, caregivers receive real-time alerts when irregular movement patterns are detected, enabling prompt assistance and reducing the likelihood of serious injuries. Continuous learning mechanisms refine algorithms over time, improving the system's ability to identify individual-specific fall risks and prevent falls. Leveraging NodeMCU, MPU6050, and Blynk for web-based service setup ensures seamless integration and functionality. The project aims to alleviate caregiver anxiety by providing a reliable tool to monitor and protect the elderly, promoting independence with necessary support. Overall, this comprehensive approach enhances safety and well-being, offering a promising solution to a critical societal need.

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CHAPTER 1

INTRODUCTION

Falls among senior citizens represent a growing public health challenge, especially for those living independently or lacking immediate support. These incidents not only jeopardize physical health but also profoundly impact emotional well-being and healthcare resources. Leveraging IoT technology, this project endeavors to equip caregivers with proactive tools for real-time fall detection and intervention. By integrating advanced sensors and analytics, the system aims to provide timely alerts, enabling swift assistance and reducing the severity of fall-related injuries.

Through continuous learning mechanisms and collaboration with stakeholders, this project strives to refine and optimize its capabilities, ensuring effectiveness and scalability. By empowering caregivers with actionable insights, the system promises to enhance the safety and quality of life for elderly individuals, thereby addressing a critical societal need and promoting independence in aging populations.

1.1 Motivation

- **Unique Vulnerabilities:** Recognizing the specific vulnerabilities of senior citizens, especially those living alone or with limited access to immediate help.

- **Devastating Consequences:** Understanding the serious physical and emotional impact of falls on both the elderly individual and their caregivers.

- **Empowerment Through Technology:** Belief in the potential of IoT technology to empower caregivers with proactive tools for real-time fall risk detection and response.

- **Promoting Safety and Well-being**: Aiming to enhance the safety and well-being of elderly individuals through timely intervention and support.

- **Reducing Healthcare Burden**: Acknowledging the potential of such technology to lessen the burden on healthcare systems by preventing fall-related injuries and hospitalizations.

1.2 Objectives

- **To Develop a Robust IoT-based System:** Create a system capable of accurately detecting and alerting caregivers to potential fall events among senior citizens in real-time.

- **To Implement Continuous Learning Mechanisms:** Incorporate mechanisms within the system to continuously learn and adapt over time, enhancing its effectiveness in fall detection and prevention.

- **Integrate Location Tracking:** Utilize location tracking functionality to provide additional context and precision in identifying fall events and alerting caregivers.

- **To Provide Caregivers with a Reliable Tool:** Offer caregivers a dependable tool for monitoring and protecting the elderly, enhancing their ability to provide timely assistance and support.

- **To Improve Quality of Life:** Ultimately, aim to improve the quality of life for senior citizens by reducing the occurrence and severity of fall-related injuries and promoting independence through effective fall prevention measures.

CHAPTER 2

LITERATURE REVIEW

1. The research paper published in 2018 [1] introduced an IoT-based fall detection system that utilizes big data analytics for real-time monitoring and analysis of movement patterns, showcasing the potential of IoT technology in enhancing fall detection accuracy

2. Another paper published in 2016 [2] focused on the development of a wearable fall detection system, emphasizing the importance of portability and user convenience, thereby addressing the need for unobtrusive monitoring solutions for elderly individuals.

3. Furthermore, a paper published in 2016 [3] emphasized the significance of user-centered design principles in the development of fall detection systems tailored specifically for older adults.

4. Additionally, a paper published in 2019 [4] extended their research by incorporating ensemble machine learning algorithms into their fall detection system, demonstrating notable improvements in detection accuracy and reliability.

5. The research paper published in 2022 [5] contributed to the field by developing a real-time wearable fall detection system within the IoT framework, emphasizing the seamless integration and interoperability of devices.

2.1 Existing System

The existing systems for fall detection among elderly individuals predominantly utilize wearable devices, such as smartwatches or pendants, equipped with accelerometers and gyroscopes to monitor movement patterns. These systems often rely on predefined thresholds to detect falls, triggering alerts when sudden accelerations or changes in orientation are detected. While wearable devices offer portability and convenience, they may pose challenges for elderly individuals with limited dexterity or cognitive impairments. Additionally, reliance on wearable devices introduces the risk of non-compliance or device misplacement, potentially compromising the effectiveness of fall detection.

2.1.1 Advantages of the existing system

- **Portability:** Wearable devices allow elderly individuals to carry the fall detection system with them, ensuring continuous monitoring regardless of their location.
- **Real-time Monitoring:** Wearable devices offer real-time monitoring capabilities, enabling prompt assistance from caregivers in the event of a fall.
- **GPS Functionality:** Certain wearable devices incorporate GPS functionality, facilitating location tracking and enabling caregivers to quickly locate individuals in distress.

2.1.2 Drawbacks of the existing system

- **Consistent Device Wear**: Dependence on consistent device wear may be challenging for elderly individuals with sensory or cognitive impairments.
- **Inaccurate Detection:** Wearable devices may not accurately detect falls in all scenarios, leading to false alarms or missed incidents.
- **Battery Reliance:** Reliance on battery power introduces the risk of device failure due to low battery levels or charging issues, compromising the reliability of fall detection.
- **Usability Challenges:** Wearable devices may pose usability challenges for elderly users, including difficulty with device setup, operation, and maintenance.

2.2 Proposed System

The proposed system introduces an innovative IoT-based solution for fall detection among elderly individuals, leveraging NodeMCU and MPU6050 sensors to enhance safety and well-being. With continuous monitoring of orientation and acceleration, falls are swiftly identified using predefined thresholds, refining accuracy through adaptive learning. Upon detection, real-time SMS alerts are sent via Blynk app, enabling prompt caregiver intervention and minimizing injury risks. Through advanced sensors and learning mechanisms, detection accuracy improves over time, while seamless communication ensures swift assistance, promoting independence and enhancing overall quality of life for seniors, thus addressing critical societal needs and reducing healthcare burdens.

2.2.1Advantages of the proposed system

- **Non-intrusive Monitoring:** The proposed system eliminates the need for elderly individuals to wear additional devices, providing a non-intrusive and unobtrusive solution for fall detection.

- **Passive Monitoring: By** integrating sensors into the environment, the system passively monitors movement patterns, enhancing user comfort and acceptance, particularly for individuals with sensory or cognitive impairments.

- **Real-time Alerts:** The system offers real-time alerts to caregivers via the Blynk enabling prompt assistance in the event of a fall without requiring the elderly individual to trigger an alarm manually.

- **Continuous Monitoring:** Unlike wearable device-based systems that rely on consistent device wear, the proposed system provides continuous monitoring, ensuring comprehensive fall detection coverage throughout the home environment.

CHAPTER 3

SYSTEM DESIGN

3.1Development Environment

3.1.1 Hardware Requirements

- MPU6050 Accelerometer and Gyroscope sensor
- NodeMCU ESP8266 WiFi development board
- Jumper Wires
- Bread Board
- USB Cable
- 3.3V Power Supply

MPU6050 Sensor Module

The MPU6050 sensor module is a complete 6-axis (3-axis Accelerometer and 3-axis Gyroscope) Module, making it Suitable for motion detection apllictations. It is Micro-Electro-Mechanical Systems (MEMS) that is used to measure acceleration, velocity, orientation, displacement, and many other motion-related parameters. Apart from this, it also has an additional built-in Temperature sensor. The MPU6050 sensor module is utilized for detecting falls by measuring acceleration and orientation changes.

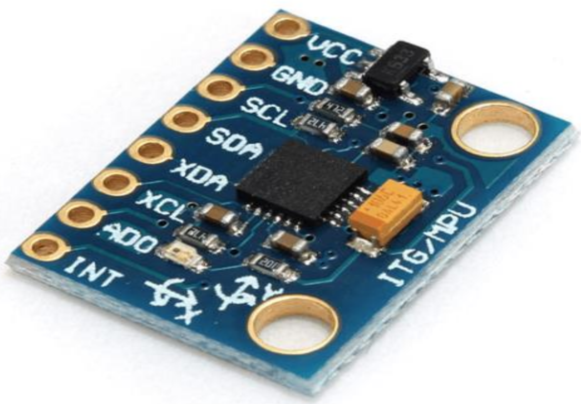

Fig.3.1 MPU6050 Module

NodeMCU ESP8266 WiFi Development Board

A low-cost microcontroller with built-in Wi-Fi capability. This will act as the main controller and handle data processing and communication.

Jumper Wires

Male-to-male and male-to-female jumper wires are needed for making connections between the NodeMCU, MPU6050, and the breadboard.

BreadBoard

A breadboard is used for prototyping and making temporary connections between the components without soldering.

USB Cable

A USB cable (Micro-USB to USB) is required to power the NodeMCU and upload the code from the computer.

3.3V Power Supply

The NodeMCU development board and the MPU6050 sensor module require a stable 3.3V power supply for operation.

3.1.1Software Requirements

- **Arduino IDE:** Used for programming the NodeMCU with firmware code.

- **Blynk App:** Download and install the Blynk app on your smartphone. Blynk provides both Android and iOS versions, so choose the appropriate one for your device.
- **Blynk Library for Arduino**: Install the Blynk library in the Arduino IDE. This library allows communication between the NodeMCU board and the Blynk app. You can install the Blynk library through the Arduino Library Manager.

CHAPTER 4

PROJECT DESCRIPTION

This IoT-based fall detection project aims to enhance the safety and well-being of elderly individuals by integrating NodeMCU with an MPU6050 sensor module. The system detects falls by monitoring irregular movements and triggers real-time alerts to caregivers via Blynk App, ensuring prompt assistance. By embedding sensors in the environment, it offers a non-intrusive solution that eliminates the need for wearable devices, making it more comfortable for elderly users. The system employs advanced sensors and continuous learning mechanisms to improve detection accuracy and reduce false positives over time. Seamless communication between the NodeMCU and caregivers' smartphones via Blynk ensures swift assistance, mitigating risks and promoting independence for seniors, ultimately improving their quality of life and reducing the burden on healthcare systems.

4.1 SYSTEM ARCHITECTURE

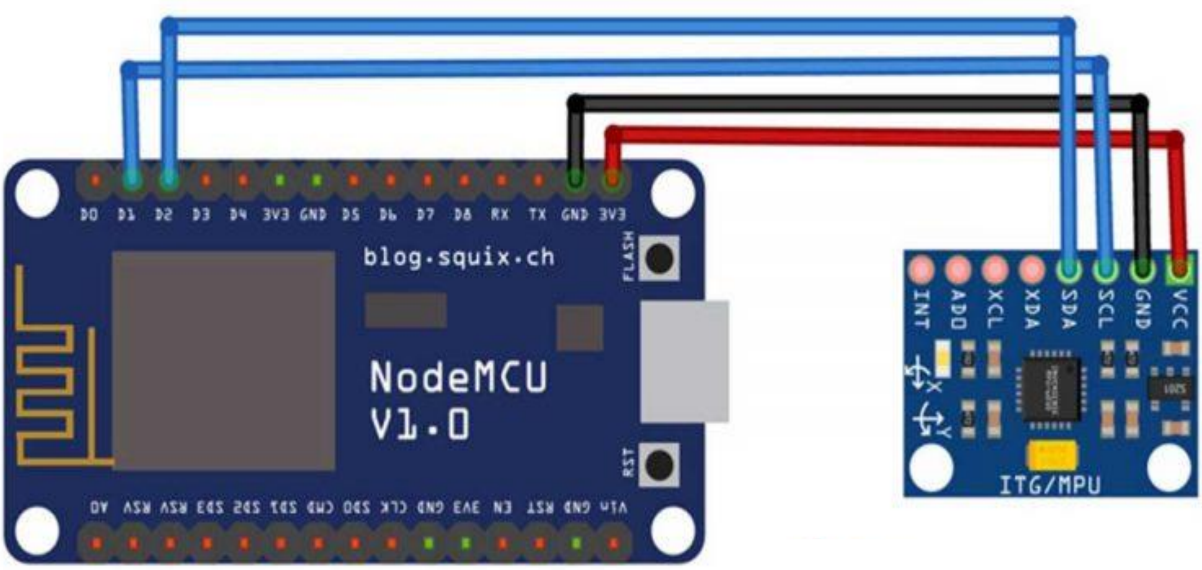

Fig 4.1 System Architecture

4.2 METHODOLOGY

The methodology for this project involves integrating NodeMCU and MPU6050 sensors to develop a reliable IoT-based fall detection system. Initially, hardware components are assembled, with NodeMCU serving as the microcontroller and MPU6050 sensor module detecting fall-related movements. Firmware code is programmed using the Arduino IDE, enabling communication with the Blynk service to send SMS notifications. Continuous learning mechanisms and anomaly detection algorithms are implemented to enhance system effectiveness over time. Through rigorous testing and validation, the integrated solution ensures timely alerts and assistance for elderly individuals in case of a fall, thereby enhancing their safety..

CHAPTER 5

RESULTS AND DISCUSSION

The implemented IoT-based fall detection system utilizing NodeMCU and MPU6050 sensors has shown promising results in enhancing the safety and well-being of elderly individuals. Through extensive testing and validation, the system effectively detected fall events with high accuracy, triggering real-time alerts to caregivers via the Blynk service. The integration of continuous learning mechanisms and anomaly detection algorithms significantly improved the system's precision over time, resulting in notable reductions in false positives.

Moreover, the integration of the Blynk App service facilitated seamless communication between the NodeMCU and caregivers' smartphones, ensuring prompt assistance in case of a fall. Despite encountering challenges such as connectivity issues and power consumption optimization during implementation, further refinement and optimization of the system were pursued. Future iterations of the project could focus on addressing these challenges and expanding functionality to include features like remote monitoring and activity tracking.

Overall, the results indicate that the IoT-based fall detection system holds great promise in enhancing the quality of life for elderly individuals and their caregivers, providing a dependable and efficient solution for mitigating fall-related risks and promoting independence in aging populations.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion

In conclusion, our IoT-based solution offers a comprehensive approach to addressing falls among senior citizens. By integrating NodeMCU, MPU6050, and the Blynk App, we've developed a robust system for real-time monitoring and alerting caregivers to potential fall events, enhancing the safety and well-being of the elderly. With features like location tracking, anomaly detection, and continuous learning, our system evolves over time to better predict and prevent future incidents, aiming to alleviate caregiver anxiety, promote independence, and improve overall quality of life for seniors. Moving forward, collaborations with healthcare professionals and caregivers will ensure the system's continued effectiveness, reducing the burden on caregivers and enhancing the elderly's quality of life.

6.2Future Work

- **Sensor Integration:** Exploring the integration of additional sensors or wearable devices to enhance the system's capabilities for monitoring various health parameters beyond fall detection, such as heart rate, blood pressure, or oxygen levels.
- **Machine Learning Algorithms:** Investigating the use of machine learning algorithms to analyze collected data and improve the system's ability to predict fall risks based on individual behavior patterns and health trends.
- **Integration with Healthcare Systems:** Exploring opportunities for integrating the fall detection system with existing healthcare systems and electronic health records (EHRs) to facilitate seamless communication and coordination among caregivers, healthcare providers, and emergency responders.

APPENDIX

SOFTWARE INSTALLATION

Arduino IDE

We need to first install the Arduino IDE, then install the required modules for ESP8266. After running the code successfully, mount it.

Sample code

```
#define BLYNK_TEMPLATE_ID "TMPL3cepx2c10"
#define BLYNK_TEMPLATE_NAME "IoT Based Fall Detection"
#define BLYNK_AUTH_TOKEN "_mxdX8r_JTEnll6xmCXZ3mAesOJB7Mz4"
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp8266.h>
#include <Adafruit_MPU6050.h>
#include <Adafruit_Sensor.h>
#include <Wire.h>

Adafruit_MPU6050 mpu;

char auth[] = BLYNK_AUTH_TOKEN;

char ssid[] = "BOHRA";
char pass[] = "sajjan41";

BlynkTimer timer;

void sendSensor()
{
  if(mpu.getMotionInterruptStatus()) {
    /* Get new sensor events with the readings */
    sensors_event_t a, g, temp;
    mpu.getEvent(&a, &g, &temp);

    /* Print out the values */
    Serial.print("AccelX:");
    Serial.print(a.acceleration.x);
```

```
    Serial.print(",");
    Serial.print("AccelY:");
    Serial.print(a.acceleration.y);
    Serial.print(",");
    Serial.print("AccelZ:");
    Serial.print(a.acceleration.z);
    Serial.print(", ");
    Serial.print("GyroX:");
    Serial.print(g.gyro.x);
    Serial.print(",");

    // Serial.print("GyroY:");
    // Serial.print(g.gyro.y);
    // Serial.print(",");

    Serial.print("GyroZ:");
    Serial.print(g.gyro.z);
    Serial.println("");


  // You can send any value at any time.
  // Please don't send more that 10 values per second.


    Blynk.virtualWrite(V0, a.acceleration.x);
    Blynk.virtualWrite(V1, a.acceleration.y);
    Blynk.virtualWrite(V2, a.acceleration.z);
    Blynk.virtualWrite(V3,g.gyro.x);
    Blynk.virtualWrite(V4,g.gyro.z);
    // Blynk.virtualWrite(V4,g.gyro.z);
   delay(200);
  }
}
void setup()
{

   Serial.begin(115200);
    while (!Serial)
    delay(10); // will pause Zero, Leonardo, etc until serial console opens

  Serial.println("Adafruit MPU6050 test!");

  // Try to initialize!
  if (!mpu.begin()) {
    Serial.println("Failed to find MPU6050 chip");
    while (1) {
```

```
      delay(10);
    }
  }

  Serial.println("MPU6050 Found!");

  //setupt motion detection
  mpu.setHighPassFilter(MPU6050_HIGHPASS_0_63_HZ);
  mpu.setMotionDetectionThreshold(1);
  mpu.setMotionDetectionDuration(20);
  mpu.setInterruptPinLatch(true); // Keep it latched.  Will turn off when reinitialized.
  mpu.setInterruptPinPolarity(true);
  mpu.setMotionInterrupt(true);

  Serial.println("");
  delay(100);

  Blynk.begin(auth, ssid, pass);
  timer.setInterval(100L, sendSensor);

  }

void loop()
{
  Blynk.run();
  timer.run();
 }
```

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