

# Design of a Multi-Sensors Wearable System for Continuous Monitoring of People with Parkinson's Disease

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**ABSTRACT** - This project presents the design and implementation of a multi-sensor wearable system for continuous home monitoring of individuals with Parkinson's disease. The system is developed using an Arduino Mega microcontroller integrated with various sensors, including a MAX pulse oximeter for measuring SpO<sub>2</sub> and heart rate, a blood pressure sensor for BP monitoring, an ADXL345 accelerometer for fall detection, an ADXL335 sensor for tremor analysis, and an IR sensor for sleep monitoring. Additionally, GPS and GSM modules are incorporated to enable real-time location tracking and emergency communication. Sensor data is continuously transmitted to a Python-based platform, where machine learning algorithms analyze vital parameters such as BPM and SpO<sub>2</sub> to detect abnormalities. When critical conditions are identified, the system automatically sends alerts through email, SMS, and phone calls to caregivers. Immediate alerts are also generated by the Arduino for events such as falls, abnormal BP, and excessive tremors, ensuring rapid response. All collected data is stored locally in Excel and uploaded to an IoT platform for remote monitoring and analysis, thereby improving patient safety, enabling continuous health tracking, and reducing caregiver workload.

**Key Words:** Parkinson's Disease, Wearable Health Monitoring, Internet of Things (IoT), Machine Learning, Fall Detection, Remote Patient Monitoring.

## 1. INTRODUCTION

Parkinson's disease is a progressive neurological disorder that significantly affects motor functions, balance, and cognitive abilities, leading to symptoms such as tremors, rigidity, and impaired coordination. As the disease advances, patients become increasingly vulnerable to

sudden health complications, particularly in home environments where continuous medical supervision is not readily available. Traditional healthcare monitoring approaches primarily rely on periodic clinical visits and manual observation, which are often insufficient for detecting real-time changes in a patient's condition. This delay in identifying critical events such as falls, abnormal vital signs, or severe tremors can lead to serious health risks and reduced quality of life.



**Fig. 1 Postural and Movement Changes in Parkinson's Disease**

To address these challenges, there is a growing need for an intelligent, real-time, and continuous monitoring system that ensures patient safety through early detection and timely intervention. Motivated by the limitations of existing systems, this project focuses on developing a cost-effective multi-sensor wearable solution that integrates various physiological and motion sensors with machine learning techniques. The system is designed to monitor key health parameters such as blood pressure, SpO<sub>2</sub> levels, heart rate, and body movements using an Arduino Mega microcontroller.

Furthermore, the incorporation of Internet of Things (IoT) technology enables remote monitoring by

caregivers and healthcare professionals, while real-time alerts through buzzer, SMS, and email ensure immediate response during emergencies. By combining continuous monitoring, intelligent analysis, and automated alert mechanisms, this project aims to enhance patient safety, reduce caregiver burden, and improve the overall quality of healthcare management for Parkinson's patients in home-based settings.

## 2. LITERATURE SURVEY

Gait impairments are considered key indicators of overall health, particularly in patients suffering from neurological disorders such as Parkinson's disease. Accurate assessment of gait patterns plays a crucial role in understanding disease progression and patient condition. Traditionally, gait analysis has been performed in controlled laboratory environments using specialized equipment. However, these methods often fail to capture real-world movement patterns, as patients may behave differently in clinical settings compared to their daily routines. This limitation highlights the need for continuous and practical monitoring systems that can reflect natural, everyday activities.

In recent years, wearable sensors, especially Inertial Measurement Units (IMUs), have gained significant attention for gait analysis due to their ability to measure acceleration, orientation, and motion effectively. Despite their advantages, the accuracy of IMU-based systems can vary depending on sensor placement, calibration, and patient-specific conditions, making real-world validation essential. In addition to IMUs, other technologies such as body-worn cameras, Global Navigation Satellite Systems (GNSS), and pressure insoles have been explored for gait detection. While these methods offer certain benefits, they also present limitations, including privacy concerns in camera-based systems, reduced accuracy of GNSS in indoor environments, and incomplete spatial data from pressure insoles.

To overcome these challenges, recent research has focused on combining multiple sensing technologies to enhance accuracy and reliability. Systems integrating IMUs with pressure insoles have demonstrated improved gait analysis; however, many of these solutions lack transparency and are primarily validated in controlled environments, limiting their applicability in real-life scenarios. The INDIP system represents a more advanced approach by integrating multiple sensors for comprehensive gait monitoring under real-world conditions, providing more reliable movement analysis. Future research directions emphasize improving accuracy, usability, and real-world validation of wearable

monitoring systems. The integration of multi-sensor data with machine learning techniques is expected to further enhance system performance, enabling more effective monitoring and better support for both patients and healthcare providers.

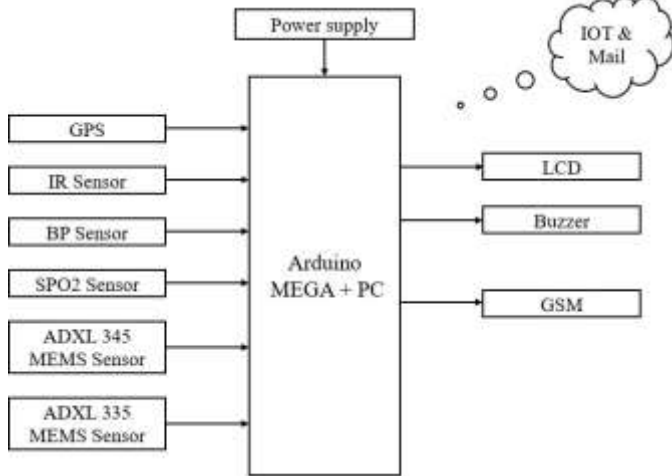
## 3. EXISTING SYSTEM

In traditional home health monitoring for Parkinson's patients, health assessment is mainly performed through periodic visits by caregivers or medical professionals. These methods rely on manual observation of symptoms such as tremors, abnormal posture, irregular pulse, or temperature fluctuations. Some existing automated systems use basic sensors or conventional algorithms, which require significant human intervention and provide limited insight into patient health. Such systems often lack continuous monitoring, involve costly equipment, and are not easily deployable for home use. The absence of integrated multi-sensor and IoT-based solutions results in delayed detection of critical conditions, reduced patient safety, and increased caregiver burden.

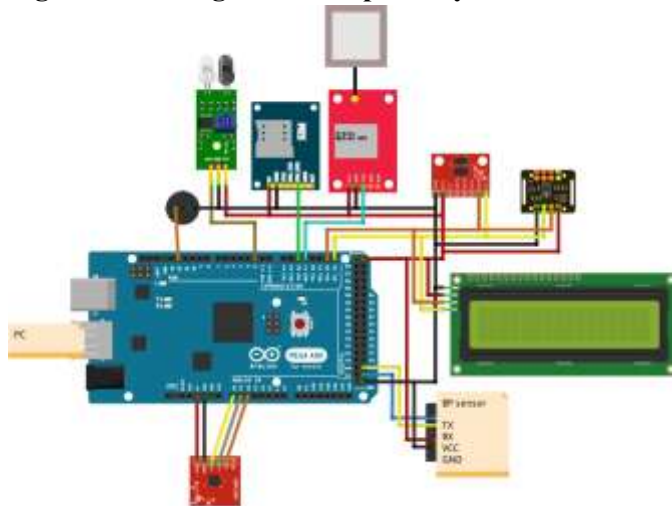
## 4. PROPOSED SYSTEM

The proposed model is a multi-sensor wearable monitoring system designed to provide continuous and real-time health assessment for individuals with Parkinson's disease. The system is centered around an Arduino Mega microcontroller that interfaces with various sensors, including a MAX pulse oximeter for measuring heart rate (BPM) and SpO<sub>2</sub>, a blood pressure sensor for BP monitoring, an ADXL345 accelerometer for fall detection, an ADXL335 sensor for tremor analysis, and an IR sensor for sleep monitoring. These sensors continuously collect physiological and motion data, which is transmitted to a Python-based processing unit. In the Python environment, machine learning algorithms are employed to analyze BPM and SpO<sub>2</sub> values to identify abnormal conditions. When an anomaly is detected, the system automatically triggers alerts via GSM, including SMS, phone calls, and email notifications, along with the patient's GPS location. Additionally, critical events such as abnormal BP, fall detection, and excessive tremors are immediately handled by the Arduino itself to ensure rapid response without processing delay. All sensor data is systematically stored in local Excel files and uploaded to an IoT platform for remote monitoring, historical

analysis, and improved healthcare decision-making.



**Fig 2: Block Diagram of Proposed system**



**Fig 3: Schematic Diagram Proposed system**

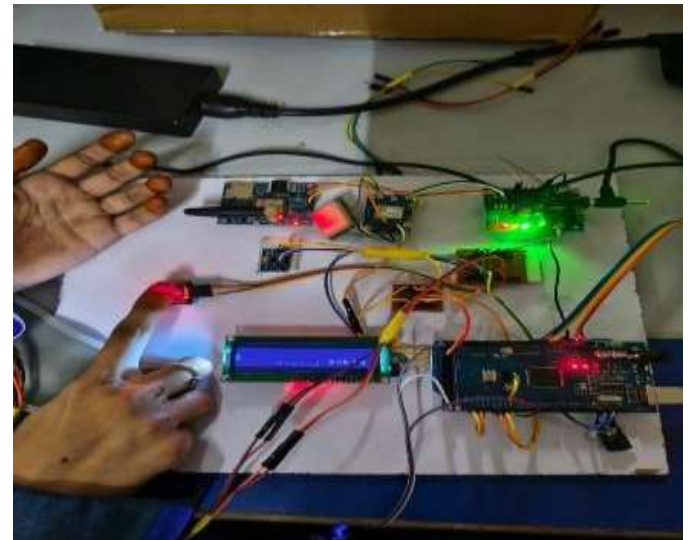
**5.RESULTS**



**Fig. 4 Hardware Setup**

The above figure illustrates the hardware implementation of the proposed multi-sensor wearable system for Parkinson’s patients. It uses an Arduino

Mega interfaced with sensors such as a blood pressure monitor, pulse oximeter, and MEMS accelerometers. GSM and GPS modules enable communication and location tracking, while an LCD displays real-time data. The system supports continuous monitoring, data processing, and alert generation for effective remote patient supervision.



**Fig. 5 SpO<sub>2</sub> and Pulse Rate Monitoring**

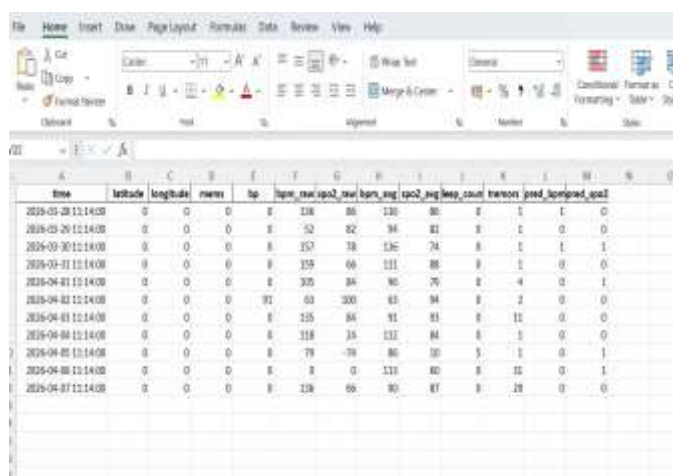
The above figure illustrates the SpO<sub>2</sub> measurement process integrated within the system. In this process, the user places their finger on the pulse oximeter sensor to obtain vital health parameters such as oxygen saturation (SpO<sub>2</sub>) and pulse rate. Once the finger is properly positioned, the sensor emits light through the fingertip and detects variations in light absorption caused by blood flow. Based on this principle, accurate SpO<sub>2</sub> and heart rate values are determined.

The system ensures continuous and reliable acquisition of physiological signals. After processing, the measured values are displayed locally on the LCD module to provide immediate feedback to the user, and are simultaneously uploaded to the ThingSpeak cloud platform via the communication module for remote monitoring and analysis.



abnormal tremor levels or a sudden motion pattern indicative of a fall is detected, the system classifies it as a critical event.

Upon detection, the Arduino-based system immediately triggers an alert through the GSM module by sending an SMS notification and initiating a call to the respective caregiver. The alert message also includes the real-time GPS location of the patient, enabling quick and precise assistance. This automated response mechanism ensures continuous monitoring, early detection of tremors, and immediate communication during fall emergencies, significantly improving patient safety and reducing response time.



time	latitude	longitude	name	bp	bpm	spo2	mems	tremor	sleep	count	tremor	predicted_health
2025-03-28 12:14:00	0	0	0	8	138	86	130	86	8	1	1	0
2025-03-29 12:14:00	0	0	0	8	52	82	34	81	8	1	0	0
2025-03-30 12:14:00	0	0	0	8	157	78	136	74	8	1	1	1
2025-03-31 12:14:00	0	0	0	8	155	66	111	88	8	1	0	0
2025-04-01 12:14:00	0	0	0	8	105	84	90	76	8	4	0	1
2025-04-02 12:14:00	0	0	0	8	91	83	100	61	94	8	2	0
2025-04-03 12:14:00	0	0	0	8	125	84	91	91	8	11	0	0
2025-04-04 12:14:00	0	0	0	8	118	74	111	84	8	1	0	0
2025-04-05 12:14:00	0	0	0	8	79	79	86	10	5	1	0	1
2025-04-06 12:14:00	0	0	0	8	8	0	111	80	8	11	0	1
2025-04-07 12:14:00	0	0	0	8	138	66	80	87	8	18	0	0

Fig. 10 Data Stored in Excel Sheet

This figure shows the data received via email and stored in tabular format for further analysis. This sheet contains timestamped wearable sensor data including vitals BPM, SpO<sub>2</sub>, MEMS readings, blood pressure, tremors, sleep count, and predicted health parameters.” Each record contains timestamped sensor readings, including SpO<sub>2</sub> values, heart rate (BPM), accelerometer-based tremor counts, and location details such as latitude and longitude. The system automatically compiles and sends this data through email, ensuring remote accessibility and backup. This feature enables efficient monitoring, data logging, and easy integration with analytical tools like Excel for visualization and evaluation.

## 6. CONCLUSIONS

This project presents the design and implementation of a multi-sensor wearable system for continuous monitoring of Parkinson’s patients. By integrating sensors for measuring vital parameters such as BP, SpO<sub>2</sub>, heart rate, and body movements, the system enables real-time health monitoring in a home environment. The use of

IoT technology allows remote access to patient data through the ThingSpeak IoT platform, while machine learning using the Random Forest algorithm enhances the detection of abnormal conditions. The system also provides immediate alerts through buzzer, GSM, and email notifications with detailed information such as location and time, improving patient safety and timely intervention. Overall, the proposed system offers a cost-effective, reliable, and efficient solution for continuous healthcare monitoring.

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