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An IOT Assisted Real Time Monitoring System for Parkinson's Disease

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Abstract: Parkinson's disease (PD) is a progressive neurological disorder that significantly impacts motor and nonmotor functions, reducing the quality of life of affected individuals. The advent of Internet of Things (IoT) technology offers promising solutions for real-time and remote monitoring of PD symptoms, enhancing disease management and patient care. Wearable sensors and environmental monitoring devices play a crucial role in tracking symptoms such as tremors, bradykinesia, and dyskinesia, while AI-powered platforms analyze data trends to predict symptom progression and enable proactive medical interventions. One of the most promising advancements in this field is the integration of fall detection mechanisms with wearable devices. PD patients are at a high risk of falls, which can lead to severe injuries. The objective of this research is to enhance the quality of life of PD patients through the implementation of IoT-based monitoring and intervention systems. By leveraging real-time data collection, IoT-based solutions offer a transformative approach to managing Parkinson's disease by providing continuous, real-time monitoring and personalized care.

Keywords: Levodopa, wireless communication, cloud computing, fall detection, wearable sensors, accelerometers, bradykinesia

1. Introduction:

The emergence of the Internet of Things (IoT) presents a revolutionary chance to use cutting-edge patient monitoring systems to transform the management of Parkinson's disease. A network of linked devices with sensors and software that gather and share data in real time over the internet is referred to as the Internet of Things (IoT). IoT technology can enable customized interventions based on each patient's needs and preferences, which is crucial for managing Parkinson's disease. IoT-based systems have the potential to improve patient outcomes, improve quality of life, and lower healthcare costs by continuously monitoring motor and non-motor symptoms, identifying changes in the progression of the disease, and facilitating remote consultations. IoT technology has the potential to revolutionize the treatment of Parkinson's disease by facilitating proactive, individualized, and ongoing care. The full potential of IoT can be realized by cooperatively tackling current obstacles and developing creative solutions. Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects movement and various other bodily functions, significantly impacting the quality of life of affected individuals. It presents both motor symptoms, such as tremors, bradykinesia (slowness of movement), and dyskinesia (involuntary movements), as well as nonmotor symptoms, including cognitive decline, mood disorders, and sleep disturbances. Managing PD effectively requires continuous monitoring and timely interventions, which is where the Internet of Things (IoT) plays a crucial role. IoT-based technology enables real-time and remote monitoring of Parkinson's disease symptoms, offering a more comprehensive approach to patient care. Wearable sensors embedded in smartwatches, bracelets, or even clothing can track key motor symptoms such as tremors and bradykinesia.

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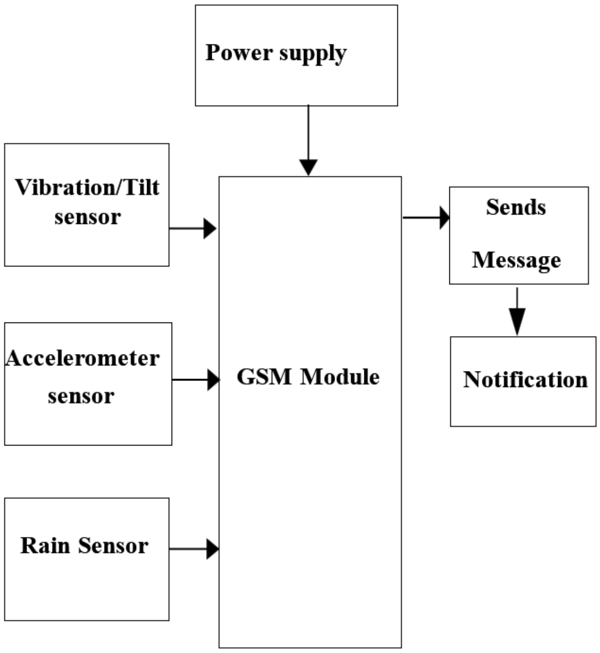

Figure-1 Block Diagram

2. Literature Review

According to Huo et al., the measurement of Parkinson's disease (PD) symptoms has greatly improved with heterogeneous sensing systems. Their multisensory platform, which combined mechanomyography (MMG), force sensors, and inertial measurement units (IMUs), offered a reliable method for detecting tremor, rigidity, and bradykinesia. The system's ability to provide objective, remote monitoring was highlighted by its 85.4% agreement with clinical UPDRS scores. Notably, this invention provides a scalable substitute for conventional evaluations that depend on clinician observation, thereby addressing a significant constraint in rigidity measurement.

Brodie et al. investigated how sensory stimulation through smart socks could help PD patients stabilize their gait right away. The study found that activating lower-limb afferents reduced step time variability by 44% and improved gait speed by 15%. These results demonstrate how wearable technology can improve the safety and mobility of people with Parkinson's disease. However, drawbacks like the small sample size and difficulties incorporating these gadgets into daily life call for more research into their usefulness.

According to Skaramagkas et al.'s review, deep learning has become a potent tool for PD diagnosis and monitoring. Multimodal data sources, including speech, facial expressions, and gait patterns, were found to be essential inputs for deep learning models in their systematic review. In terms of diagnostic accuracy, these models performed better than conventional machine learning methods. However, there are a number of obstacles to clinical implementation, including limited datasets, interpretability of the model, and generalizability across different populations.

3. Methodology and Application

Requirement Analysis

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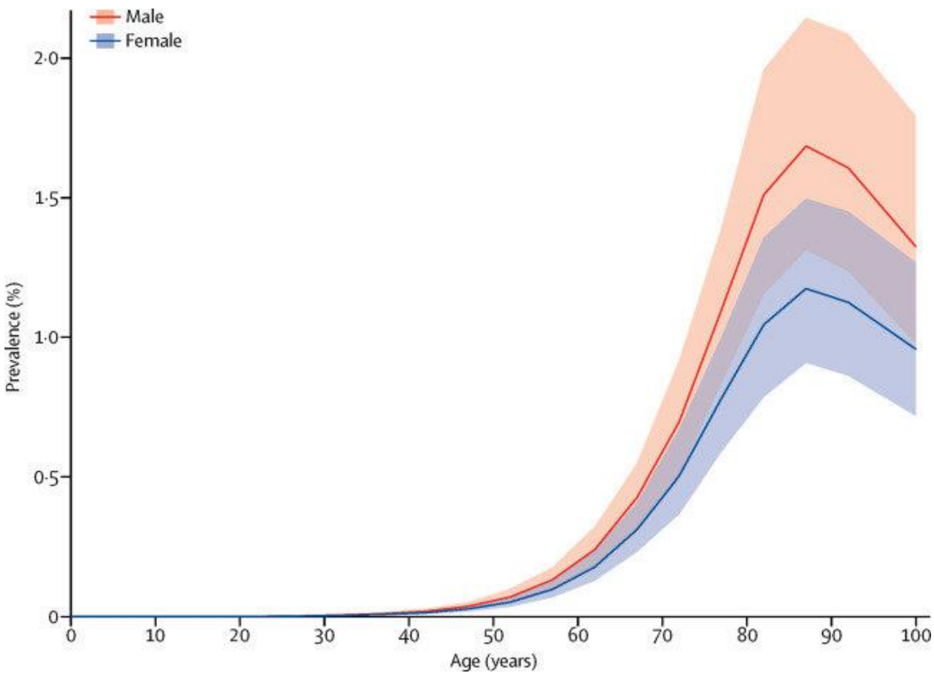

Figure-2 Global prevalence of Parkinson's disease by age and sex, 2016. Prevalence is expressed as the percentage of the population that is affected by the disease. Shading indicates 95% uncertainty intervals

Conceptual Design

The core of the system is the NodeMCU ESP8266 microcontroller, which is chosen for its affordability, low power consumption, and built-in Wi-Fi capability. The system integrates multiple sensors to monitor PD-specific symptoms, including tremors, falls, and hygiene issues. These sensors collect real-time data, which is processed by the microcontroller and transmitted to a cloud-based IoT platform. Architecture ensures seamless communication between hardware and software components, enabling real-time data visualization and notification delivery to caregivers and medical professionals.

1. The **Node MCU ESP8266** microcontroller serves as the central processing unit, taking in sensor data, processing it, and sending it over Wi-Fi to the Internet of Things platform.
2. **Tilt/Angle Measurement** - Accelerometer: This device continuously records the patient's tilt angles, abrupt acceleration changes, and posture. Algorithms for fall detection are used to distinguish between fall and normal movements.
3. **Tremor Detection**: Vibration Sensor: This sensor detects abnormal tremors frequently linked to Parkinson's disease by measuring vibration frequency and intensity. The system detects severe shivering.
4. **Rain Sensor (Moisture Detection):** This repurposed device tackles hygiene concerns by detecting moisture in the patient's bedding or clothing.
5. **Power Supply System:** The system uses a dependable power supply mechanism, such as rechargeable batteries and low-power consumption designs, to guarantee continuous operation.
6. **GSM Module**: A GSM module's primary purpose is to enable a device to communicate over a cellular network, allowing for the sending and receiving of data, voice calls, and SMS messages.

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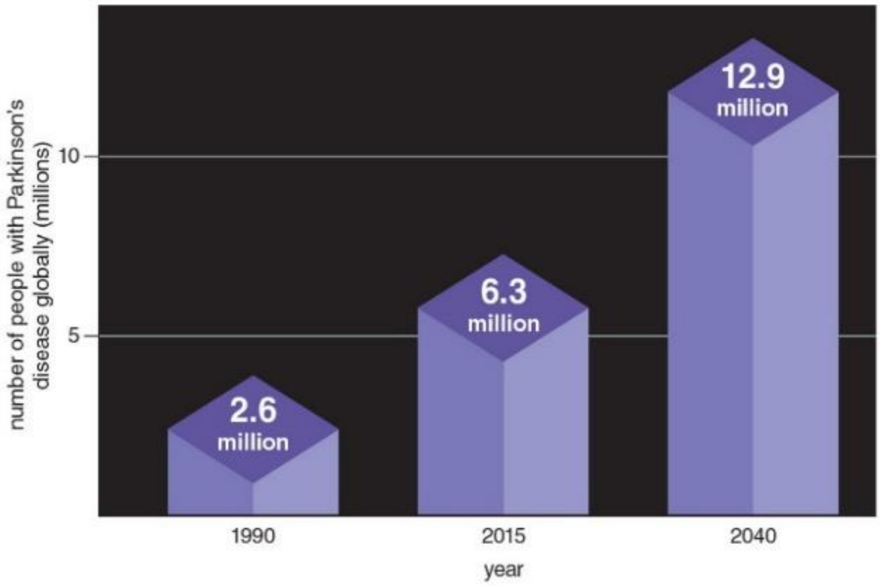

Figure-3 From 1990 to 2015, the number of people living with Parkinson's more than doubled from 2.6 million to 6.3 million, according to a 2015 study in Lancet Neurology. By 2040, the number is projected to double again to at least 12.9 million, a stunning rise

4. System Architecture

Hardware Subsystem

- **Node MCU:** The NodeMCU ESP8266 is a low-cost, compact, and versatile Wi-Fi microcontroller board based on the Espressif Systems ESP8266 chip. It's primarily used for Internet of Things (IoT) applications and can be programmed using the Arduino IDE.
- **Accelerometer Sensor:** Accelerometers are incredibly small sensors that measure acceleration along three axes (X, Y, and Z) using micromachined structures.
- **Vibration Sensor:** The vibration sensor is also known as a piezoelectric sensor. Numerous processes are measured with these versatile tools.
- **Rain Sensor:** It is used to detect motion from patients and humidity.
- **Power Supply:** The primary function of a power supply is to convert electrical energy from a source, like an outlet, into the correct voltage, current, and frequency required by electronic devices.
- **GSM Module:** These modules use a SIM card to authenticate with a mobile network operator and establish a link for communication. A GSM module's primary purpose is to enable a device to communicate over a cellular network, allowing for the sending and receiving of data and SMS messages.

Software Subsystem

The NodeMCU programming model is comparable to Node.js. It is event-driven and asynchronous. As a result, many functions have callback function parameters. The brief samples below will give you a sense of what a NodeMCU program looks like. Check out the *lua_examples* folder in the GitHub repository for more detailed examples.

Embedded System Programming

Programming for embedded systems differs from creating desktop applications. The following are important features of an embedded system in contrast to PCs:

- **Resource limitations:** Embedded devices have limited ROM, RAM, stack space, and lower processing power.

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- **Different components:** PCs and embedded systems use different components; embedded systems usually use smaller, lower-power components.
- **Hardware dependence:** Systems that are embedded are more dependent on the hardware.
- **Code size and speed:** These are two important aspects of embedded programming. Available program memory and programming language usage determine code size, while processing power and timing constraints determine code speed.

The aim of embedded system programming is to get the most features in the least amount of time and space.

5. Results and Discussion

The proposed Internet of Things (IoT)-based framework for monitoring the side effects of Parkinson's disease was successfully implemented and tested with the integration of various hardware components, including the NodeMCU ESP8266 microcontroller, accelerometer sensor, vibration sensor, GSM module, rain sensor, and a regulated power supply unit. The accelerometer and vibration sensors played a crucial role in detecting tremors, abnormal body movements, and postural instability in real time. These sensors, interfaced with the NodeMCU, continuously captured movement data and transmitted it via the onboard Wi-Fi module to a remote server for further analysis.

The implementation of the GSM module provided an additional communication pathway through SMS alerts, ensuring that critical health updates could reach caregivers or medical personnel even in the absence of internet connectivity. The rain sensor was utilized innovatively to detect moisture or sweat levels, which may indirectly indicate stress or autonomic dysfunction in patients. The power supply module ensured consistent and uninterrupted operation of the entire system, thereby enhancing reliability and efficiency.

The overall system demonstrated promising results in terms of continuous patient monitoring, objective symptom assessment, and real-time communication. This contributed to improved treatment adherence and enabled healthcare providers to make timely, data-driven clinical decisions. The low-cost and modular design makes the system scalable and adaptable for broader clinical use, especially in home-based or rural healthcare settings

6. Future Directions

Future research will focus on refining sensor accuracy, miniaturization, and comfort to ensure long-term usability for patients. Further development of AI algorithms for predictive analytics and adaptive intervention strategies will be essential, including an airbag system. Large-scale clinical trials are needed to validate the effectiveness and safety of wearable airbag systems and other IoT-based tools. Additionally, integrating these technologies with electronic health records (EHRs) and expanding telemedicine capabilities will enhance remote care coordination. Exploring cost-effective and scalable deployment models will also be vital to making this technology accessible to a broader patient population worldwide.

7. Conclusion

Overall, the suggested Internet of Things-based framework for monitoring the side effects of Parkinson's disease offers a promising approach to improving the management and care of those who have the disease. The system provides a number of benefits for both patients and healthcare providers by utilizing accelerometers and vibration sensors connected to a microcontroller, Wi-Fi module, bell, and power supply. The proposed IoT-based framework for monitoring Parkinson's disease side effects presents a promising approach to improving patient care and disease management. Utilizing accelerometer and vibration sensors linked to a microcontroller, Wi-Fi module, and alert system, the framework provides continuous monitoring, objective assessment, and real-time data collection. This enhances treatment coordination, improves patient engagement, and supports better adherence to therapy. Utilizing accelerometer and vibration sensors linked to a microcontroller, Wi-Fi module, and alert system, the framework provides continuous monitoring, objective assessment, and real-time data collection.

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