Proposed Research Project

Title:

An AI-Enabled Edge Computing Framework for Real-Time Patient Health Monitoring Using Wireless Sensor Networks

Keywords. IoT, AI, edge computing, and healthcare.

1. Background & Motivation

The increasing prevalence of chronic illnesses such as cardiovascular diseases, diabetes, and neurological disorders highlights the need for **continuous and reliable health monitoring systems**. Traditional cloud-based solutions introduce challenges such as high latency, dependence on internet connectivity, and privacy concerns.
Wireless sensors capable of measuring **ECG, blood pressure, EEG, and blood glucose** can provide real-time insights into patient health. However, to make the system responsive and efficient, intelligent processing at the **edge (sink node)** is essential.

2. Problem Statement

How can an **AI-driven edge computing sink node** be designed to:

- Efficiently collect and process real-time health signals (ECG, BP, EEG, glucose)?
- Perform local inference to detect anomalies in patient health?
- Generate timely **alerts/notifications** to caregivers or medical professionals, without over-reliance on cloud connectivity?

3. Objectives

1. **Design a WBAN system** using wireless sensors for ECG, blood pressure, EEG, and glucose monitoring.
2. **Develop a smart sink node** integrating AI and edge computing to process collected signals locally.
3. Implement **AI algorithms** for anomaly detection (e.g., arrhythmia detection, abnormal BP levels, epileptic seizure prediction, or hyper/hypoglycemia episodes).
4. Build a **notification framework** to alert patients/caregivers through mobile apps, SMS, or IoT dashboards.
5. Ensure **low latency, energy efficiency, and data privacy** compared to cloud-only solutions.

4. Methodology

- **Sensor Layer:** Deploy low-power wireless sensors (ECG, BP, EEG, glucose) forming a WBAN.
- **Communication Layer:** Transmit data securely to the sink node (Bluetooth Low Energy, ZigBee, or LoRa).
- **Sink Node with AI & Edge Computing:**
    - Pre-process signals (noise removal, normalization).
    - Run **AI models (e.g., lightweight CNN, LSTM, or anomaly detection algorithms)** locally for real-time health assessment.
    - Store critical results, while offloading only summarized data to the cloud for long-term analysis.
- **Notification Layer:** Trigger alerts when anomalies are detected and display results on a mobile app/web dashboard.

5. Expected Contributions

- A **prototype health monitoring system** that combines **wireless sensing + edge intelligence + AI anomaly detection**.
- Reduced **latency and bandwidth consumption** compared to cloud-only monitoring.
- Enhanced **privacy** by local data processing.
- Improved **reliability of patient monitoring** with real-time notifications for life-critical conditions.

6. Potential AI Component Ideas

- **ECG:** Arrhythmia detection with lightweight CNN models.
- **Blood Pressure:** Hypertension/hypotension anomaly detection using threshold + ML hybrid models.
- **EEG:** Epileptic seizure prediction with RNN/LSTM.
- **Glucose:** Predictive trend analysis with regression + anomaly detection.