

# Chapter 11

## IoT-Enabled Wearable Device for Stroke Rehabilitation at Home

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### ABSTRACT

*This article presents a LoRa-based health monitoring device designed for rehabilitation patients. The system combines body surface EMG sensing with inertial motion tracking to record muscle activation, joint angle, and repetition count. A wearable unit transmits processed features over LoRa (Long Range network) to a cloud server. The cloud is a place where data is stored. The cloud provides the end-point for visualization. Patients and clinicians access the data via web and mobile dashboards that display real-time EMG graphs, angle observations, session history, and feedback. Signal preprocessing includes bandpass filtering, rectification, RMS calculation, and normalization. Experiments showed EMG error  $\leq 6\%$ , angle error  $\leq 3^\circ$ , and rep detection  $F1 \approx 0.96$ . LoRa communication achieved  $> 90\%$  packet delivery indoors and outdoors with latency  $\leq 500$  ms. Battery life exceeded 30 hours of continuous use. Case studies confirmed utility in hospitals, homes, clinics, and rural centers.*

### 1. INTRODUCTION

Rehabilitation after injury or illness requires long periods of repeated exercise. Progress depends on continuous monitoring. Traditional methods rely on clinical supervision. Patients are often asked to perform exercises at home without feed-

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back. Lack of monitoring leads to slow recovery or incomplete recovery. Wearable devices have been introduced to support rehabilitation. These devices collect signals from the body and provide feedback to clinicians. Most devices use Bluetooth or Wi-Fi to transmit data. These technologies have limits. Range is short. Power consumption is high. Patients in large hospitals or rural areas face difficulties. Muscle monitoring is a core part of rehabilitation. Electromyography (EMG) is used to measure electrical activity in muscles. EMG helps to assess recovery after stroke, surgery, or injury. Motion tracking is also important. Sensors like accelerometers or gyroscopes can capture joint angles. Combining EMG and motion data gives a clear view of patient progress.

The proposed system uses LoRa for data transmission. LoRa is a long-range, low-power wireless protocol. It allows devices to send small packets over several kilometers. This makes it suitable for hospitals, rehabilitation centers, and community health programs. LoRa consumes less power than Wi-Fi or Bluetooth. This extends battery life and reduces the need for frequent charging. The device is a wearable armband (presented in Figure 1). It includes EMG sensors, an angle sensor, a LoRa module, and a small screen. The armband is lightweight and easy to attach. Data is sent to a backend server through a LoRa gateway. The backend is built with Resful service and stores data in JSON format.

Clinicians and patients can access the data using a web or mobile dashboard. The dashboard displays real-time EMG activity, joint angles, number of repetitions, and battery level. It also keeps a history of sessions. The system supports starting and ending rehabilitation sessions. Patients can see their progress over time.

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