PLANT WEARABLE IOT DASHBOARD

Final Project Report

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Abstract

This project demonstrates the design and implementation of a Plant Wearable IoT Dashboard, an Android application connected via Bluetooth Low Energy (BLE) to an ESP32-based sensor node. The system is designed for monitoring plant stress parameters including VOC levels, leaf temperature, and humidity. The system successfully integrates hardware, firmware, and a mobile app to provide real-time data visualization, stress alerts, and decision-support tools for precision agriculture.

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1. Introduction

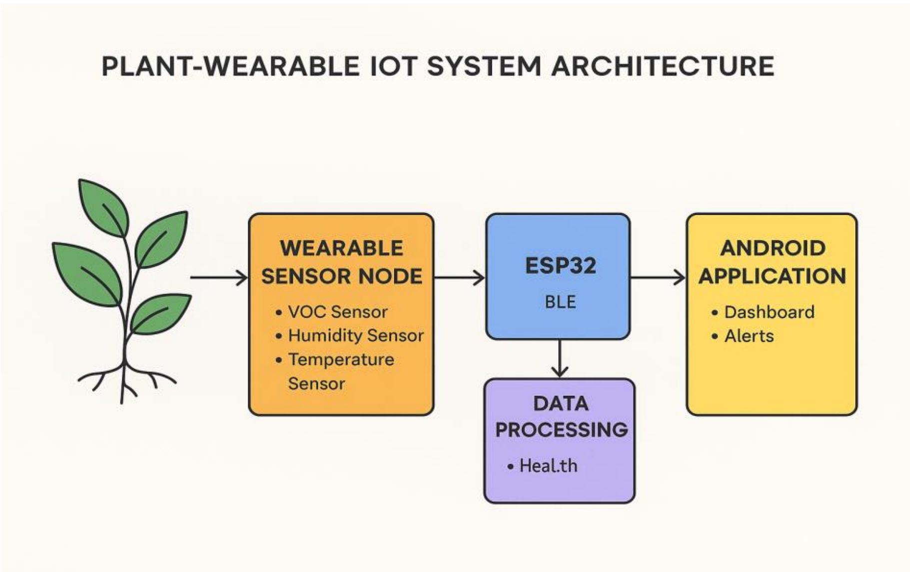
Agricultural productivity depends heavily on timely detection of plant stress conditions. Traditional methods often lack scalability and real-time responsiveness. This project introduces a wearable IoT system mounted on plants, transmitting vital signals to a mobile app, enabling proactive monitoring and decision-making.

2. Literature Review

Prior research has demonstrated the use of IoT sensors for soil moisture, climate control, and crop monitoring. BLE-based wearable devices are increasingly applied in agriculture for real-time, low-power sensing. Android platforms provide a field-friendly interface for farmers and researchers. This project builds on these foundations with an integrated, modular plant monitoring system.

3. System Design & Architecture

The system is comprised of an ESP32 microcontroller, a DHT22 (Temperature/Humidity) sensor, and an MP503 VOC sensor. Firmware was developed using the Arduino IDE, and the mobile application was built in Android Studio with MPAndroidChart for visualization. Communication flows from the sensor to the ESP32, which transmits data via BLE to the Android App for display on a dashboard and



for alert processing.

4. Implementation

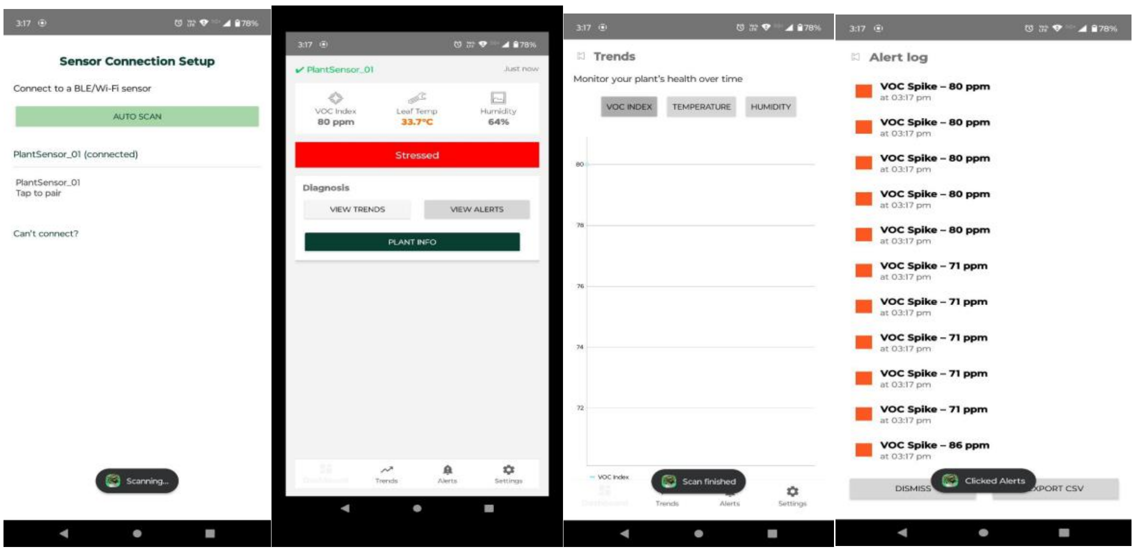
The ESP32 firmware was developed to act as a BLE server, transmitting formatted sensor data packets to the client application. The Android app includes multiple screens: Sensor Connection, Dashboard, Trends, Alerts, and Settings. A

`BLEManager` component handles the GATT connections, ensuring periodic data updates every ~3 seconds. The alert system uses threshold-based logic (e.g., VOC > 50ppm, Temp > 35°C, Humidity < 40%) to trigger user notifications, which are then logged in an alert history screen.

5. Results

The implementation resulted in a functional prototype with the following successful outcomes:

- Successful and stable BLE pairing was achieved with the ESP32 device.
- The real-time dashboard updates correctly, and stress alert thresholds trigger as expected under simulated stress conditions.
- Trends were plotted with meaningful patterns using the MPAndroidChart library.
- The demo was tested with a live plant setup, and significant correlations were observed between sensor readings and the plant's health status.



6. Discussion

The primary strengths of the prototype are its real-time BLE streaming capability, low-cost design, and modular Android application. Key limitations include the limited BLE range of approximately 10 meters, the approximate nature of the VOC sensor calibration, and the lack of persistent data storage in the current version. Challenges overcome during implementation included BLE library conflicts, instances of connection instability, and debugging sensor wiring issues.

7. Future Work

Several enhancements are planned for future iterations of the project:

- Cloud integration for remote monitoring and data aggregation.
- Implementation of a local SQLite database or CSV storage for offline history.
- Development of machine learning models for predictive stress analysis.
- Expansion of the sensor suite to include CO_2, soil pH, and moisture sensors.

8. Conclusion

The Plant Wearable IoT Dashboard successfully demonstrates the feasibility of integrating BLE sensors with a mobile application for real-time plant stress monitoring. The working prototype validates a scalable and accessible solution that can serve as a foundation for future smart agriculture and precision farming applications.

References

1. Espressif ESP32 Documentation
2. Android BLE Developer Guide
3. MPAndroidChart Documentation
4. DHT22 Sensor Datasheet
5. MQ135/MP503 VOC Sensor Datasheet

Appendices

A. Timeline: 4 weeks (Requirement Analysis → BLE Integration → Graphs & Alerts → Demo & Documentation)

B. Screenshots: Complete set of screenshots provided separately.

C. Demo Video: Provided separately as supplementary material.

D. Code Snippet:

`BLEManager.kt` handles scanning, connection, and data updates.