IoT-Based Smart Waste Management System

1. Introduction

The IoT-Based Smart Waste Management System is designed to automate the process of monitoring waste levels in bins and controlling the bin lid based on user proximity. It uses ESP32, ultrasonic sensors, a servo motor, and the Blynk IoT platform to send real-time updates to a mobile application. The system enhances waste collection efficiency, reduces manual monitoring efforts, and promotes a cleaner environment.

2. Components Used

- ESP32 Microcontroller
- HC-SR04 Ultrasonic Sensors (Person Detection & Bin Level Measurement)
- Servo Motor (for automatic lid control)
- Jumper Wires
- Breadboard
- Power Supply (5V)
- Blynk IoT Platform

3. Working Principle

The system employs two ultrasonic sensors:
1. Person Detection Sensor: Detects if a person is near the bin. If detected within 20 cm, the servo motor opens the lid automatically and closes it after 2 seconds.
2. Bin Level Sensor: Measures the waste level inside the bin. The distance data is converted into a percentage (0% = full, 100% = empty). If the bin is more than 90% full, a notification is sent via Blynk.

4. Code Explanation

- Wi-Fi & Blynk Initialization: The ESP32 connects to Wi-Fi and Blynk using authentication credentials.
- Servo Motor Control: Controlled using the Servo library, rotates between 0° (closed) and 90° (open).
- Person Detection: Trigger pin sends an ultrasonic pulse; Echo pin receives the signal to calculate distance. If less than 20 cm, the lid opens.
- Bin Level Measurement: Similar ultrasonic principle is used. The measured distance is mapped into a fill percentage.
- Event Trigger: If bin level ≥ 90%, a notification is triggered via Blynk.

5. Advantages
- Automated waste monitoring
- Reduces manpower for bin checking
- Promotes cleanliness
- Real-time alerts via Blynk app

6. Applications
- Smart cities
- Airports and railway stations
- Malls and public places
- Corporate offices

7. Conclusion
The IoT-Based Smart Waste Management System offers an efficient way to handle waste disposal and monitoring. With real-time alerts, automated lid control, and remote monitoring capabilities, it reduces manual effort and supports smart city initiatives.