NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

## Internet of Things Laboratory (EC2601-1)

***A Project report on***

# Automated Inventory Verification and Tracking System for Warehouses

**Submitted By**


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# CERTIFICATE

This is to certify that Rithesh **(**NNM22EC133**),** Rohith Shettigar **(**NNM22EC135**),** Pancham Pai **(**NNM22EC136**),** S R Vamshith **(**NNM22EC137**),** bonafide students of N.M.A.M. Institute of Technology, Nitte have submitted the report for the project entitled "**INVENTORY MANAGEMENT SYSTEM"** in partial fulfillment of the requirements for the Internet of Things Laboratory (EC2601-1) during the year 2024-2025

**Project Evaluation**

| Name of the Examiners | Signature with date |
|---|---|
| 1. _____ | _____ |
| 2. _____ | _____ |

# ABSTRACT

Warehouse inventory management faces significant challenges when performed manually, including misplaced items, stock discrepancies, and operational inefficiencies. To address these issues, this project proposes an Automated Inventory Verification and Tracking System leveraging IoT and cloud-based technologies. The system validates incoming products against a cloud database, automatically assigns storage locations, and provides real-time inventory updates. Non-compliant items are rejected to prevent errors, while stakeholders gain live visibility into stock status via a centralized dashboard. By minimizing manual intervention, the system enhances accuracy, reduces costs, and optimizes warehouse operations. The implementation integrates sensor-based verification, automated sorting, and cloud connectivity, ensuring scalability for industrial applications. This project demonstrates how automation can transform traditional inventory management into a reliable, efficient, and error-resistant process.

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# List of Figures

# Abbreviations:

- IoT Internet of Things
- DB Database
- API Application Programming Interface
- RFID Radio Frequency Identification
- LCD Liquid Crystal Display
- OTP One-Time Password
- MCU Microcontroller Unit
- UI User Interface
- HTTP HyperText Transfer Protocol
- GPIO General-Purpose Input/Output
- JSON JavaScript Object Notation

# CHAPTER 1

# INTRODUCTION

In today's fast-moving industrial and commercial world, effective warehouse management is essential for reducing operational costs, improving accuracy, and increasing productivity. Traditional inventory tracking systems often rely on manual labor, which can lead to errors, misplacements, and delays.

This project aims to address these issues by developing an Automated Inventory Verification and Tracking System using IoT technology. The system verifies incoming products against a cloud database, assigns them appropriate storage locations, and updates inventory status in real-time. Unverified products are rejected, ensuring only authorized goods are handled.

The integration of automation not only improves the speed and accuracy of warehouse operations but also reduces manual effort and increases efficiency. This solution has potential applications in logistics, retail, and manufacturing industries, where reliable inventory management is critical.

## 1.1 Objectives

The primary objective of this project is to develop an Automated Inventory Verification and Tracking System using Internet of Things (IoT) technology. This system aims to streamline warehouse operations by integrating sensor-based automation with real-time cloud data management. The specific objectives are:

- To automate the verification process of incoming products using RFID technology.
- To ensure real-time inventory status updates using Firebase cloud integration.
- To assign and display appropriate storage slot information for verified products.

- To provide automated product routing using IR sensors and servo-controlled gates.
- To create a user-friendly mobile application that allows warehouse personnel and vendors to monitor inventory status from remote locations.
- To minimize human errors in product sorting and storage through sensor-based decision-making.
- To develop a scalable framework that can be extended to support multi-lane warehouse configurations in the future.
- To reduce manual effort and improve efficiency in warehouse operations using IoT-based automation.

# CHAPTER 2

# METHODOLOGY

The system is designed to automate inventory verification and slot allocation in warehouses using IoT technology. At the core of the setup is the ESP32-WROOM-DA microcontroller, which handles all communication between the components and the cloud database.

The process begins when a product is placed on the conveyor. An infrared (IR) sensor detects its presence and activates the system from sleep mode. The product then reaches the RFID reader, which scans its unique ID tag. This ID is sent to a Firebase cloud database using Wi-Fi, where the product is verified.

If the product is found in the database, it is marked as valid, and a storage slot number is assigned. This slot number is displayed on an LCD screen for visual confirmation. If the product is not found, it is rejected, and no further action is taken.

As the verified product moves forward, a second IR sensor detects it near the end of the conveyor. This triggers a servo motor to open a small gate. Once the product passes through the gate, the servo closes it, guiding the item into its assigned storage slot.

The entire system is programmed using the Arduino IDE, and a custom Android app—developed using Kotlin and XML in Android Studio—is used to monitor product status in real time. This app connects to the same Firebase database and allows warehouse staff or vendors to track inventory from their smartphones.

By combining sensors, cloud communication, and automation, the system ensures accurate product verification, reduces manual errors, and improves overall warehouse efficiency**.**

## 2.1 Block Diagram

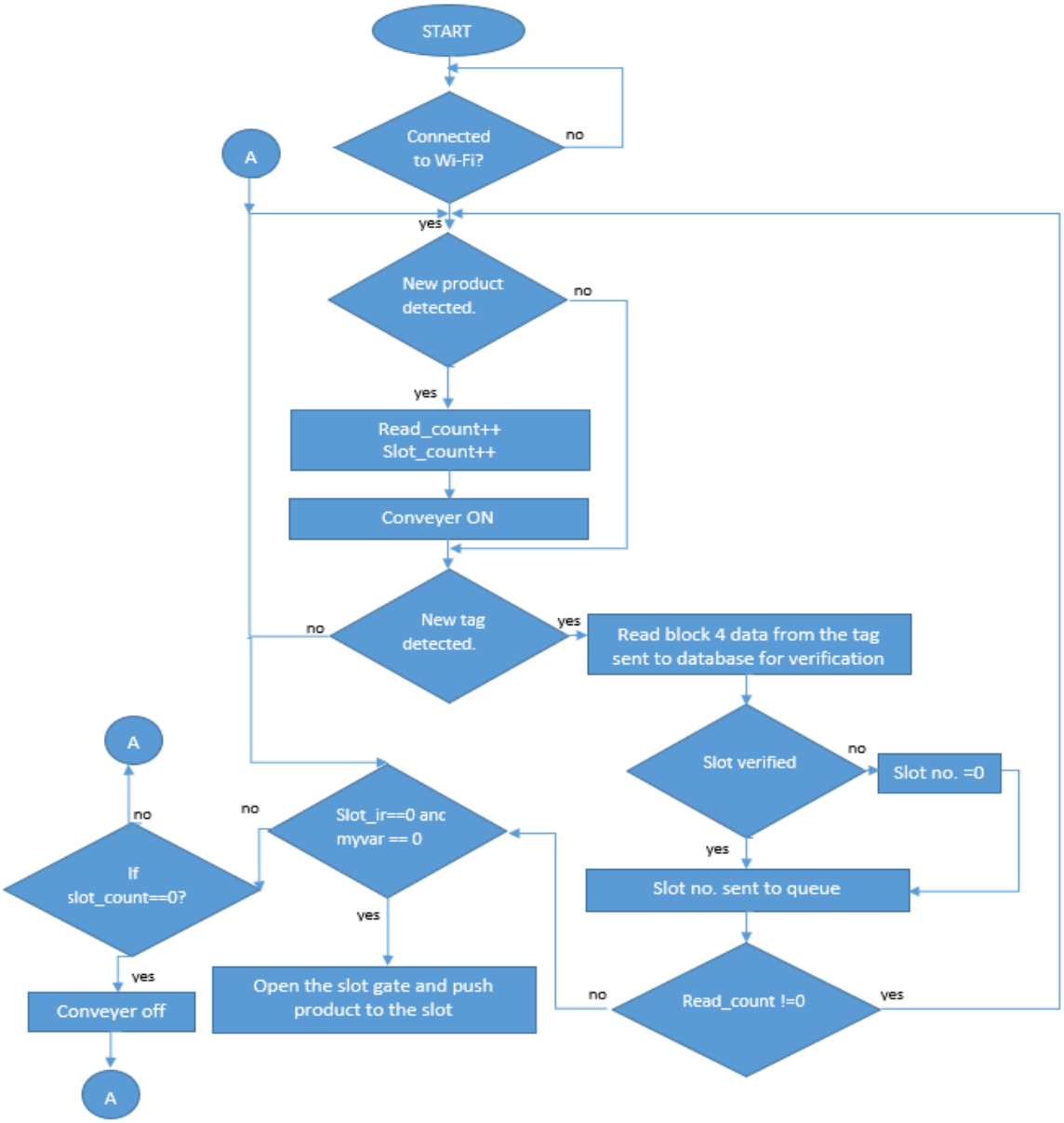


Figure 2.1 : Block Diagram

# CHAPTER 3

# HARDWARE AND SOFTWARE REQUIREMENTS

## 3.1 HARDWARE REQUIREMENTS

- ESP32-WROOM-DA – Acts as the main controller, processing commands and enabling Wi-Fi connectivity.
- RC522 RFID Reader – Scans the RFID tags of products for identification.
- NFC Tags – Unique identifiers attached to each product for sorting.
- IR Sensors (x2) – One detects product entry, the other triggers the gate mechanism.
- SG90 Servo Motor – Controls the gate mechanism to direct products into appropriate slots.
- 16x2 LCD Display – Shows real-time product status and assigned slot.
- Breadboard & Jumper Wires – Used for prototyping and making electronic connections.
- USB Power Supply – Provides power to the ESP32 and peripheral components.
- Wooden Frame – Supports the conveyor system and holds hardware in place.

## 3.2 SOFTWARE REQUIREMENTS

- Arduino IDE – Used to write, compile, and upload code to the ESP32 microcontroller.

- ESP32 Board Package & Libraries – Includes WiFi.h, Firebase_ESP_Client.h, MFRC522.h, LiquidCrystal_I2C.h, and Servo.h.
- Firebase Console – Used for storing and monitoring real-time data from the sorting system.
- Mobile App – Can be integrated later for remote monitoring of sorting logs.

## Code :

**https://github.com/pancham12345678/inventory_maintenance./tree/main**

# CHAPTER 4

# RESULTS AND DISCUSSIONS

The proposed Automated Inventory Verification and Tracking System was successfully designed, implemented, and tested using the ESP32-WROOM-DA microcontroller. The system automates the process of product verification, slot allocation, and inventory tracking, aiming to improve the efficiency of warehouse operations.

## Observed Output and System Functionality:

- When a product is placed on the conveyor, the first IR sensor detects its presence and activates the system from sleep mode.
- The RFID module reads the product's ID and sends it to the Firebase cloud database through Wi-Fi.
- If the product is authenticated, Firebase returns a slot number, which is displayed on the 16x2 LCD.
- As the product continues, the second IR sensor detects it again and triggers the servo motor to open the gate.

- The gate closes after the product passes, guiding it into its assigned slot for storage.

## Mobile App Support:

A custom-built Android application, developed using Kotlin and XML in Android Studio, is connected to Firebase. It provides live updates about the product's verification status, storage location, and availability, making the system user-friendly and accessible on smartphones.

## Performance Highlights:

- System Responsiveness: The ESP32 handled sensor inputs and cloud communication in real-time without noticeable delay.
- Automation Accuracy: Valid products were identified and placed accurately into assigned slots. Invalid products were effectively filtered.
- Power Efficiency: The sleep/wake feature helped minimize unnecessary power usage during idle periods.
- Cloud Integration: Firebase ensured real-time data sync between the microcontroller and mobile application.
- User Interaction: The LCD gave immediate feedback, and the mobile app extended the system's accessibility and control.

## Challenges and Opportunities for Improvement:

- The system currently supports one lane of product flow. Scalability to multiple conveyors could make it suitable for larger warehouses.
- Adding more precise sensors could further enhance product detection and handling.
- Incorporating a motorized conveyor belt would automate product movement more fully, rather than relying on manual placement.

The working model demonstrated consistent and reliable performance during testing, showing strong potential for real-world application in warehouse automation.


Figure 4.1 : Index page


Figure 4.2 : Inventory Details

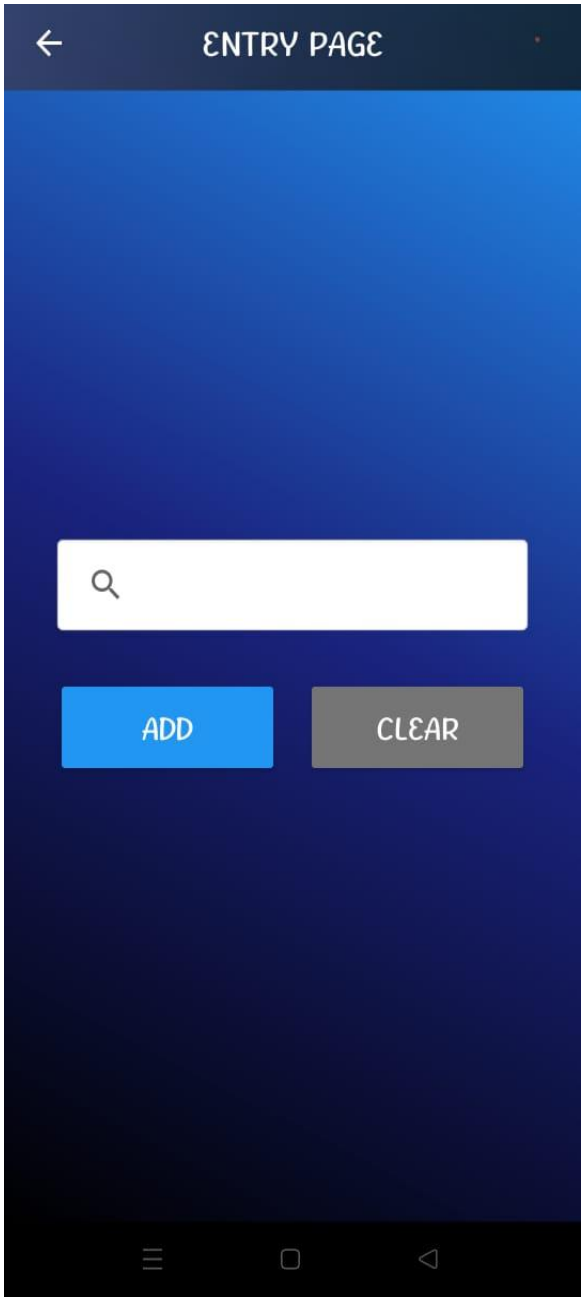


Figure 4.3 : Search Box

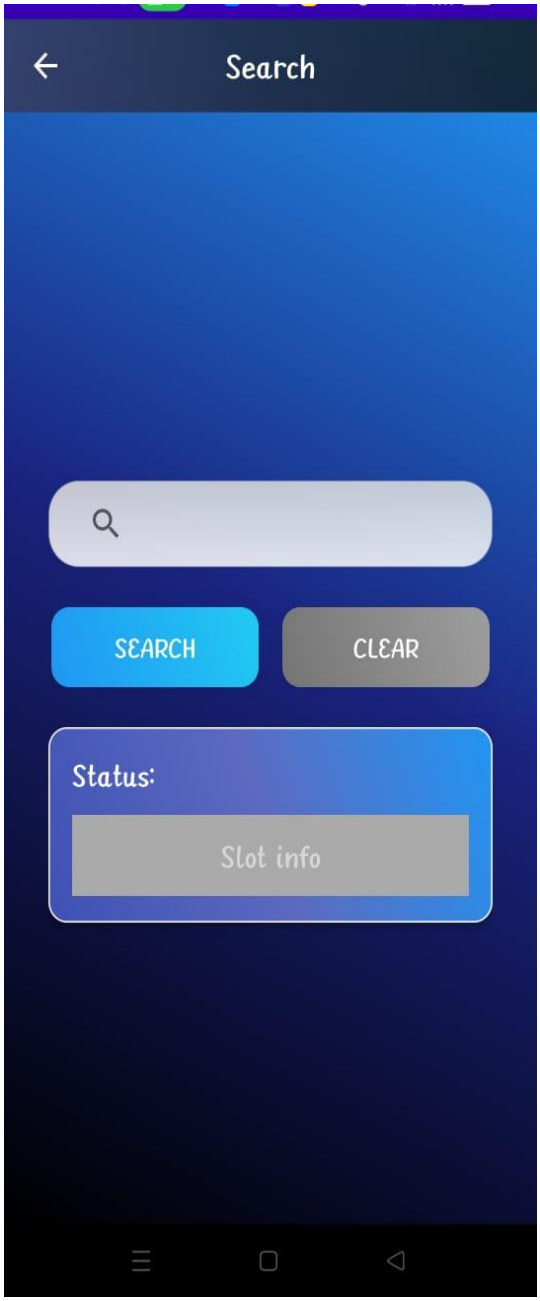


Figure 4.4 : Search Result

# CONCLUSION

The Automated Inventory Verification and Tracking System using the ESP32-WROOM-DA microcontroller successfully automates key warehouse tasks like product verification, slot allocation, and inventory tracking. By using RFID, Firebase, and a mobile app, the system reduces manual errors and makes warehouse operations more efficient.

The system worked well during testing, providing real-time updates on product status and accurately guiding items to their assigned storage slots. The mobile app allowed for easy tracking and management of inventory from anywhere.

While the system is effective for a single conveyor line, future improvements could include supporting multiple conveyors, adding more sensors for obstacle detection, and integrating a motorized conveyor for better speed control. These upgrades could make the system more adaptable for larger, more complex warehouse environments.

Overall, this project is a great starting point for warehouse automation and offers a scalable solution that could improve inventory management in real-world applications.

# REFERENCES

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[2] https://www.sciencedirect.com/science/article/pii/S2212827115012019