PROJECT REPORT

ON

SMART LAUNDRY BAG TRACKING SYSTEM

Submitted By

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1. Abstract

In large-scale hostel and laundry facilities, managing and locating individual laundry bags remains a challenging and time-consuming process. Manual tracking methods often lead to misplaced bags, delays, and frustration among users.

This project introduces a Smart Laundry Bag Tracking System that combines RFID technology, Pose Detection (Machine Learning), and Google Cloud Integration to automate and optimize the process.

Each laundry bag is tagged with a unique RFID identifier detected by a microcontroller-based reader system, while a MediaPipe-based camera module detects the worker's hand movement to determine the rack level (Top, Middle, Bottom) where the bag is placed.

All collected data — including bag ID, timestamp, and rack position — are uploaded to Google Cloud, enabling real-time access for students through a web dashboard.

The proposed system significantly enhances operational accuracy, reduces human error, and introduces digital transparency to laundry management.

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2. Introduction

Laundry management in large student hostels is a daily operation that often becomes inefficient due to manual handling. Hundreds of laundry bags arrive at the laundry room, and workers must sort, fold, and store them without any structured digital tracking. Since most bags look identical, they are frequently misplaced across different racks or shelves, leading to confusion and delays. Students often spend unnecessary time searching for their bags, especially during peak hours, which creates frustration for both students and staff.

To overcome these issues, this project introduces a Smart Laundry Bag Tracking System that integrates RFID technology, camera-based pose detection, and cloud connectivity. When a laundry bag reaches the counter, its RFID tag is instantly scanned and recorded. A camera then observes the worker placing the bag on the rack, and a pose detection model determines the exact shelf level—top, middle, or bottom. All this information is uploaded to the cloud and displayed on a student-friendly dashboard, allowing students to check their bag location instantly without physically searching through racks.

This automated approach reduces manual errors, ensures accurate storage tracking, and brings transparency and efficiency to the hostel laundry process.

3. Methodology

The Smart Laundry Bag Tracking System integrates hardware components, computer vision techniques, and cloud-based data management to automate the entire laundry tracking workflow. The complete operation is divided into three major stages, each performing a key function necessary for seamless tracking—from the moment a bag arrives at the folding station to the moment the student views its update on the dashboard.

3.1 Stage 1 – RFID Tag Detection

The first stage of the system involves RFID tag detection. Every laundry bag is assigned an RFID tag that carries a unique identification number. When the worker prepares the completed laundry for storage, the bag is brought close to the RFID reader fixed on the folding table. The RFID reader continuously scans its surroundings and immediately detects the presence of the tag once it enters the readable range. As soon as the tag ID is captured, the microcontroller processes the data, records the detection time, and sends the information to the cloud over Wi-Fi. This ensures that the bag is formally registered in the system before it is stored. The moment the ID is successfully uploaded to the cloud, the microcontroller triggers the second stage by activating the camera module, ensuring a seamless transition from identification to placement tracking.

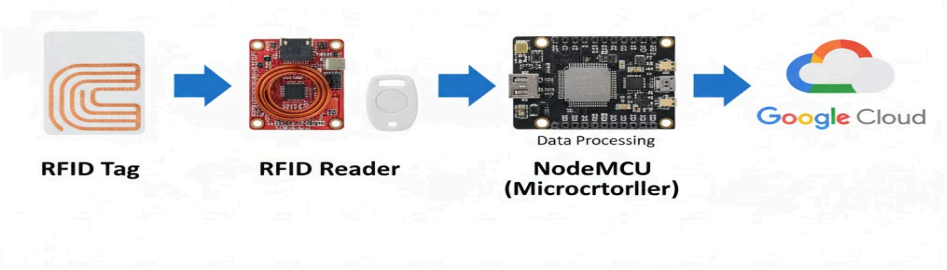

Fig 1:Workflow of RFID Tag Detection and Data Processing

3.2 Stage 2 – Pose Detection for Rack Level Identification

The second stage focuses on identifying the exact shelf level where the bag is placed using a pose detection model. After receiving the activation signal from the microcontroller, the camera begins recording the worker's movements as they approach the rack. The MediaPipe pose detection algorithm analyzes the live video feed, detecting key body landmarks such as the wrist, elbow, and shoulder. Among these, the wrist plays the most crucial role in determining the final placement level. The camera's field of view is divided into three horizontal sections corresponding to the top, middle, and bottom shelves of the rack. As the worker moves their hand while holding the bag, the system continuously tracks the wrist's vertical position. If the wrist appears in the topmost region, the placement is classified as Level 2; if it lies in the middle region, it is marked as Level 1; and if it appears in the lower region, it is identified as Level 0. To improve accuracy, the system confirms the placement only when the wrist remains within the same region for several consecutive frames, preventing incorrect results caused by fast or unstable movements. Once the shelf level is confirmed, the detected position is temporarily stored and prepared for cloud upload.

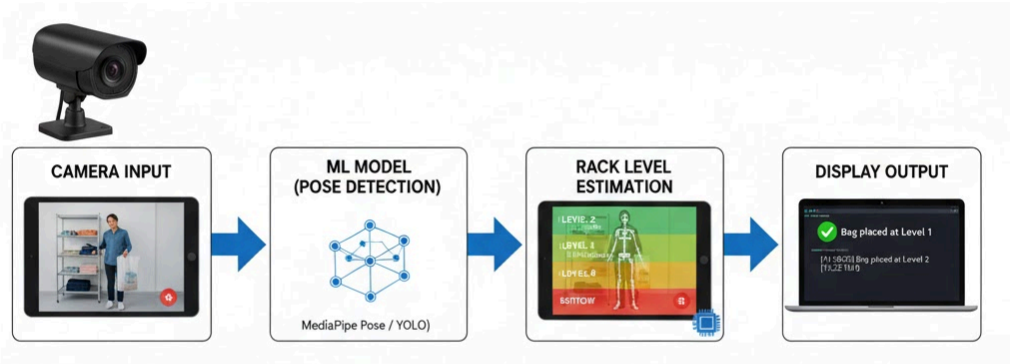

Fig 2: Rack Level Detection Process Using Camera and Pose Estimation

3.3 Stage 3 – Google Cloud and Dashboard Integration

The third stage of the system deals with cloud integration and dashboard synchronization. After both the RFID tag ID and the detected rack level are obtained, the system compiles the information into a structured data packet that contains the bag's unique ID, storage level, and timestamp. This packet is then uploaded to the Google Cloud database through secure communication protocols. The cloud server stores the information and keeps it accessible for retrieval by the student dashboard. The dashboard, built as a lightweight and user-friendly interface, continuously checks for updates from the cloud. When a student logs in, they are presented with the latest information regarding their laundry bag, including the exact shelf level where it is stored. This real-time visibility eliminates the need for physical searching and ensures that students can easily locate their bags without confusion or delay.

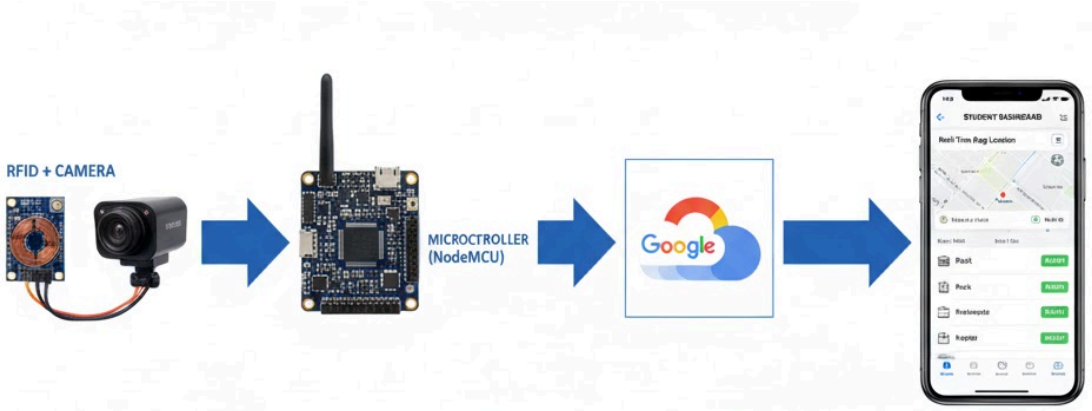

Fig 3:Overall Architecture of the Smart Laundry Tracking System

4. Overall Flow Diagram

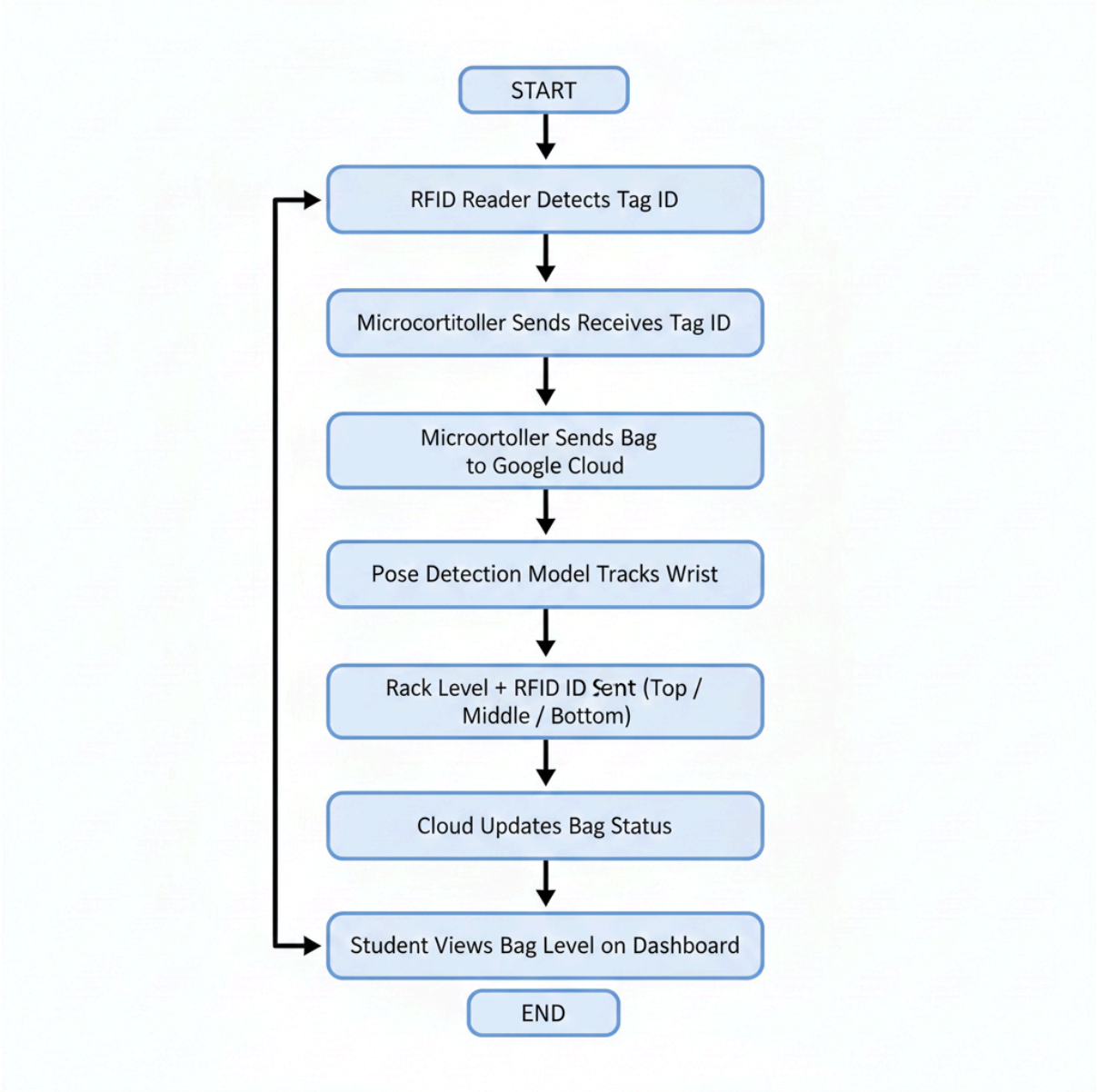

Fig 4: Overall Flowchart

5. Outcomes

The developed system demonstrated reliable and consistent results during testing. The RFID reader was able to detect and record tag IDs efficiently, even when multiple bags were processed consecutively. There were no instances of duplication or missed scans, indicating strong accuracy of the detection module. The pose detection model performed well under various conditions, consistently identifying wrist positions and correctly determining the corresponding rack levels. The system's stability mechanism significantly helped in preventing false detections, ensuring that the placement was recorded only when the worker's hand remained steady within a defined region. Once detected, the information was uploaded to the cloud almost instantly, and the dashboard reflected the update without delay. Students were able to view the exact shelf level of their laundry bags from their devices, demonstrating the effectiveness of the real-time tracking feature.

Fig 5: RFID and Tag Identification

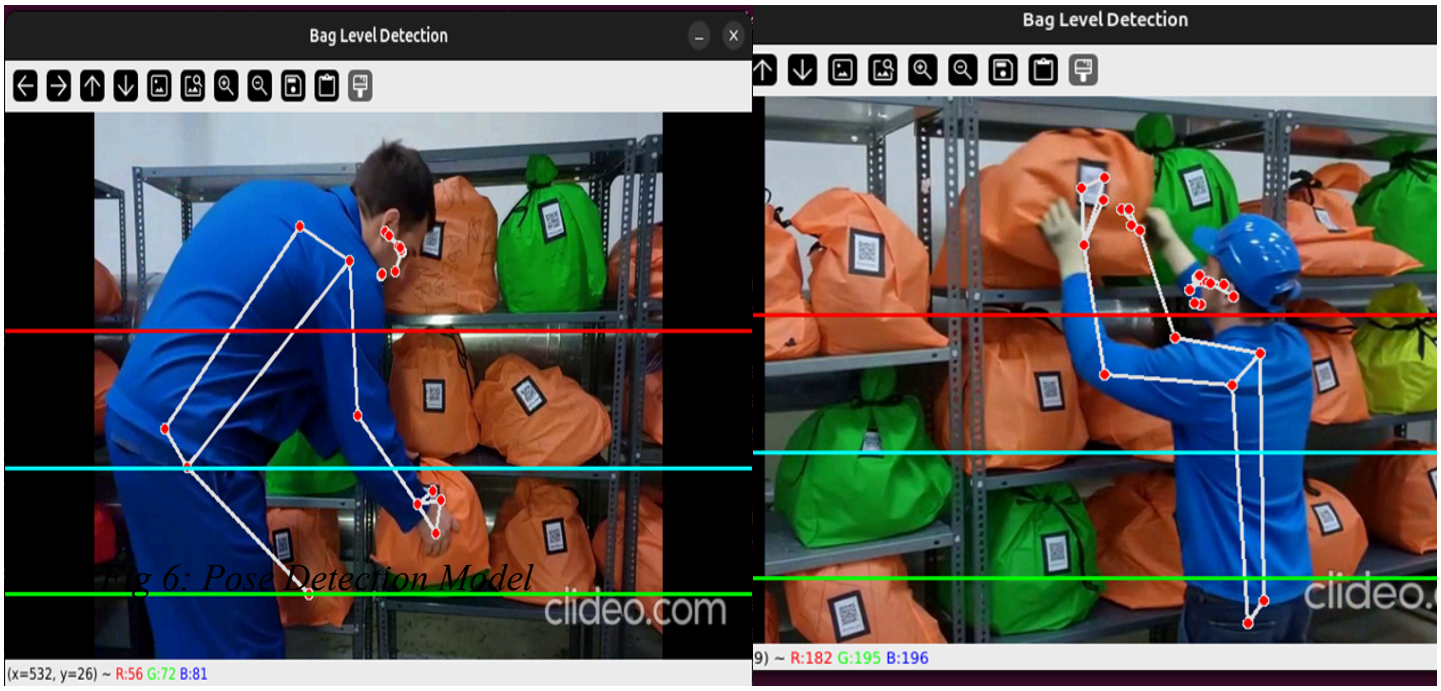

Fig 6: Pose Detection Model

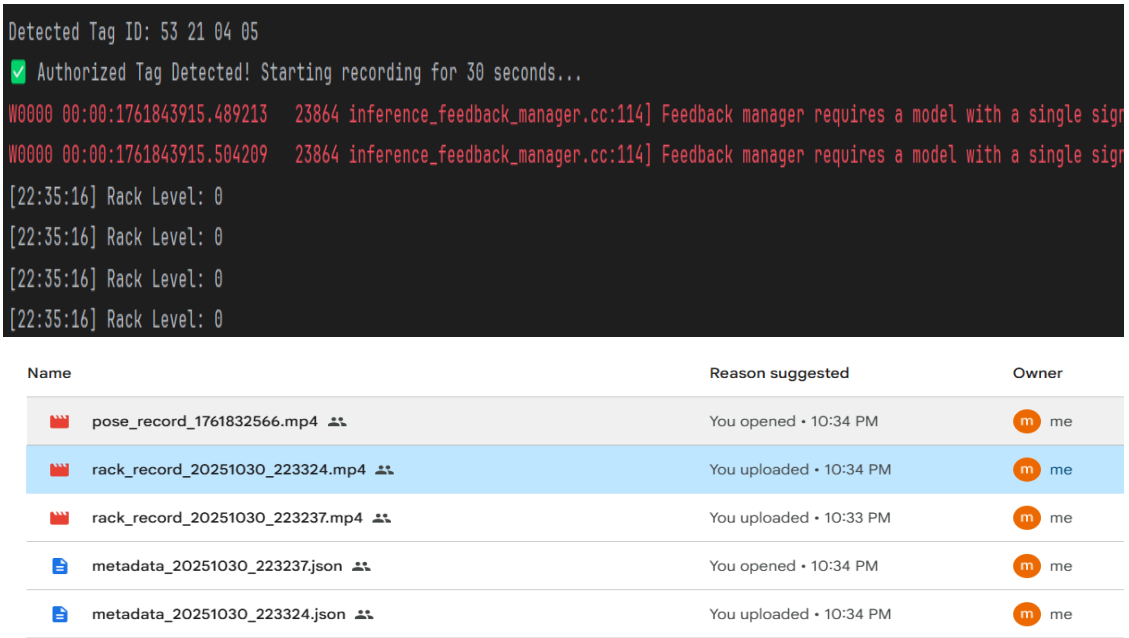

Fig 7: Google Cloud Data Upload and Dashboard Visualization

6. Results and Discussion

The Smart Laundry Bag Tracking System successfully proved its capability to automate the entire tracking process in a controlled test environment. The RFID module operated smoothly, reading tags within close proximity and generating precise time-stamped entries. The pose detection model exhibited strong performance, particularly in differentiating between the three shelf levels based on wrist movement. The introduction of stability checks further improved its reliability by reducing noise and avoiding premature level detection. The integration with Google Cloud enabled instantaneous data uploads, and the dashboard displayed updates with minimal latency. These results indicate that the system can significantly reduce the workload of laundry staff, improve operational efficiency, and eliminate the manual challenges faced by students searching for their laundry bags.

7. Conclusion and Future Scope

The Smart Laundry Bag Tracking System successfully solves the long-standing issue of misplaced bags and inefficient manual handling in hostel laundry rooms. By integrating RFID detection, pose-based shelf identification, and cloud synchronization, the system introduces automation and accuracy into the process.

For future improvements, the system can incorporate:

- More advanced AI models (like YOLO-based detection)
- Multi-camera setups for larger storage racks
- Mobile notifications
- Voice-assisted rack guidance

These enhancements can further strengthen the system and expand it to hospitals, hotels, and large laundry services.