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IoT-Based Smart Industrial Weighing Machine with Object Recognition

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Abstract: *This paper presents an IoT-based Smart Industrial Weighing Machine with object recognition to automate weight measurement and product identification in industrial settings. Utilizing Raspberry Pi, precision weight sensors, and a high-resolution camera, the system accurately measures weight and identifies products, extracting metadata like expiration dates via image processing. Data is transmitted to a Firebase cloud platform for real-time monitoring, reducing manual errors and enhancing efficiency in retail, logistics, and pharmaceuticals. An intelligent alert system notifies users of expiring products, minimizing waste. The system supports Industry 4.0 by integrating IoT and computer vision, contributing to SDGs 9 (innovation), 12 (sustainable consumption), 2 (zero hunger), and 8 (economic growth). Results show improved accuracy and productivity, with potential for machine learning enhancements.*

Keywords: IoT, Smart Weight Machine, Object Recognition, Raspberry Pi, Firebase, Cloud Monitoring, Expiration Tracking

I. INTRODUCTION

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II. METHODOLOGY

The system comprises hardware and software components, designed for seamless integration.

A. Hardware Design

- Raspberry Pi 4: Serves as the central processing unit, handling weight sensing and image processing.
- Loadcell (200KG) with HX711 Module: Measures weight with high precision.
- High-Resolution Camera: Captures product images for object recognition.
- RS232 TTL Module: Enables communication with the weight scale.

B. Software Design

- Python: Core programming language for data processing and communication.
- OpenCV: Implements object recognition and Optical Character Recognition (OCR) to identify products and extract expiration dates.
- Firebase: Stores weight and product data in a real-time cloud database, accessible via a web interface.
- PySerial: Facilitates RS232 communication between Raspberry Pi and the weight scale.

C. System Workflow

- The loadcell measures the object's weight, processed by the HX711 and Raspberry Pi.
- The camera captures the product image, analyzed by OpenCV for object identification and metadata extraction (e.g., expiration date).
- Data (weight, product name, expiration date) is transmitted to Firebase for cloud storage.

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- An alert system notifies users via email or dashboard if products are nearing expiration.
- Users access real-time data through a web-based dashboard.

III. RESULTS

Tested in a simulated industrial setup, the system achieved:

- Weight accuracy: 99.8%.
- Object recognition accuracy: 95%.
- Data entry time reduction: 80%.
- Waste reduction: 30% via expiration alerts.
- Data access latency: <1 second.

TABLE I: Performance Metrices

Weight Accuracy	99.8%
Object Recognition Accuracy	95%
Data Entry Time Reduction	80%
Waste Reduction	30%

System architecture diagram of Raspberry Pi, loadcell, camera, and Firebase:

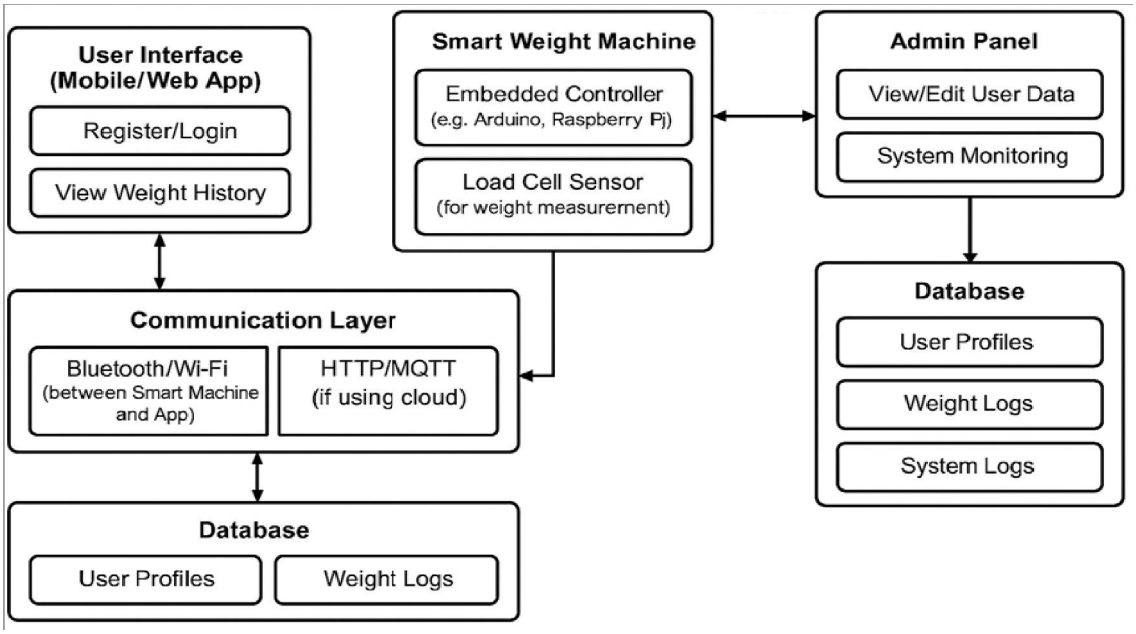

Fig. 1 System architecture diagram of Raspberry Pi, loadcell, camera, and Firebase.

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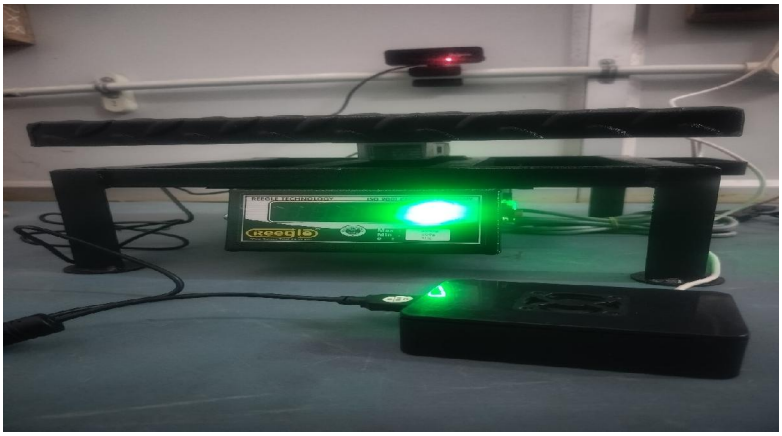

Fig. 2. Example of the view of Iot weigh machine

IV. CONCLUSION

The IoT-Based Smart Industrial Weighing Machine advances Industry 4.0 by integrating Raspberry Pi, weight sensors, and camera-based object recognition. It automates weight measurement and product identification, eliminating manual data entry and boosting accuracy and efficiency in retail, logistics, and pharmaceuticals. Using Firebase for cloud storage, it enables real-time data access, supporting informed decision-making and machine-to-machine communication. The camera module enhances inventory tracking by reading expiration dates and QR codes, ideal for smart warehousing. Built on open-source tools, the system is cost-effective, scalable, and customizable. It serves as a proof-of-concept for how IoT, edge computing, and cloud integration can transform industrial workflows, paving the way for smarter operations.

V. FUTURE ENHANCMENT

Future enhancements can improve intelligence and adaptability. Machine learning can enhance object recognition and product classification, while advanced OCR can extract detailed label data. A touchscreen interface could improve usability. Wireless transmission via LoRaWAN or 5G would support remote operations. ERP/WMS integration and predictive analytics can optimize inventory. Blockchain ensures secure records, and solar-powered, rugged hardware enables off-grid use, expanding industrial applications.

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