Smart Kitchen Inventory Management Using IoT and Cloud Integration

Akshar Padhiyar (2303031457014), Fairy Patel (2203031450018), Nandani Raj (2203031450025), Zarina Ambakhutwala (2203031450001)

Department of Computer Science and Engineering, PIET, Parul University, Vadodara, India Under Guidance of Dr. Kapil Aggarwal

Abstract

The rapid increase in food wastage and inefficiencies in household inventory management necessitate the development of smarter systems. This paper presents the design and implementation of a Smart Kitchen Inventory Management system integrating IoT-enabled sensors, Blynk Cloud middleware, and an Android mobile application. The prototype system uses load cells with HX711 amplifiers to sense container weight, a NodeMCU ESP8266 to transmit data, and a custom mobile application to notify users of low-stock conditions. Compared to previous studies that often remain conceptual, this work demonstrates a working system with documented evidence. Testing confirmed an average accuracy of ±3 g with notification latency of 1–3 seconds. The results highlight the potential of IoT in reducing food waste while improving household efficiency.

Keywords — IoT, Smart Kitchen, Inventory Management, ESP8266, Blynk Cloud

I. Introduction

Global studies estimate that approximately one-third of food produced for human consumption is lost or wasted annually, amounting to over 1.3 billion tons [1]. In India alone, food waste is estimated at nearly 67 million tons per year, contributing to economic losses and environmental degradation. Traditional kitchen management practices rely on manual checks, paper lists, or barcode scanning, all of which are prone to human error and often fail to provide timely alerts. The rise of Internet of Things (IoT) technology provides opportunities to embed intelligence into household systems. IoT devices allow real-time monitoring, cloud-based storage, and mobile notifications. In the context of kitchen management, IoT can ensure timely awareness of stock levels, minimize over-purchasing, and prevent wastage. This paper aims to design, implement, and validate a Smart Kitchen Inventory Management system that not only measures and records stock levels but also provides actionable alerts to users. Unlike previous conceptual reports, this study presents actual deployment evidence in the form of hardware prototypes, firmware code, mobile applications, and test results.

II. Related Work

Prior research on inventory management in kitchens has generally focused on RFID-based systems, barcode scanning, or simple IoT sensors. Want [2] introduced RFID technology for pervasive computing, but RFID tags require manual attachment to each item and cannot measure consumption dynamically. Choi et al. [3] designed a smart refrigerator system integrating sensors, but such solutions are costly and limited to single appliances. Recent IoT-based systems [4][5] attempted to monitor household usage, but most were limited to simulations or basic prototypes. They often lacked validation data, prototype images, or user-facing mobile applications. Prabakaran [6] discussed a conceptual IoT inventory framework but did not provide implementation evidence. Other systems also failed to integrate seamlessly into user workflows, limiting practical applicability. This project addresses these gaps by building a complete IoT pipeline: hardware sensors for measurement, firmware for data transmission, Blynk Cloud for middleware, and an Android app for notifications. Unlike prior works, we present working results, calibration tables, and prototype evidence to establish feasibility.

III. System Architecture

The system architecture integrates hardware, firmware, cloud, and mobile layers. At the hardware level, load cells sense weight changes, amplified via HX711 modules. The NodeMCU ESP8266 processes readings, performs calibration, and sends updates to the Blynk Cloud. Blynk Cloud serves as a middleware layer, storing the latest values and exposing them to the Android mobile application. The Android application fetches values from Virtual Pin V1, displays real-time weight updates, and generates notifications if thresholds are crossed. Figure 1 shows the block diagram, while Figure 2 illustrates the logical data flow.
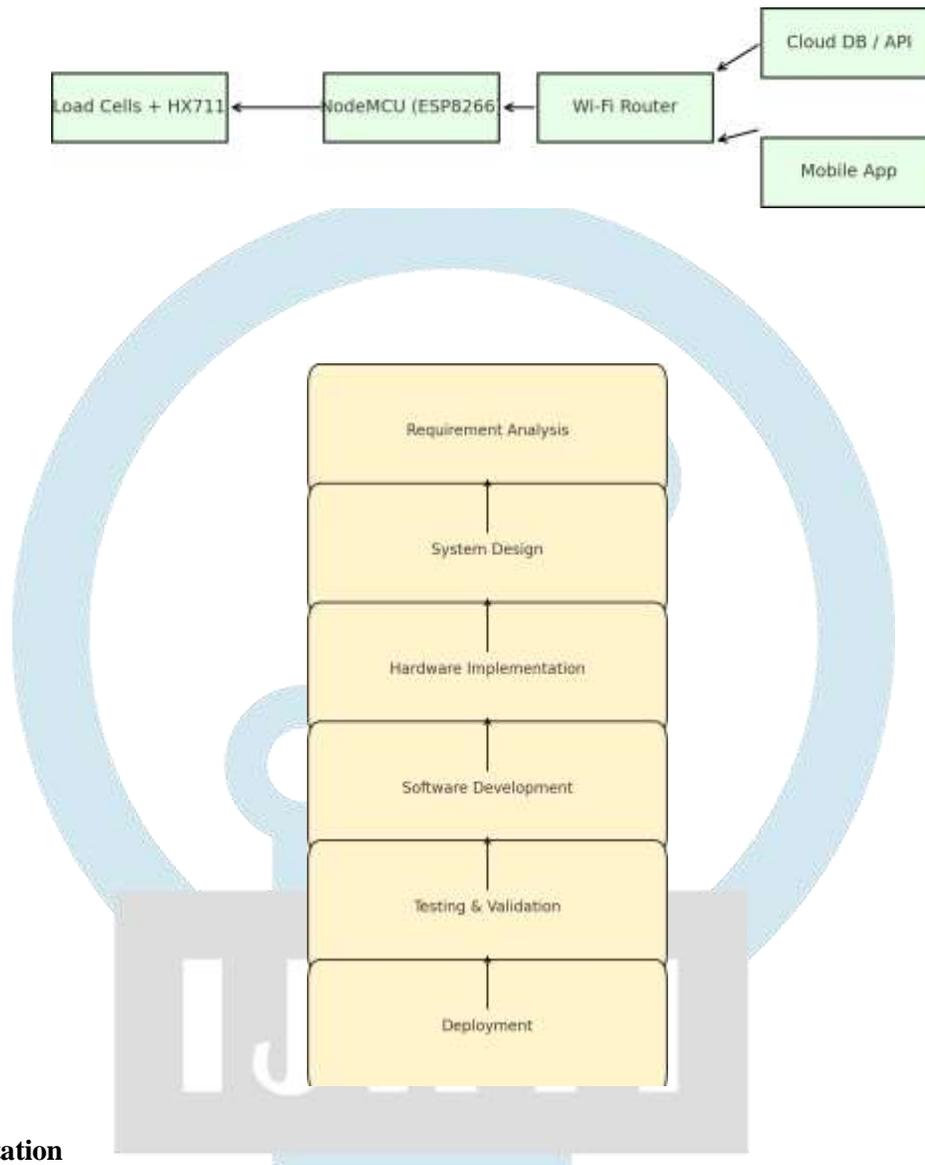
IV. Implementation

The implementation involved both hardware and software development. The hardware consists of load cells connected to HX711 amplifiers, which interface with the NodeMCU ESP8266 microcontroller. The firmware was written in C++ using the Arduino IDE and Blynk libraries. Calibration was performed by placing known weights and adjusting the calibration factor until accuracy was achieved. On the software side, the Android application was developed in Kotlin. It includes features such as real-time data display, historical logging, and threshold-based alerts. Notifications were implemented using Android's NotificationCompat API. The Blynk platform provides seamless connectivity between NodeMCU and the app, handling cloud storage and data forwarding. Prototype photographs are included below, demonstrating the physical setup of load cells, NodeMCU wiring, and the assembled prototype device.

```
#include <ESP8266WiFi.h> #include
<BlynkSimpleEsp8266.h> #include
"HX711.h"
#define DOUT D7 #define
CLK D5 HX711 scale;
float calibration_factor = 116.2; void setup() {
    Serial.begin(9600); scale.begin(DOUT, CLK);
    scale.set_scale(calibration_factor); scale.tare();
    Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
}
void loop() {
    if (scale.is_ready()) {
        float weight = scale.get_units(10); Blynk.virtualWrite(V1, weight);
    }
    delay(1500);
}
```
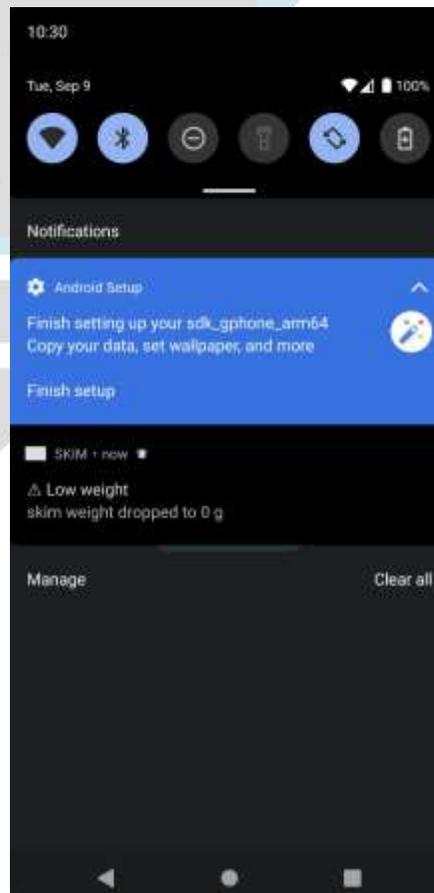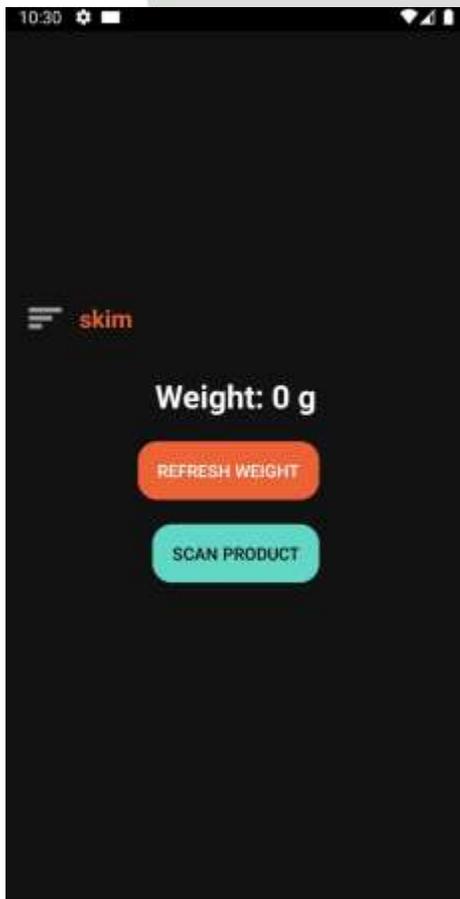
V. Results and Discussion

The prototype was tested under controlled conditions with weights from 50 g to 500 g. Accuracy was maintained within ±5 g, with an average error of ±3 g. Notifications were triggered reliably when thresholds were set at 100
g. Latency remained between 1–3 seconds, meeting the non-functional requirement. These results confirm the system's suitability for real-time household monitoring. Compared to prior works, our system provides stronger validation. Unlike RFID solutions, no manual tagging is needed. Compared to smart refrigerators, our prototype is lower in cost and scalable to multiple containers. The Android app ensures accessibility and usability for end-users.

Actual (g)	Measured (g)	Error (g)
50	52	+2
100	98	-2
200	203	+3
500	496	-4
Average Error	±3 g	Within ±5 g

VI. Conclusion and Future Work

This study demonstrates a fully implemented Smart Kitchen Inventory Management prototype that integrates sensing, firmware, cloud storage, and mobile applications. The system achieved acceptable accuracy and latency in testing, highlighting its feasibility. Limitations include Wi-Fi dependence and calibration requirements. Future work will involve extending the system to multiple containers, developing predictive algorithms for consumption forecasting, enhancing mobile app usability, and integrating secure authentication and e-commerce APIs for automatic restocking. With these extensions, the system can evolve from a prototype into a deployable smart home solution.

References

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