SMART MEDICINE REMINDER

A PROJECT REPORT

submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

RAJALAKSHMI ENGINEERING COLLEGE,

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MAY 2024

RAJALAKSHMI ENGINEERING COLLEGE, CHENNAI

BONAFIDE CERTIFICATE

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ABSTRACT

Medication non-adherence remains a critical challenge in healthcare, particularly among elderly and chronically ill patients, often leading to worsened health outcomes and increased healthcare costs. To address this issue, this project proposes the development of an integrated medication adherence system combining a smart pillbox and a wearable device, designed to improve compliance through real-time reminders, monitoring, and adaptive escalation. The methodology includes a literature review to guide system requirements, followed by design, prototype development, testing, and iterative refinement. The system features a smart pillbox equipped with proximity and motion sensors to track pill intake, a vibrating wristband for discreet reminders and basic health monitoring, and an escalation mechanism that initiates phone alerts if doses are missed. By leveraging IoT technologies and automated feedback, the system enhances adherence, reduces caregiver burden, and promotes patient safety. Future work will explore improvements in system scalability, integration with electronic health records, and broader deployment in home and clinical settings.

ACKNOWLEDGEMENT

First, we thank the almighty God for the successful completion of the project. Our sincere thanks to our chairman Mr. S. Meganathan, B.E., F.I.E., for his sincere endeavor in educating us in his premier institution. We would like to express our deep gratitude to our beloved Chairperson Dr. Thangam Meganathan, Ph.D., for her enthusiastic motivation which inspired us a lot in completing this project, and Vice-Chairman Mr. Abhay Shankar Meganthan, B.E., M.S., for providing us with the requisite infrastructure. We also express our sincere gratitude to our college principal, Dr.S.N.Murugesan M.E., PhD., and Dr. P. Kumar M.E., Ph.D., Head of the Department of Computer Science and Engineering, and our project guide Ms. S. Ponmani M.E.,MBA, for her encouragement and guiding us throughout the project. We would like to thank our parents, friends, all faculty members, and supporting staff for their direct and indirect involvement in the successful completion of the project for their encouragement and support

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CHAPTER 1

INTRODUCTION

Medication adherence is a critical element of effective healthcare, yet it remains a widespread challenge across all age groups, particularly among elderly patients and those with chronic conditions. Non-adherence to prescribed medication regimens often leads to worsening health outcomes, increased hospital visits, and rising healthcare costs. As the global population ages and the prevalence of chronic diseases increases, ensuring that patients take their medications as prescribed has become a growing priority for healthcare systems worldwide.

Traditional solutions, such as pill organizers, written schedules, and mobile alarm reminders, have attempted to address this issue but often fall short. These methods rely heavily on patient memory and discipline, offering little to no verification of whether medications were actually taken. For individuals with cognitive impairments or busy daily routines, these systems are frequently ignored, forgotten, or misused, leading to gaps in medication adherence that can compromise treatment outcomes and place additional strain on caregivers.

With the rapid development of emerging technologies, particularly the Internet of Things (IoT), new opportunities have emerged to create more reliable, automated adherence solutions. This study focuses on the design and development of a smart medication adherence system that integrates a smart pillbox, a vibrating wristband, and an emergency escalation feature. By combining sensor technologies, data processing algorithms, and real-time communication, the system provides layered reminders, monitors patient behavior, and offers caregiver support. Through literature review, requirements analysis, system design, prototype development, and testing, this study aims to demonstrate the system’s potential to significantly improve medication adherence and enhance overall patient care.

1.1 Motivation

Improving Medication Adherence: Medication non-adherence is a widespread problem that leads to poor health outcomes, increased hospitalizations, and higher healthcare costs. This project is motivated by the need to improve adherence through an integrated system that provides timely and reliable reminders, helping patients follow their prescribed treatment plans effectively.

Enhancing Patient Safety and Independence: Many patients, particularly the elderly and those with chronic conditions, struggle to manage medications on their own. By combining smart reminders, monitoring, and emergency escalation, the project aims to increase patient safety, reduce caregiver burden, and promote greater independence for individuals managing complex medication regimens.

Leveraging IoT and Smart Devices: The project harnesses the power of Internet of Things (IoT) technologies, including sensors, wearables, and data communication, to create an intelligent medication adherence system. This allows for real-time monitoring, automated reminders, and seamless communication, ensuring that medication intake is tracked and supported with minimal user effort.

1.2 Objectives

The primary aim of the *Medicine Reminder & Tracker* project is to develop a smart, reliable, and user-friendly system that ensures timely medication intake and supports overall health monitoring. The key objectives are:

Develop an IoT-Based Medication Adherence System: The primary objective is to design and implement a smart medication adherence system that combines reminder functions, intake verification, and emergency escalation to ensure timely and accurate medication intake.

Integration of Smart Devices and Sensors: Incorporate a smart pillbox equipped with proximity and motion sensors, along with a vibrating wristband, to monitor medication events. These devices will work together to detect medication intake, provide reminders, and track patient activity.

Data Monitoring and Alert Mechanisms: Develop an integrated monitoring system that collects and processes real-time data from connected devices. Implement algorithms that can detect missed doses, trigger follow-up reminders, and escalate alerts by notifying caregivers or initiating automated phone calls when necessary.

CHAPTER 2

LITERATURE REVIEW

[1] **Smart Medication Adherence System Using IoT**

This paper presents a smart medication adherence system leveraging IoT technology to help patients follow prescribed medication schedules. The system integrates smart pillboxes with sensors and mobile applications to provide reminders and track adherence. It emphasizes real-time monitoring and alerts for caregivers in case of missed doses, aiming to improve patient compliance and reduce healthcare risks.

[2] **A Wearable IoT-Based System for Medication Reminder and Monitoring**

The study proposes a wearable system equipped with vibration and sound alerts to remind patients to take their medications. It also includes a mobile application that records intake history and sends notifications to family members or healthcare providers. The system focuses on elderly patients and those with chronic diseases, aiming to improve adherence and reduce caregiver burden.

[3] **IoT-Enabled Smart Pillbox with Automatic Dispensing Mechanism**

This paper introduces an IoT-enabled smart pillbox that not only reminds users to take their medicine but also automates the dispensing of the correct dose at the scheduled time. The system uses cloud connectivity to update doctors and pharmacists about adherence patterns and enables remote configuration of medication schedules.

[4] **Real-Time Patient Monitoring and Medication Management System**

The paper proposes a comprehensive IoT healthcare system that integrates wearable sensors to monitor patient vital signs and smart devices to manage medication intake.

The system leverages cloud-based data analytics to detect abnormal health patterns and medication non-compliance, enabling proactive intervention by healthcare providers.

[5] **Design and Implementation of a Smart Medicine Box for Elderly Patients**
This research focuses on the design of a low-cost smart medicine box that provides visual and auditory reminders, records pill-taking events, and sends notifications to family members if a dose is missed. The system targets elderly patients living alone and aims to increase medication adherence while maintaining user-friendliness and affordability.

2.1 Existing System

2.1.1 Advantages of the existing system

While existing medication reminder systems have limitations, they still offer some advantages that have contributed to their widespread use, particularly among older adults and caregivers. These benefits include:

1. Simplicity and Accessibility

Manual systems such as alarms, written schedules, and pill organizers are easy to use and do not require technical knowledge. They are cost-effective and readily available, making them suitable for users with limited resources or digital literacy.

2. Low Cost

Most traditional solutions involve minimal investment. Basic alarms, mechanical pillboxes, or calendar-based tracking methods are inexpensive compared to advanced electronic devices or smart wearables.

3. Independence from Internet or Power

Manual systems do not rely on internet connectivity or frequent charging, making them highly reliable in areas with limited technological infrastructure or power supply issues.

4. Familiarity and Comfort

Older adults are often more comfortable using simple, non-digital tools that they are familiar with, reducing resistance to adoption and ensuring continued use.

2.1.2 Drawbacks of the existing system

Despite their simplicity and low cost, existing medication reminder systems have several critical limitations that reduce their effectiveness, especially for elderly patients or those with chronic conditions. These drawbacks include:

1. Lack of Intake Verification

Traditional reminders like alarms or basic apps can alert users, but they do not confirm whether the medicine has actually been taken. This can lead to skipped doses or accidental double dosing.

2. Easily Ignored or Forgotten

Auditory reminders such as phone alarms or buzzers can be missed, ignored, or silenced, especially by users with hearing impairments or memory issues. There is no secondary follow-up mechanism to ensure compliance.

3. No Escalation Mechanism

If a user misses a dose, current systems offer no automatic way to alert caregivers or trigger an emergency response. This puts patients at risk, particularly those who live alone or require close monitoring.

4. No Integration with Health Monitoring

Most existing systems do not monitor vital health parameters such as heart rate or body temperature, making it difficult to correlate medication adherence with the patient's health status.

5. Limited Customization

Manual pillboxes and simple reminder apps often lack flexibility to handle complex medication schedules (e.g., multiple medicines at different times of the day), which can lead to confusion and errors.

2.2 Proposed System

The *Medicine Reminder & Tracker* is a smart, integrated solution designed to improve medication adherence and health monitoring. It consists of two main components: a **smart pillbox** and a **vibrating wristband**.

Smart Pillbox

The pillbox provides scheduled beeping alerts using a real-time clock (RTC). It detects user presence through a **proximity sensor** and confirms medicine intake using a **motion sensor**. If no activity is detected within 15 minutes, the system automatically triggers a phone call via the **SIM800LGSM module** to alert caregivers or emergency contacts.

Vibrating Wristband

The wristband vibrates to discreetly notify the user of medicine time. It also monitors **heart rate** (MAX30102), **body temperature** (MLX90614), and **movement** (MPU6050). It syncs with the pillbox through **Bluetooth** to track activity and health in real time.

System Highlights

- Uses ESP32 and Arduino Nano 33 BLE Sense for control
- Battery-powered and portable
- Provides multi-sensory alerts
- Ensures medicine intake is verified and monitored
- Escalates missed doses with emergency calls

This system bridges the gap between reminders and real-time monitoring, offering a reliable solution for patients who need support managing their medications.

2.2.1 Advantages of the proposed system

 Automated Reminders with Escalation:

- Scheduled beeping alerts at medication times.
- Automatic escalation via phone call if the medicine isn't taken within 15 minutes.

 Multi-Sensory Notifications:

- Audio alerts (beeping).
- Tactile feedback via vibration on the wristband for discreet reminders.

 Intelligent Verification of Medicine Intake:

- Proximity sensor detects hand movement near the pillbox.
- Motion sensors track pillbox interaction to confirm medicine intake.
- Load cell verifies if pills were removed (optional).

 Health Monitoring Integration:

- The wristband continuously monitors **heart rate** and **body temperature**.
- Syncs health data with medication records for better patient monitoring.

 Activity Detection:

- Accelerometer on the wristband ensures the user is active and responsive, improving adherence data accuracy.

 Real-Time Adherence Tracking:

- Seamless data sync between the pillbox and wristband ensures that medication status is monitored in real time.

 Wireless Connectivity:

- Bluetooth-enabled components allow wireless communication between modules.

 Support for Cognitively Impaired or Elderly Users:

- Reduces dependence on memory or manual tracking.
- Emergency escalation increases safety.

 Portable and Rechargeable Design:

- Battery-powered with charging modules for continuous use.

CHAPTER 3

SYSTEM DESIGN

3.1Development Environment

3.1.1 Hardware Requirements

1. Microcontrollers and Processing Units

The system relies on two primary microcontrollers. The **ESP32** is used for the smart pillbox due to its powerful processing capabilities, integrated Wi-Fi and Bluetooth, and multiple GPIOs, which are essential for interfacing with various sensors and modules. For the wearable wristband, the **Arduino Nano 33 BLE Sense** is chosen as it is compact, energy-efficient, and has built-in Bluetooth Low Energy (BLE) capabilities. It also includes onboard sensors, but external modules are used for more accurate health monitoring.

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2. Smart Pillbox Hardware

The pillbox is equipped with several essential components. A **PIR motion sensor** detects the presence of a hand near the pillbox, serving as a trigger to stop the alarm and verify user interaction. A **load cell paired with an HX711 amplifier module** is used to detect changes in weight, confirming whether a pill has been removed. The **DS3231 Real-Time Clock (RTC) module** ensures precise scheduling of medicine alerts. For auditory notifications, a **buzzer module** is integrated to emit beeping sounds at designated times. To handle emergency scenarios, a **SIM800L GSM module** is included, enabling the system to make phone calls if the user fails to take the medicine within a certain timeframe (e.g., 15 minutes).

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3. Wristband Hardware

The wearable wristband is designed to complement the pillbox by providing discreet and continuous reminders and monitoring. A **vibration motor** is used to alert the user without disturbing others. To track the user's vital signs, the wristband incorporates a **MAX30102 pulse sensor** for heart rate monitoring and an **MLX90614 infrared temperature sensor** for measuring body temperature. Additionally, an **MPU6050 accelerometer and gyroscope** module is included to detect motion, which helps verify if the user is active or responding to alerts. A **Bluetooth module** (such as HC-05 or HC-06) is used for wireless communication with the pillbox, ensuring real-time synchronization of reminders and adherence tracking.

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4. Power Supply

Both the pillbox and wristband are powered by **3.7V Li-ion rechargeable batteries (1000mAh or higher)** to ensure portability. These batteries are charged using **TP4056 charging modules**, which offer safe and efficient charging with overcharge protection.

For longer testing sessions or deployment without frequent charging, a **12V adapter or power bank** can be used as a supplementary power source.

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5. Additional Components

To assemble and prototype the system, standard **jumper wires and breadboards** are used for making electrical connections. In the final product, a **custom PCB** or a suitable **enclosure** may be designed to integrate all components securely and make the system user-friendly, durable, and compact.

3.1.1 Software Requirements

1. Arduino IDE

2.Tinkercad

3.Serial Monitor

4.Optional: Visual Studio Code + PlatformIO

CHAPTER 4

PROJECT DESCRIPTION

4.1 SYSTEM ARCHITECTURE

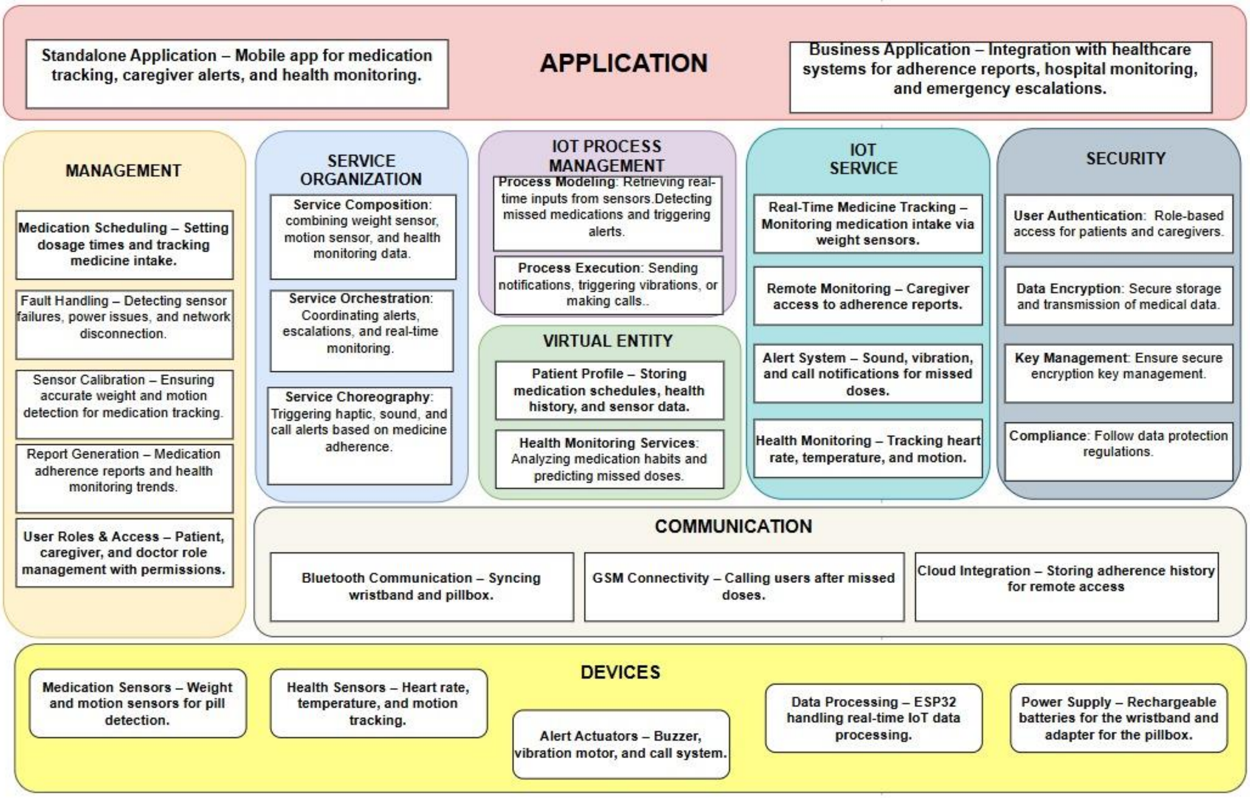

Fig 4.1 System Architecture

4.2 METHODOLOGY

The methodology used in the development of the smart medicine reminder and tracker involves an integrated system combining a smart pillbox and a vibrating wristband to ensure timely medication intake, monitoring, and verification.

The smart pillbox uses a proximity sensor to detect when a user's hand approaches and motion tracking to confirm if the medicine is taken. If no action is detected within 15 minutes, the system escalates the reminder by initiating an emergency phone call.

The wristband provides discreet vibration alerts and continuously monitors heart rate and body temperature for general health tracking. It also detects movement to confirm activity and syncs with the smart pillbox for real-time adherence tracking.

The system architecture includes:

Standalone Application: A mobile app for medication tracking, caregiver alerts, and health monitoring.

Business Application: Integration with healthcare systems for adherence reports, hospital monitoring, and emergency escalations.

IoT Service: Real-time medicine tracking via weight sensors and remote monitoring for caregiver access.

IoT Process Management: Processing real-time inputs from sensors to detect missed medications and trigger alerts.

Virtual Entity: Storing patient profiles, medication schedules, health history, and sensor data.

Security: User authentication, data encryption, key management, and compliance with data protection regulations.

The system utilizes various components such as microcontrollers, sensors, and modules for the pillbox and wristband, including:

ESP32 and Arduino Nano 33 BLE Sense microcontrollers.

PIR Motion Sensor, Load Cell + HX711 Module, Buzzer Module, SIM800L GSM Module, and DS3231 RTC Module for the pillbox.

Vibration Motor, MAX30102 Pulse Sensor, MLX90614 Temperature Sensor, MPU6050 Accelerometer, and a Bluetooth Module for the wristband.

The working mechanism involves scheduling medication, user interaction with the pillbox, alert notifications, detection of intake, and phone call reminders if necessary.

CHAPTER 5

RESULTS AND DISCUSSION

Results:

Improved Adherence: The system *expects* to improve medication adherence by addressing the shortcomings of the existing systems. The smart pillbox and wristband are designed to ensure timely intake through multi-sensory reminders and real-time monitoring.

Effective Reminders & Escalation: The system *anticipates* that the combination of beeping alerts, vibration, and emergency phone calls will effectively remind users to take their medication and prevent missed doses.

Accurate Monitoring: The system *intends* to accurately monitor medication intake using proximity and motion sensors in the pillbox and motion detection in the wristband.

Enhanced Safety: The system *aims* to enhance patient safety through the escalation feature, ensuring that caregivers are notified if a dose is missed.

Integrated Health Data: The system *plans* to provide integrated health data by monitoring heart rate and body temperature, potentially offering a more holistic view of the patient's condition.

Discussion:

Addressing Limitations of Existing Systems: The PDF frames the proposed system as a solution to the limitations of manual tracking, limited escalation methods, lack of verification, and absence of health monitoring in current practices. The discussion is centered on how the smart pillbox and wristband overcome these issues.

Importance of Integration: The PDF emphasizes the importance of an integrated approach combining reminders, monitoring, and verification to achieve proper medication adherence. The discussion highlights how the system's components work together to provide a comprehensive solution.

Technology's Role in Healthcare: The PDF implicitly discusses the role of technology in improving healthcare outcomes, particularly for patients requiring regular medication and monitoring. The use of sensors, IoT, and mobile applications is presented as a way to enhance adherence, safety, and efficiency.

Potential for Improved Patient Care: The PDF suggests that the system has the potential to improve patient care by providing timely reminders, reducing the risk of missed doses, and enabling better monitoring of both medication intake and health status.

It's crucial to remember that this is a "pre-results" discussion. A true Results and Discussion would require testing the system and analyzing the data obtained.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion

The proposed smart medicine reminder and tracker system offers a comprehensive solution to address the challenges of medication adherence. By integrating a smart pillbox with timely reminders and a vibrating wristband for discreet alerts and health monitoring, the system aims to improve the reliability of medication intake, provide effective escalation mechanisms, and ensure accurate monitoring. The system's architecture, incorporating IoT technology, a mobile application, and integration with healthcare systems, further emphasizes its potential to enhance patient care and safety.

6.2Future work

Refinements to the system's algorithms could enable more accurate predictions of when users are likely to miss a dose. Integrating the system with Electronic Health Record (EHR) systems would streamline data sharing and improve care coordination. Offering greater customization of reminders and alerts would cater to individual user preferences. Further exploration of advanced sensor technologies could enhance the precision of medication intake detection. Efforts to improve the system's user interface and accessibility, particularly for elderly users, are warranted. Finally, conducting long-term studies to validate the system's effectiveness in improving medication adherence and analyzing medication habits to predict missed doses, along with developing health monitoring services that include tracking heart rate, temperature, and motion, would provide valuable insights and further refine its capabilities.

APPENDIX

SOFTWARE INSTALLATION

Installation of arduino 2.3.4:

To install Arduino 2.3.4, begin by downloading the appropriate installer file from the official Arduino website. Once the download is complete, run the installer and carefully review and agree to the license terms presented. Next, proceed to choose the desired installation location on your computer's file system. During the installation process, ensure that you install any necessary drivers, as prompted by the installer. Finally, after the installation is finished, you can launch the Arduino IDE to begin using it

Sample code

```
#define BLYNK_TEMPLATE_ID "TMPL3nmv78uvy"
#define BLYNK_TEMPLATE_NAME "weight data"
#define BLYNK_AUTH_TOKEN "drTiz32gvKPCLoYsF06JLn5PqT6Lxg5h"

#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
#include "HX711.h"

// WiFi credentials
char ssid[] = "Galaxy A54 5G AA3F";
char pass[] = "hellsyea";

// Pin definitions
const int motorPin = 27;
const int LOADCELL_DOUT_PIN = 5;
const int LOADCELL_SCK_PIN = 18;

HX711 scale;
BlynkTimer timer;
```

```
// Motor control from Blynk button on V1
BLYNK_WRITE(V1) {
  int value = param.asInt();
  Serial.print("Motor Button Value: ");
  Serial.println(value);
  digitalWrite(motorPin, value);
}

// Send weight to Blynk gauge on V2
void sendWeight() {
  if (scale.is_ready()) {
    float reading = scale.get_units(5);  // Take average of 5 readings
    if (isnan(reading) || isinf(reading)) {
      Serial.println("Invalid weight reading.");
      return;
    }
    Serial.print("Weight: ");
    Serial.println(reading, 2);
    Blynk.virtualWrite(V2, reading);
  } else {
    Serial.println("HX711 not ready.");
  }
}

void setup() {
  Serial.begin(115200);
  pinMode(motorPin, OUTPUT);
  digitalWrite(motorPin, LOW);  // Make sure motor is off at start

  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);

  // Wait until HX711 is ready
  Serial.println("Waiting for HX711...");
  while (!scale.is_ready()) {
    Serial.println("HX711 not connected or not ready.");
    delay(1000);
  }

  // Tare scale
  Serial.println("Taring the scale...");
  scale.tare();

  // Calibration
```

```
  Serial.println("Place a known 30g weight on the scale...");
  delay(5000);  // Give you time to place the weight

  float raw = scale.get_units(10);
  if (isnan(raw) || isinf(raw) || raw == 0) {
    Serial.println("Calibration failed. Check load cell and try again.");
    return;
  }

  float scaleFactor = raw / 30.0;  // 30g known weight
  Serial.print("Raw average: ");
  Serial.println(raw, 2);
  Serial.print("Calculated scale factor: ");
  Serial.println(scaleFactor, 4);

  scale.set_scale(scaleFactor);   // Save the scale factor

  // Start weight readings every second
  timer.setInterval(1000L, sendWeight);
}

void loop() {
  Blynk.run();
  timer.run();
}
```

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