1. Project Proposal

Student Information

- **Name: Mustafa Özger**
- **Student ID: 20210808054**

Project Title

Smart Food Container Fill Level Monitoring and Notification System

Project Description

This project aims to develop an IoT-based system that monitors the fill level of a food container along with its internal temperature and humidity parameters. The system will trigger mobile notifications when the food container reaches a critical fill level or when the temperature exceeds a predefined threshold. Visual status indicators are provided via an OLED display and an RGB LED, which will show red for critical, yellow for moderate, and green for normal conditions.
The project leverages an ESP32 microcontroller to interface with an ultrasonic distance sensor, a DHT22 temperature/humidity sensor, an LDR light sensor, an OLED screen, an RGB LED, and a relay module to manage sensor activation based on ambient light conditions. The following simple system architecture diagram illustrates the planned setup:

Components Used

- **Hardware:**
    - **ESP32 Development Board**
    - **Ultrasonic Distance Sensor**
    - **LDR Light Sensor**
    - **DHT22 Temperature and Humidity Sensor**
    - **OLED Display**
    - **RGB LED (red, green, blue)**
    - **Relay Module**
    - **Breadboard, jumper wires, resistors**

Expected Outcome and Challenges

- **Expected Outcomes:**
    - Accurate measurement of the food container's fill level and its internal temperature/humidity.
    - Visual feedback through the OLED display and RGB LED based on critical (red), moderate (yellow), or normal (green) states.
    - Real-time mobile notifications sent via WiFi when a critical condition is detected.

    - Prevention of false alarms by using the LDR to disable the distance sensor when ambient light conditions exceed a set threshold.

- **Challenges and Solutions:**
    - Sensor Calibration:
      Each sensor must be calibrated to provide accurate readings. This can be addressed by iterative testing and fine-tuning threshold values.
    - Wiring and Connection Issues:
      Ensure reliable connections by testing individual sensors on a breadboard before finalizing the assembly. Consider moving to a soldered PCB for long-term reliability.
    - WiFi Connectivity:
      Provide a stable WiFi environment for the ESP32 and implement error handling to manage connectivity issues.
    - Relay Control Integration:
      Carefully test the integration between the LDR sensor and the relay module to ensure that false triggers are minimized.

GitHub Repository Link

https://github.com/mustafaozger/SmartFoodContainer

---

2. Project Report

Introduction

Effective monitoring of food containers is essential for ensuring proper storage conditions and timely refilling or maintenance. Traditional methods of monitoring container fill levels and environmental conditions can be inefficient and labor-intensive. By leveraging IoT technologies, this project introduces an automated solution that monitors fill levels, temperature, and humidity inside food containers while triggering notifications for timely intervention. This project serves as a practical application of IoT in enhancing operational efficiency and reducing manual oversight in food storage management.

System Architecture

The system is built around the ESP32 microcontroller, which serves as the central control unit. The key components include:

- **Sensors:**
    - Ultrasonic Distance Sensor: Measures the fill level of the food container.
    - DHT22 Sensor: Monitors the internal temperature and humidity.
    - LDR Light Sensor: Detects ambient light levels to control sensor activation.
- **Output Devices:**
    - OLED Display: Provides local, real-time data visualization.

    - RGB LED: Offers visual status indicators (red, yellow, green) based on sensor readings.

- **Control Unit:**
    - Relay Module: Manages the operational state of the distance sensor based on LDR input.
- **Communication:**
    - The ESP32's built-in WiFi module enables data transmission to an IoT platform and mobile devices for remote monitoring and notifications.

Implementation Details

- **Hardware Setup:**
  Sensors, the RGB LED, OLED display, and relay module are connected to designated pins on the ESP32. The connections are initially prototyped on a breadboard, with plans to transfer the circuit to a more permanent setup after successful testing.
- **Sensor Integration:**
    - Ultrasonic Sensor: Utilizes trigger and echo pins to measure distance.
    - DHT22: Reads temperature and humidity data via a digital pin.
    - LDR: Connected in a voltage divider configuration to perform analog readings.
- **Communication Protocols:**
  The ESP32 communicates sensor data over WiFi using HTTP requests or through an IoT platform such as Blynk. Relevant libraries and APIs are integrated into the system for efficient data transmission.
- **Data Analytics:**
  Incoming sensor data is evaluated against predefined thresholds. When critical conditions are detected (e.g., food container fill level below a certain distance or temperature exceeding a set point), notifications are triggered, and data is displayed locally.
- **Security Measures:**
  The WiFi communication is secured by proper configuration of network settings, and sensor data integrity is ensured through error-checking routines.

Results and Analysis

- **Testing Phases:**
  Each sensor was individually tested to ensure accuracy and reliability. The OLED display and RGB LED provided clear visual feedback on system status.
- **Data Presentation:**
  Real-time sensor data (distance, temperature, humidity, light level) is successfully displayed on the OLED screen.
- **Notification System:**
  The RGB LED indicates system status based on set thresholds (red for critical, yellow for

moderate, green for normal), and mobile notifications are sent via WiFi during critical events.

- **Analysis:**
  Test results confirm that the system accurately monitors the food container's condition, and the integration of the LDR effectively minimizes false alarms by disabling the distance sensor under high ambient light conditions.

Conclusion

This project successfully demonstrates an IoT-based solution for monitoring and managing food container conditions. The ESP32-based system integrates multiple sensors and output devices to provide real-time, actionable data. Future enhancements may include cloud-based analytics and more sophisticated alert mechanisms to further improve system performance and reliability.

References

1. **ESP32 Arduino Core**
2. **Blynk**
3. **Firebase**

---

3. Project Presentation

Oral Presentation

The presentation will summarize the project's objectives, methodology, and implementation details. It will cover:

- The motivation behind using IoT for efficient food container management.
- An overview of the hardware and software components.
- A detailed walkthrough of the integration and testing phases.
- A discussion on the challenges encountered and the solutions implemented.
- A summary of the results and the overall impact of the project.

Demonstration

- **Live Application Demo:**
  Real-time sensor data will be displayed on the OLED screen, while the RGB LED indicates the current status (red, yellow, green). Additionally, the mobile notification system will be showcased to demonstrate remote alert functionality.
- **Prototype Functionality:**
  The working prototype will be presented, highlighting the seamless integration of sensors, relay control, and WiFi communication via the ESP32.

Implementation

- **Code and Circuit Explanations:**
  Detailed explanations of the source code, circuit diagrams, and sensor integration will be provided.
- **GitHub Repository Tracking:**
  The project's source code and development progress will be maintained on the GitHub repository, allowing stakeholders to follow updates and improvements.

SYSTEM ARCHİTECTURE DIAGRAM