EEE 416 - Microprocessor and Embedded Systems Laboratory

January 2023 Level-4 Term-1 Section A2

Final Project Demonstration

IoT Based Smart Egg Hatching System

SUBMITTED BY – GROUP A2.08

Al Amin Hossain
1806055

Fardin Ahmed
1806056

Biswas Rudra Jyoti Arka
1806058

Yeaz Mahmud
1806065

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Outline

1. Abstract

The "IoT Based Smart Egg Hatching System" is an innovative project aimed at revolutionizing traditional egg hatching methods by leveraging the power of the Internet of Things (IoT) technology. The system's primary objective is to enhance the efficiency and success rate of egg incubation processes while providing real-time monitoring and control to hatchery operators. Integrating smart sensors and IoT devices, the system will continuously collect and analyze crucial environmental parameters such as temperature, humidity, ensuring optimal conditions for egg development. Through a user-friendly web or mobile interface, hatchery managers can remotely access data, adjust settings, and receive instant alerts, thereby fostering an intelligent and automated egg hatching process.

2. Introduction

In the world of poultry farming, the process of egg incubation is a critical juncture that directly impacts the productivity and sustainability of the industry. Traditional methods often involve manual monitoring, leading to inconsistent results, resource wastage, and inefficiencies. The "IoT Based Smart Egg Hatching System" was conceived to address these challenges by harnessing the power of technology.

3.1 Design: Problem Formulation (PO(b))

3.1.1 Identification of Scope

- **Optimization:** Focus on enhancing egg incubation through precise environmental control.
- **IoT Integration:** Implement IoT technology for real-time monitoring and control.
- **User Interface:** Develop a user-friendly Android app (Blynk) and local control via an LCD/LED display with buttons.
- **Data Analytics:** Collect and analyze key parameters for data-driven decision-making.
- **Remote Access:** Enable remote management through IoT server (Blynk).
- **Feedback:** Gather user input and conduct evaluations for system refinement.

3.1 Design: Problem Formulation (PO(b))

3.1.2 Literature Review

- **Traditional Incubation Challenges:** Conventional egg incubation methods suffer from manual monitoring, leading to inconsistent hatch rates and resource inefficiencies.
- **IoT in Agriculture:** IoT technology has been successfully applied in agriculture, offering real-time monitoring, automation, and data-driven decision-making.
- **Smart Incubation Systems:** Existing studies showcase the potential of IoT-based smart incubation systems to optimize environmental parameters, resulting in improved hatch rates.
- **Blynk and IoT Servers:** Literature highlights the effectiveness of platforms like Blynk and IoT servers (Firebase, ThingSpeak) in facilitating remote monitoring and control.
- **Environmental Data Analytics:** Data analytics of incubation parameters play a crucial role in ensuring precise control and better decision support.

3.1 Design: Problem Formulation (PO(b))

3.1.3 Formulation of Problem

- **Manual Incubation Issues:** Manual egg incubation lacks precision, resulting in inconsistent hatch rates and resource wastage.
- **Environmental Control Challenge:** Maintaining optimal temperature and humidity levels is crucial for successful incubation.
- **Automation Solution:** The project aims to address these challenges by introducing IoT technology to automate and optimize the incubation process.
- **User-Friendly Control:** We aim to provide a user-friendly interface for hatchery operators to monitor and adjust parameters efficiently.

3.1 Design: Problem Formulation (PO(b))

3.1.4 Analysis

- **Industry Relevance:** The poultry industry's growth demands advanced incubation solutions for enhanced productivity and sustainability.
- **Technological Advancement:** Leveraging IoT technology offers precise control, real-time monitoring, and data-driven decision-making.
- **User-Centric Approach:** Incorporating user feedback ensures practicality and usability in a real-world hatchery environment.
- **Economic Impact:** Optimized hatch rates and resource efficiency contribute to cost reduction and profitability.
- **Environmental Sustainability:** Improved incubation practices align with sustainability goals by reducing resource wastage.

3.2 Design Methods (PO(a))

3.2.1 Components Used

- ESP-WROOM-32 Development Board
- DHT11 Temperature and Humidity Sensor
- Relay module 5v 4 channel
- Heating Bulb (25W)
- Cooling Fan
- Humidifier
- SG90 Servo Motor
- OLED Display
- 3D Printed Egg Tray
- Led Lamp
- Switch
- Mini Breadboard
- Wires
- 5V 2A Power Adapter
- PVC Board
- Acrylic Sheet

3.2 Design Methods (PO(a))

3.2.2 Used Microcontroller

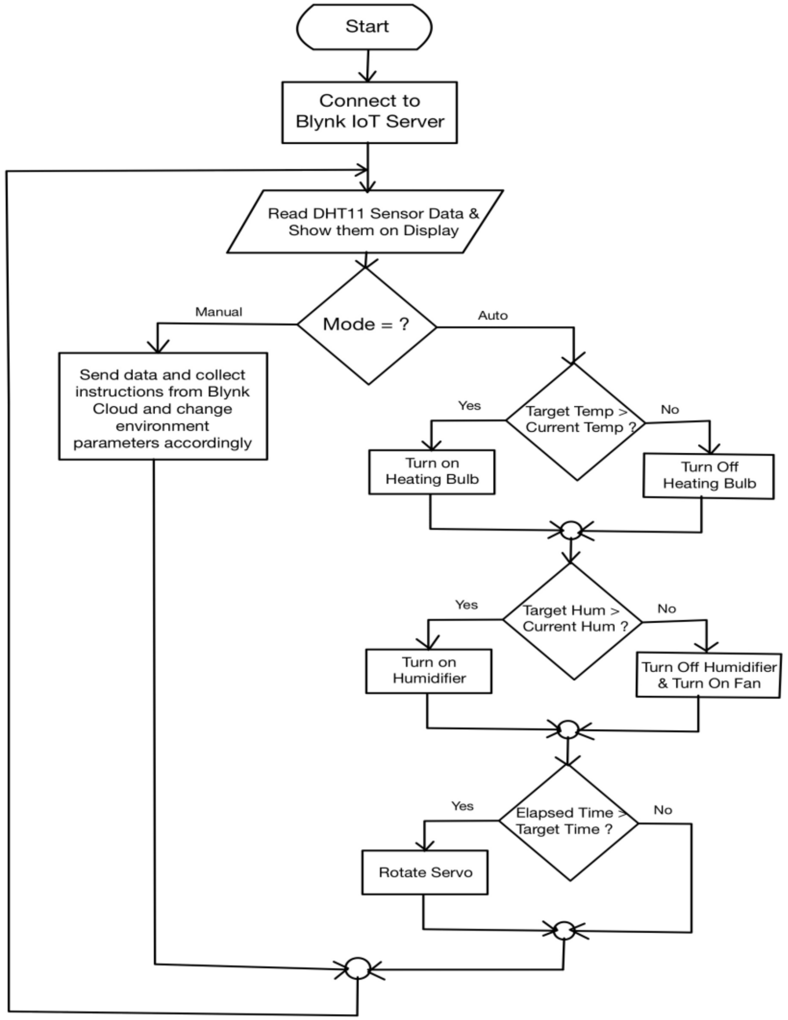
ESP-WROOM-32 Development Board

- Processor：32bit dual-core 240 MHz Tensilica LX6
- SRAM：520 KB; Flash：16 MB
- Wi-Fi Standard : FCC/CE/TELEC/KCC
- Wi-Fi Protocol：802.11 b/g/n/d/e/i/k/r
- Bluetooth Protocol：BLEv4.2 BR/EDR
- Supply Voltage: 2.2V～3.6V
- Operating temperature: -40°C～85°C
- Operating current: 80mA

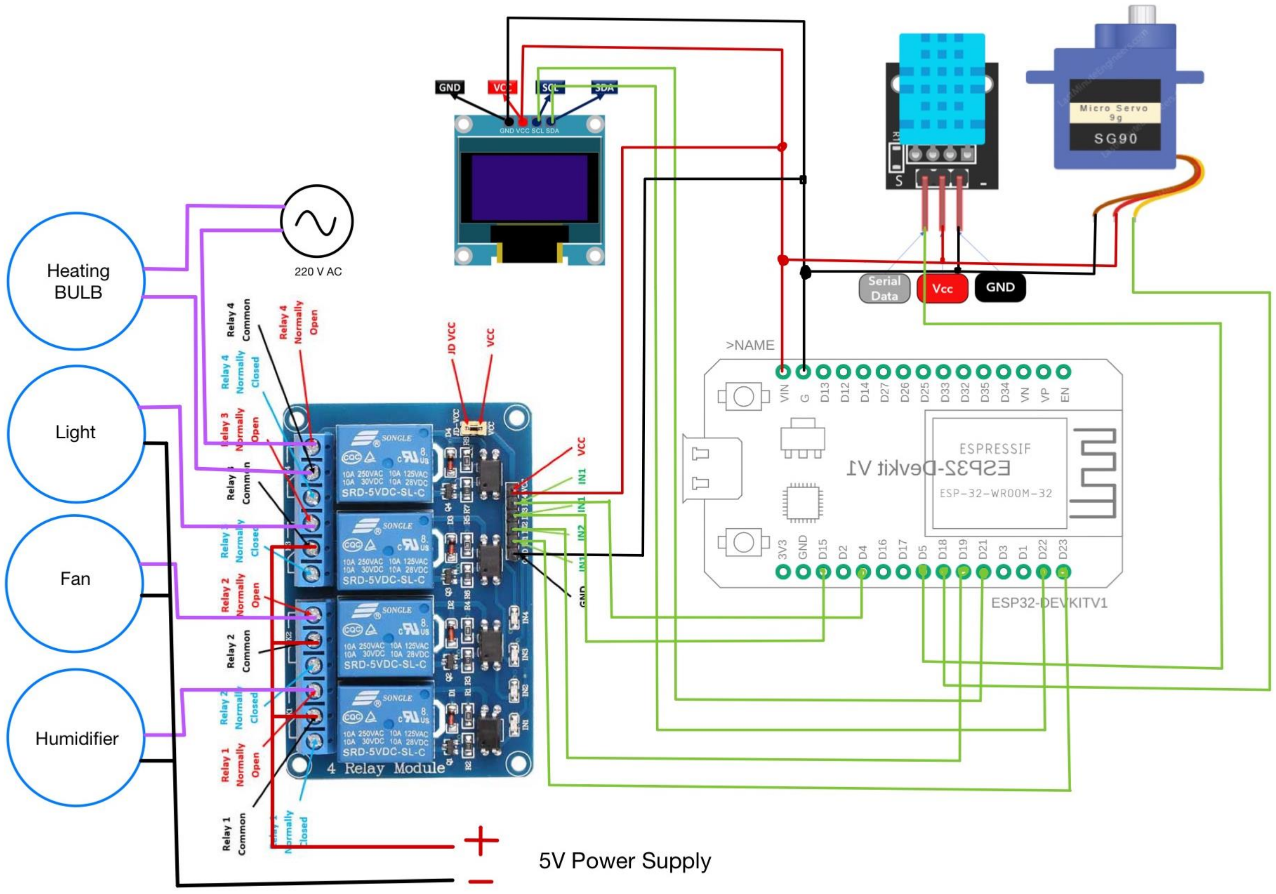
3.2 Design Methods (PO(a))

3.2.3 Algorithm

- The project's algorithm utilizes sensor data to dynamically adjust temperature and humidity parameters, optimizing the incubation environment
- Continuously updates necessary data from Blynk IoT cloud and sends current sensor reading

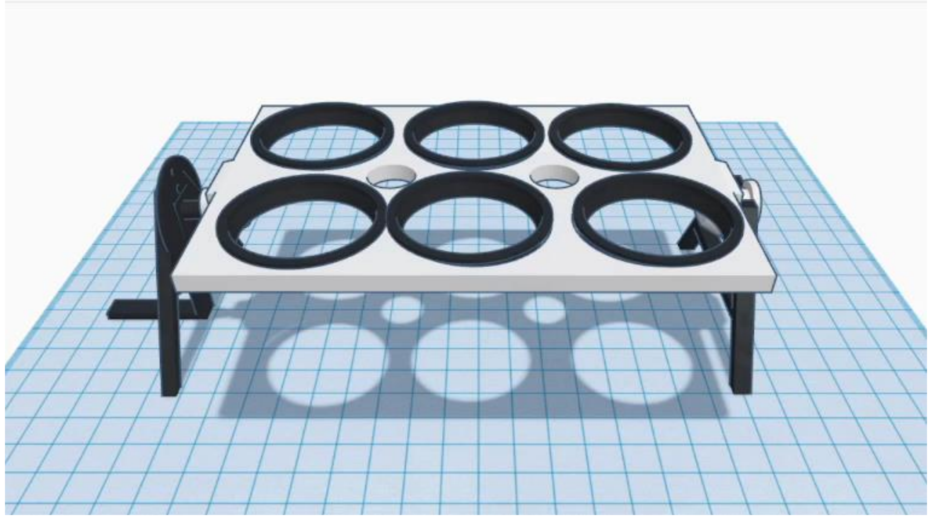


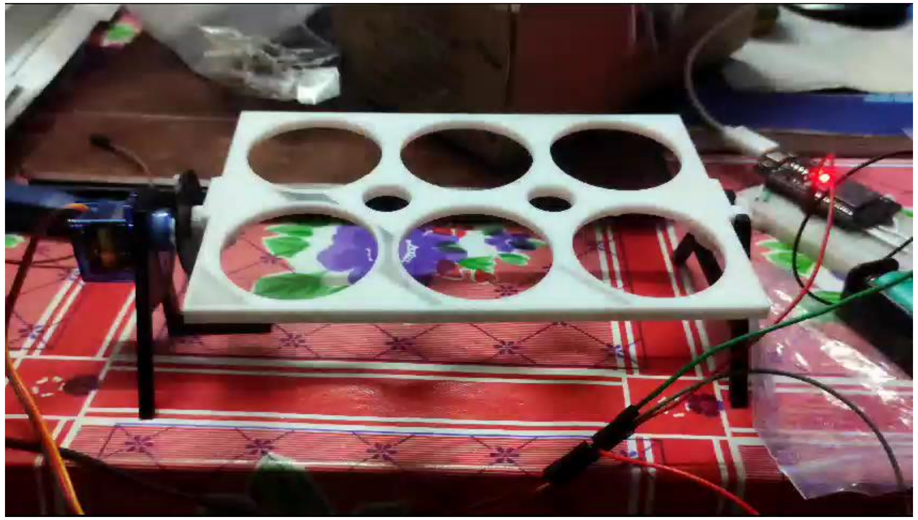
3.3 Design: Circuit Diagram



IoT Based Smart Egg Hatching System

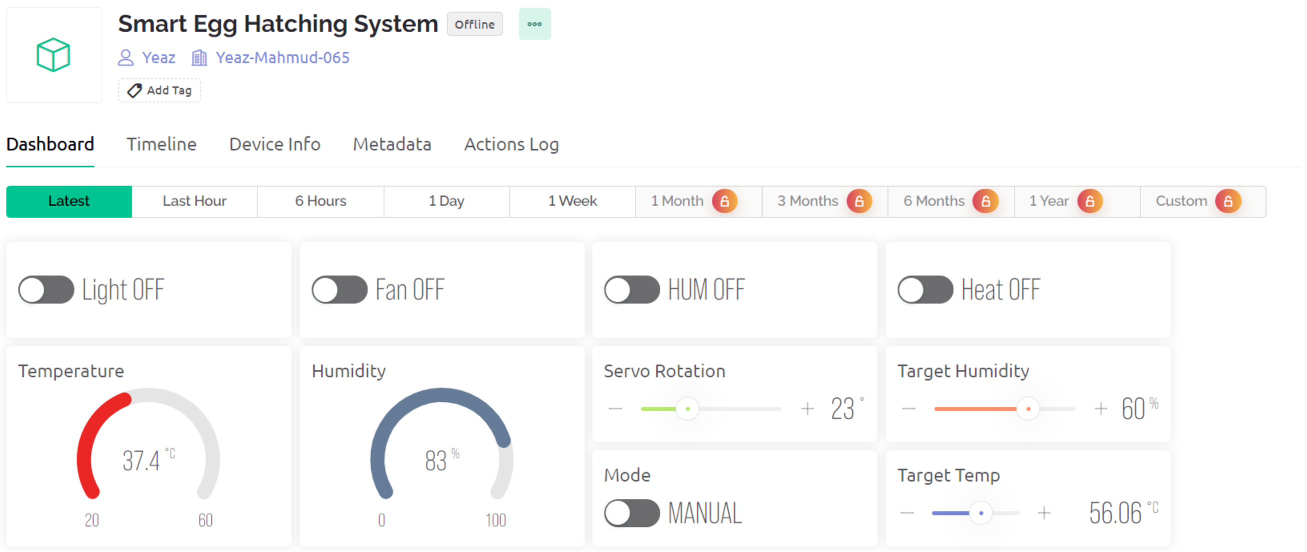
3.4 3D EGG Tray Design & Implementation



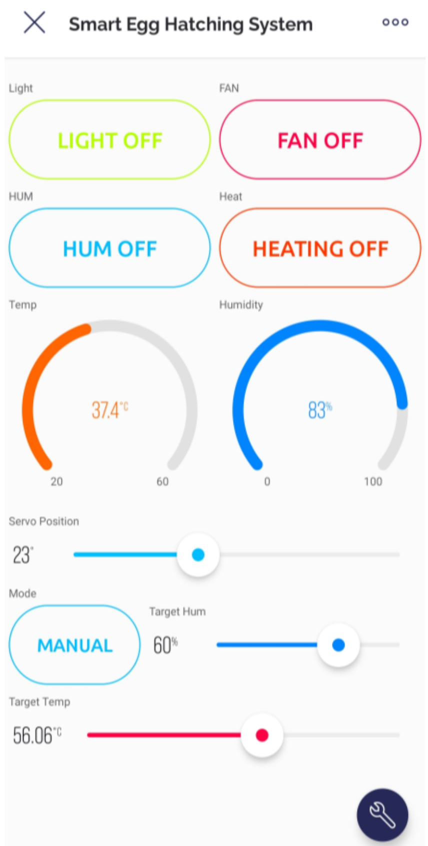


3D Design Base File Credit: Pascal Brower
Modified according to the need of our project

3.5 Design: Blynk IoT Cloud Web and Mobile App Dashboard

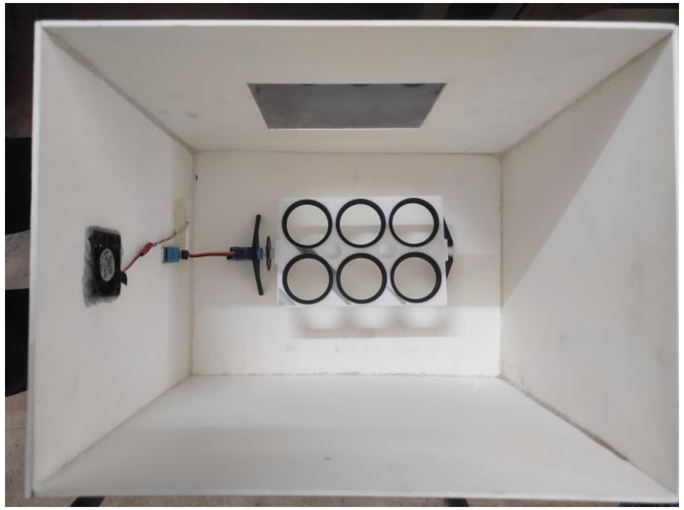


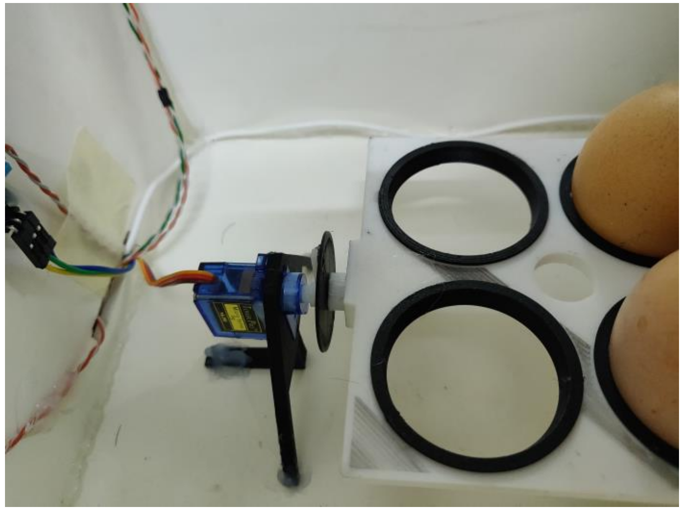
Web Dashboard

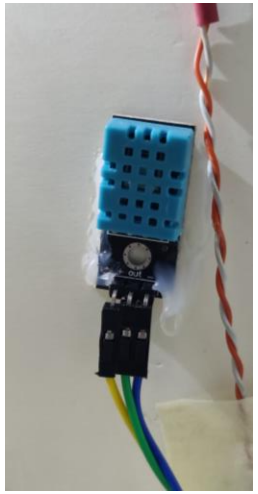


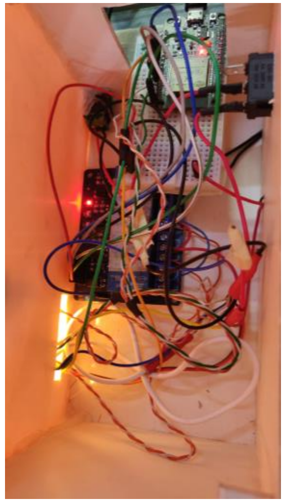
Android App Interface

3.6 Hardware Design









4 Implementation: Demonstration

4.1 Implementation: Photo Gallary

5. Design Analysis and Evaluation

- 5.1 Novelty
- 5.2 Design Considerations (PO(c))
- 5.3 Limitations of Tools (PO(e))
- 5.4 Impact Assessment (PO(f))
- 5.5 Sustainability and Envaronmental Impact Evaluation (PO(g))
- 5.6 Ethical Issues (PO(h))

5.1 Novelty

- **Interactive Egg Incubator:** Integrated IoT sensors to allow users to interact with the eggs remotely. They can adjust temperature, humidity, light through a mobile app.
- **Egg Turning:** Implement a gentle and precise egg turning mechanism, controlled by IoT. Users can set custom turning schedules, and the system can log turning data for each egg.
- **Auto Mode :** In Auto Mode, the incubator takes over the majority of tasks, reducing the need for constant user intervention. Users can set temperature, humidity ,turning speed and the system can use those log data to drive the incubator automatically.

5.2 Design Considerations (PO(c))

5.2.1 Considerations to public health and safety

1. **Biosecurity Measures:** Implement strict biosecurity measures to prevent the spread of diseases among the hatching eggs and chicks. This includes disinfection protocols, controlled access to the incubator, and appropriate handling procedures.
2. **Ventilation and Air Quality:** Ensure that the incubator has adequate ventilation to maintain healthy air quality for both the eggs and users. Use air filtration systems if necessary to reduce the risk of airborne contaminants.
3. **Temperature and Humidity Control:** Design the incubator with precise temperature and humidity control to create optimal conditions for embryo development while avoiding overheating or drying out the eggs.
4. **Safety Sensors:** Install safety sensors to monitor critical parameters like temperature, humidity, and gas levels. These sensors should trigger alarms or automatic shutdowns in case of deviations from safe ranges.
5. **Fire Safety:** Include fire safety features, such as fire-resistant materials and fire suppression systems, to minimize the risk of fire-related incidents in or around the incubator.
6. **Electrical Safety:** Ensure that all electrical components and wiring meet safety standards and regulations. Implement circuit breakers and ground fault interrupters to prevent electrical hazards.
7. **Secure Enclosure:** Design the incubator with a secure and tamper-resistant enclosure to prevent unauthorized access, especially when housing live chicks

5.2 Design Considerations (PO(c))

5.2.2 Considerations to environment

1. Energy Efficiency: Use energy-efficient components such as LED lighting, high-efficiency heating elements, and variable-speed fans to reduce power consumption. Implement smart algorithms that optimize energy usage by adjusting temperature and humidity settings based on real-time environmental conditions.

2. Materials Selection: Choose materials that are eco-friendly and sustainable. Opt for recyclable or biodegradable materials when possible. Minimize the use of plastics and other non-recyclable materials in the incubator's construction.

3. **Packaging and Shipping:** Use minimal and eco-friendly packaging for shipping the incubator to reduce waste. Encourage recycling and responsible disposal of packaging materials.

4. Eco-Friendly Manufacturing: Work with manufacturers and suppliers that adhere to environmentally responsible practices, such as reducing water and energy use in production processes.

5. Recycling and Repurposing: Encourage users to recycle or repurpose old incubators, parts, and packaging materials.

6. Sustainable Packaging Materials: Use sustainable packaging materials, such as recycled cardboard or biodegradable packaging, to minimize waste and environmental impact.

5.2 Design Considerations (PO(c))

5.2.3 Considerations to cultural and societal needs

- Our project involves respecting diverse beliefs and practices, providing customization options, supporting multiple languages, and promoting inclusivity. It also entails educating users about cultural significance, fostering community engagement, and addressing ethical concerns while being responsive to user feedback and adaptable to various cultural and societal preferences. Ultimately, the goal is to create a project that is respectful, inclusive, and culturally sensitive to cater to a wide range of users and backgrounds.

5.3 Limitations of Tools (PO(e))

1. **Cost:** Smart egg hatching systems can be expensive to develop, purchase, or maintain, making them less accessible to individuals with limited budgets.
2. **Technical Complexity:** The complexity of IoT technology and automation can be challenging for some users to set up and troubleshoot, potentially leading to frustration and reduced usability.
3. **Reliability:** IoT systems may encounter connectivity issues, software bugs, or hardware failures, which can disrupt the incubation process and endanger the eggs or chicks.
4. **Power Dependency:** These systems rely on a stable power supply. Power outages or interruptions can be detrimental to the incubation process and require backup power solutions.

5.4 Impact Assessment (PO(f))

- 5.4.1 Assessment of Societal and Cultural Issues

1. **Cultural Preservation:** The project can contribute to the preservation of cultural practices related to egg hatching by providing a modern and accessible platform for individuals to engage with traditional activities.
2. **Educational Value:** Smart egg hatching systems can serve as educational tools, teaching users about biology, animal husbandry, and the cultural significance of hatching processes.
3. **Inclusivity**: By offering multilingual support and respecting diverse beliefs and practices.

4. Loss of Tradition: Overreliance on automation and technology may lead to a reduced hands-on experience, potentially diminishing the cultural and emotional value of traditional hatching practices.

5.4 Impact Assessment (PO(f))

5.4.2 Assessment of Health and Safety Issues

1. **Improved Hatch Rates:** The project can contribute to better hatch rates by maintaining optimal incubation conditions, reducing the risk of diseases, and enhancing chick health.
2. **Disease Prevention:** Smart incubation systems may incorporate biosecurity measures to prevent the spread of diseases among eggs and chicks, promoting animal health.
3. **Energy Efficiency:** Implementing energy-efficient components can reduce the risk of electrical fires or overheating, enhancing the safety of the incubation environment.
4. **Data-Driven Monitoring:** Continuous monitoring and data collection allow users to identify and address issues promptly, reducing the risk of unexpected problems.
5. **Emergency Protocols:** Incorporating safety features like backup power sources and automatic shutdown mechanisms in case of emergencies can safeguard the health of eggs and chicks

5.4 Impact Assessment (PO(f))

5.4.3 Assessment of Legal Issues

1. **Regulatory Compliance:** Ensuring that the project complies with relevant agricultural, animal welfare, and environmental regulations can lead to a positive legal impact, reducing the risk of legal disputes or penalties.
2. **Ethical Considerations:** Addressing ethical concerns and implementing responsible animal care practices can enhance the project's legal standing by demonstrating a commitment to animal welfare and ethical standards.
3. **Data Privacy and Security:** Implementing robust data privacy and security measures can help the project comply with data protection laws and regulations, reducing the risk of legal issues related to data breaches.
4. **User Agreements:** Having clear and well-drafted user agreements, terms of service, and privacy policies can protect the project from legal disputes and liability.

5.5 Sustainability Evaluation (PO(g))

- 5.5.1 Assessment of Societal and Cultural Issues

1. **Cultural Preservation:** Assess how the project contributes to the preservation and revitalization of cultural practices related to egg hatching. Look for evidence of increased engagement with traditional activities among users.
2. **Educational Value:** Evaluate the project's impact on education and awareness of cultural traditions and practices, particularly in terms of promoting STEM learning, biology education, and cultural understanding.
3. **Inclusivity:** Measure the extent to which the project is inclusive and accessible to diverse cultural groups, taking into account features such as multilingual support and cultural customization options.
4. **Community Engagement:** Examine the extent to which the project fosters community engagement, cultural exchange, and the sharing of cultural stories related to egg hatching among users

5.5 Sustainability Evaluation (PO(g))

5.5.2 Assessment of Health and Safety Issues

1. **Improved Hatch Rates and Animal Welfare:** Assess how the project's health and safety features, such as precise temperature control and disease prevention measures, contribute to improved hatch rates and the overall welfare of eggs and chicks.
2. **Energy Efficiency and Environmental Impact:** Evaluate the project's energy efficiency measures and their long-term contribution to reducing energy consumption and environmental impact, such as reduced carbon emissions.
3. **Data-Driven Monitoring and Safety:** Measure the project's effectiveness in continuously monitoring conditions and addressing potential health and safety issues, leading to enhanced safety for users and animals.
4. **Emergency Protocols:** Examine the project's emergency protocols and their effectiveness in safeguarding eggs, chicks, and users during unforeseen events.

5.5 Sustainability Evaluation (PO(g))

5.5.3 Assessment of Legal Issues

1. **Regulatory Compliance**: Assess the project's continuous adherence to relevant agricultural, animal welfare, data privacy, and consumer protection laws and regulations.
2. **Ethical Considerations:** Measure the project's alignment with ethical standards related to animal welfare, responsible data handling, and user rights, ensuring that it remains a legally and ethically sound platform.
3. **Data Privacy and Security:** Evaluate the project's ongoing commitment to data privacy and security, ensuring that user data remains protected in accordance with evolving data protection laws.
4. **Consumer Trust:** Monitor user satisfaction and trust levels to gauge the project's effectiveness in maintaining transparent and ethical practices, which can contribute to long-term legal compliance.

6. Reflection on Individual and Team work

6.1 Individual Contribution of Each Member

6.2 Mode of TeamWork and Diversity

6.1 Individual Contribution of Each Member

- **ID 1806055** has assembled all the hardware together, made the outer body of the project and integrated final code
- **ID 1806056** has designed the OLED display interface and also done relay interfacing with ESP32
- **ID 1806058** has designed Blynk IoT dashboard and mobile application interface and integrated IoT in the project
- **ID 1806065** has modified the 3D design base file for egg rotation and interfaced sg90 servo motor and sensors with ESP32

6.2 Mode of TeamWork and Diversity

1.Clear communication: We established clear lines of communication among team members to ensure that everyone is on the same page. We communicated through Whatsapp group and made sure members feel comfortable sharing their thoughts and ideas.

2.Role clarity: We clearly defined the roles and responsibilities of each team member at very first meeting of our project to ensure that everyone understands their specific tasks and how they contribute to the project.

3. Diversity : We divided our project into four major segments and divided the work between members. Thus we embraced diversity and inclusivity in the project team.

4. Flexibility: We encouraged team members to be creative and think outside the box to come up with innovative solutions to problems.

7. Communication to External Stakeholders (PO(j))

1. Github Link: https://github.com/Yeaz065/IoT-Based-Smart-Egg-Hatching-System/tree/main

2. YouTube Link: https://youtu.be/mXY7iyu8TXU?si=E0HNB1FDPCR_WOly

8. Project Management and Cost Analysis (PO(k))

8.1 Bill of Materials

8.2 Calculation of Per Unit Cost of Prototype

8.3 Calculation of Per Unit Cost of Mass-Produced Unit

8.4 Timeline of Project Implementation

8.1 Bill of Materials

Equipment Name	Unit Price(BDT)	Quantity Required	Total Price(BDT)
ESP-WROOM-32 Development Board	700	1	BDT 700
DHT11 Temperature and Humidity Sensor	210	1	210
Relay module 5v 4 channel	199	1	199
Heating Bulb (25W)	30	1	30
Cooling Fan	140	1	140
Humidifier	365	1	365
SG90 Servo Motor	150	1	150
OLED Display	280	1	280
3D Printed Egg Tray	460	1	460
Led Lamp	9	2	18
Mini Breadboard	80	2	160
5V 2A Power Adapter	180	1	180
PVC Board (2 ft x 2 ft)	120	3	360
Acrylic Sheet (3 inch x 5 inch)	80	1	80
Miscellaneous	-	-	1095

Total = BDT 4427.00

8.2 Calculation of Per Unit Cost of Prototype

Per unit cost of prototype = BDT 4427 /-

8.3 Calculation of Per Unit Cost of Mass-Produced Unit

Approximated per unit cost of mass-production unit = BDT 3100 /-

8.4 Timeline of Project Implementation

WEEK 8

Idea Generation and project proposal submission

WEEK 9

Listing all necessary components and placing order; Selecting 3D design

WEEK 10

Interfacing sensors, relay module and display; Writing base codes

WEEK 11

Hardware assembly, project outerbody making and IoT interface design

WEEK 12

Integrating all base codes together and final testing

9. References

1. *R. Jaichandran, R. Shobana, K. Mohamed Tharick, L. Raja, H. Anandaram and K. Vijaipriya, "Automatic Hatching System by designing IoT-based Egg Incubator," 2022 3rd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2022, pp. 501-506, doi: 10.1109/ICOSEC54921.2022.9952082.*
2. *L., Niranjan. (2020). Universal Egg Incubation System for Hatching using Atemga328P, Proteus Design Tool and IoT. 10.13140/RG.2.2.10561.58721.*
3. *Forson Peprah, Samuel Gyamfi, Mark Amo-Boateng, Eric Buadi, Michael Obeng, Design and construction of smart solar powered egg incubator based on GSM/IoT, Scientific African, Volume 17,2022, e01326, ISSN 2468-2276, https://doi.org/10.1016/j.sciaf.2022.e01326.*
4. *https://www.thingiverse.com/pascal0815/designs*