IOT BASED EGG INCUBATOR

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled "**IOT BASED EGG INCUBATOR"** is the bonafide work of "**PRADEEP KUMAR S (230701230), RAHUL P (230701254)"** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

This project presents the design and implementation of a IoT-Based Egg Incubator that leverages IoT technology to automate and monitor the incubation process. The system is built around an ESP32 microcontroller, which manages various components including a DHT11 sensor for real-time monitoring of temperature and humidity. A relay module controls an AC motor to rotate the eggs at regular intervals, simulating natural incubation. A high-intensity LED is used as a heating element, providing the necessary warmth to maintain optimal incubation temperature. To prevent overheating, a DC fan is activated when the temperature exceeds a predefined threshold, ensuring a stable environment. The system also features a notification mechanism that alerts users immediately when temperature levels go beyond safe limits. By automating the incubation process and enabling remote monitoring, this IoT-enabled incubator enhances hatch rates, reduces manual dependency, and promotes efficiency in poultry farming practices.

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CHAPTER 1

INTRODUCTION

In the evolving domain of modern agriculture, particularly in poultry farming, maintaining precise environmental conditions during the incubation process is crucial for ensuring high hatchability and healthy embryo development. Factors such as temperature, humidity, and egg rotation must be meticulously controlled to replicate the natural conditions required for successful incubation. Deviations in these parameters can adversely affect the hatch rate, resulting in economic losses and compromised productivity.

With the advent of Internet of Things (IoT) technology, a new paradigm of intelligent automation and real-time monitoring has emerged, offering advanced solutions to overcome traditional challenges in incubation management. The integration of IoT-enabled sensors and microcontrollers allows for continuous tracking of environmental conditions, timely notifications of deviations, and autonomous control of heating and cooling mechanisms. These capabilities significantly enhance the reliability, consistency, and efficiency of the incubation process.

1.1 Motivation

Traditional incubation systems often rely on manual monitoring and control, which can be labor-intensive, error-prone, and inconsistent. Even minor fluctuations in temperature, humidity, or the frequency of egg rotation can have significant impacts on embryo development and hatch success rates. This inconsistency not only affects the health and viability of the chicks but also leads to reduced productivity and financial losses for poultry farmers.

The increasing demand for efficient and scalable poultry farming practices necessitates a more reliable and automated approach to incubation. The Internet of Things (IoT) presents a transformative opportunity to address these challenges by enabling real-time data acquisition, intelligent decision-making, and remote control of incubation parameters. By leveraging IoT-based sensors and microcontrollers, it becomes possible to create an automated, self-regulating incubation system that continuously monitors and adjusts conditions to optimal levels.

This project is motivated by the need to reduce manual intervention, minimize human error, and enhance hatch rates through technological innovation. The integration of IoT not only ensures better outcomes in terms of chick quality and quantity but also provides scalability for commercial poultry operations, paving the way for smarter and more sustainable farming solutions.

1.2 Objectives

The primary objective of this project is to design and develop an IoT-enabled smart incubator system that automates and optimizes the incubation process in poultry farming. The specific goals are as follows:

- **Real-Time Monitoring:**
  To continuously track critical incubation parameters such as temperature, humidity, and egg rotation using IoT-enabled sensors.
- **Automated Environmental Control:**
  To autonomously regulate heating, cooling, and humidity levels within the incubator based on real-time sensor data.
- **Remote Access and Alerts:**
  To enable remote monitoring and control of the incubator through a mobile or web application and provide instant alerts if any parameter deviates from the optimal range.
- **Data Logging and Visualization:**
  To store environmental data on a cloud platform and provide historical graphs and trends for analysis and performance tracking.

- **Energy Efficiency and Reliability:**
  To design a system that minimizes energy consumption while ensuring high reliability and consistent hatchability.
- **Improved Hatch Rates:**
  To increase embryo survival and chick hatch rates through precise and consistent environmental control.

CHAPTER 2

LITERATURE REVIEW

Poultry incubation systems have undergone significant advancements with the integration of automation and IoT technologies. This literature review highlights key research works that have contributed to the development of smart incubator systems and identifies the limitations of existing methods, thereby justifying the need for the proposed system.

[1] IoT-Based Smart Egg Incubator Using Arduino
This study describes a low-cost incubator system built using Arduino, DHT11 sensors, and relays. It enables basic monitoring and control of temperature and humidity. However, the system lacks cloud integration and real-time remote access, limiting its scalability for commercial use.

[2] Automation of Incubator Using IoT
This paper presents a design that automates temperature and humidity control using IoT sensors and microcontrollers. It integrates with a mobile application to notify users about environmental changes. Although effective, the system does not support egg rotation automation or predictive analysis of incubation performance.

[3] Design and Implementation of an Intelligent Poultry Incubator Based on Wireless Sensor Networks
The authors implemented a wireless sensor network to monitor and control

incubator conditions. While it enhances flexibility and coverage, the system is cost-intensive and complex, making it less suitable for small-scale farmers.

[4] Real-Time Egg Incubation Monitoring Using GSM and IoT This system uses GSM and Wi-Fi modules to transmit real-time temperature and humidity data. Alerts are sent to users via SMS. While the concept improves monitoring, it does not offer full automation of incubation tasks such as egg turning or integrated data visualization.

[5] Smart Incubator System with Cloud Connectivity and Mobile App Interface This research emphasizes cloud-based data logging and mobile dashboard visualization. It allows users to monitor conditions remotely and receive alerts. However, the system relies heavily on continuous internet connectivity and lacks offline control capabilities.

2.1 Existing System

- Traditional incubator systems used in poultry farming are largely **manual** or **semi-automatic**. These systems require constant human intervention to monitor and adjust critical environmental parameters such as **temperature**, **humidity**, and **egg rotation**. This approach often leads to **inconsistencies** and **delays**, which can negatively impact the hatch rate and overall productivity.

- In most conventional systems, the incubator conditions are regulated using **basic thermostats** and **humidifiers**, but there is **no mechanism** to provide real-time feedback or automatic adjustments. Users must manually record temperature and humidity readings and rotate the eggs at fixed intervals, which increases the chances of **human error** and **irregularities** in the incubation cycle.

- Additionally, traditional incubators lack **remote monitoring capabilities** and **alert systems**, making it difficult for users to respond quickly to any deviations from optimal conditions. This limitation poses significant challenges, especially in large-scale or commercial poultry operations, where constant monitoring is impractical.

2.1.1 Advantages of the existing system

- **Low Cost:** Traditional incubators are relatively inexpensive and widely accessible.
- **Simple to Operate:** They are easy to use and do not require technical expertise.
- **No Internet Dependency:** These systems function independently of network connectivity.

2.1.2 Drawbacks of the existing system

- **Lack of Real-Time Monitoring:** No continuous tracking of environmental conditions.
- **Manual Operation:** Requires frequent user involvement for data recording and egg rotation.
- **No Remote Alerts or Automation:** Users are not notified in case of abnormalities.
- **Higher Risk of Failure:** Increased likelihood of incubation failure due to human error.
- **Unsuitable for Scaling:** Not ideal for large poultry farms or automated environments.

2.2 Proposed System

The proposed system is an IoT-based smart incubator designed to overcome the limitations of traditional incubation methods. It integrates temperature, humidity, and egg rotation sensors with a microcontroller (such as ESP32 or Arduino) to ensure real-time monitoring and automated control of incubation conditions.

The system continuously collects data from the environment and uses this input to control heating, humidifying, and motor-driven egg turning mechanisms. It also uploads the data to a cloud platform, enabling users to view the status of the incubator through a mobile or web application. In case of any deviation from the optimal range, the system sends real-time alerts to the user.

Furthermore, the proposed system supports historical data logging, which helps in analyzing trends and improving incubation performance. It offers a user-friendly interface, improved hatch rates, and reduces manual effort, making it highly suitable for both small-scale farms and commercial applications.

2.2.1 Advantages of the proposed system

- **Real-Time Monitoring:** Continuously tracks temperature, humidity, and egg rotation status.
- **Automated Control:** Adjusts heating and humidity levels and rotates eggs without user intervention.
- **Remote Access:** Users can monitor and control the incubator remotely via smartphone or web dashboard.
- **Instant Alerts:** Sends notifications when any parameter deviates from the optimal range.
- **Cloud Integration:** Stores and visualizes historical data for analysis and optimization.
- **Improved Hatch Rates:** Ensures consistent and controlled conditions for embryo development.
- **Scalable Design:** Suitable for both personal and commercial poultry setups.

CHAPTER 3

SYSTEM DESIGN

3.1Development Environment

The development of the Smart IoT Egg Incubator system involved both hardware and software components that work together to automate and optimize the incubation process. The system is built using cost-effective, readily available components and open-source tools.

3.1.1 Hardware Requirements

- **ESP32 Microcontroller – Acts as the central unit to process sensor data, control devices, and handle communication via Wi-Fi.**
- **DHT11 Sensor – Measures the internal temperature and humidity of the incubator in real time.**
- **4-Channel Relay Module – Controls the AC motor (egg turning), DC fan (cooling), and LED light (heating/light).**
- **AC Motor – Rotates the eggs at defined intervals to simulate natural incubation behavior.**
- **DC Fan – Activates automatically when the temperature exceeds safe levels, ensuring proper airflow and cooling.**
- **LED Light (High-Intensity) – Functions as a heating element, maintaining optimal warmth inside the incubator.**
- **Jumper Wires and Breadboard – Used for safe and flexible prototyping during hardware integration.**
- **Power Adapter (5V / 12V) – Supplies power to the ESP32 and connected components.**

3.1.1 Software Requirements

- **Arduino IDE** – Used for programming and uploading code to the ESP32.

Supports necessary libraries for sensors and automation logic.

- **Embedded C / C++** – Language used to write control logic for temperature management, egg rotation, and real-time notifications.
- **Telegram Bot API** – Sends alerts to the user via Telegram when the temperature exceeds defined thresholds.
- **Serial Monitor (Arduino IDE)** – Helps debug and test sensor readings and system responses during development.

CHAPTER 4

PROJECT DESCRIPTION

4.1 SYSTEM ARCHITECTURE

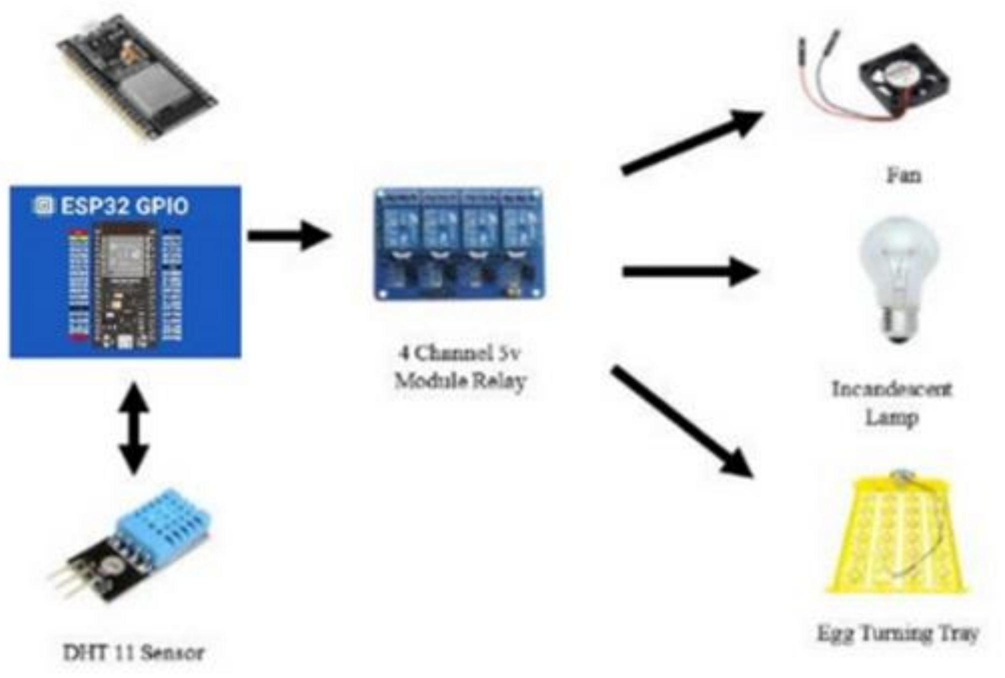

Fig 4.1 System Architecture

4.2 METHODOLOGY

Problem Definition:The methodology begins with identifying the problem in conventional egg incubation methods, which are largely manual and lack precision in maintaining environmental conditions. Issues such as inaccurate temperature control, inconsistent humidity, and irregular egg rotation negatively impact hatch rates. Therefore, the goal is to develop a smart IoT-based incubator that automates and monitors these key parameters to ensure optimal incubation conditions and reduce human intervention.

Literature Review:A detailed review of existing smart incubator solutions was conducted to understand their functionalities and limitations. Various IoT architectures, temperature and humidity sensors (such as

DHT11), microcontroller platforms (ESP32), and notification systems (Telegram bot) were studied. This helped in identifying features that could be incorporated into the proposed system, including real-time monitoring, autonomous control, and remote alerts.

Requirements Analysis: Functional and non-functional requirements were clearly outlined. Functional requirements include real-time temperature and humidity sensing, motor-controlled egg rotation, and remote alerts through Telegram. Non-functional requirements include reliability, ease of use, low cost, and suitability for small-scale use. Component selection and system scalability were also considered during this phase.

System Design: The system was designed using ESP32 as the main controller, connected to a DHT11 sensor for capturing temperature and humidity data. A 4-channel relay module was used to control an AC motor (for egg rotation), a DC fan (for ventilation), and an LED light (for heating). The ESP32 is programmed to compare sensor data with threshold values and trigger the respective devices accordingly. When the temperature exceeds a predefined limit, a notification is sent to the user via Telegram.

Prototype Development: All components were assembled on a breadboard, and the ESP32 was programmed using Arduino IDE. The system was tested in an enclosed incubator setup. The Telegram bot was configured to send real-time alerts. Egg rotation was scheduled at regular intervals using delay functions in the code, while fan and heater control was based on sensor data feedback.

Evaluation and Testing: The system was tested under various conditions to assess response accuracy, sensor reliability, and device control logic. Real eggs were incubated in a trial run to validate the system's performance. The Telegram alert system was verified for real-time communication, and device actions were monitored to ensure stable temperature regulation and consistent egg turning.

CHAPTER 5

RESULTS AND DISCUSSION

The Smart IoT-Based Egg Incubator was successfully implemented using the ESP32 microcontroller, DHT11 sensor, 4-channel relay module, AC motor, DC fan, and LED light. The system continuously monitored temperature in real-time and effectively controlled internal components to maintain a stable incubation environment.

Temperature readings were collected at regular intervals and compared against predefined thresholds. When the temperature exceeded the set limit, the ESP32 triggered the DC fan to regulate heat and restore balance. Simultaneously, a Telegram alert was sent to the user's mobile device, ensuring immediate awareness of the abnormal condition. The LED light acted as a heating element and was activated when temperatures dropped below the desired level.

The AC motor was programmed to rotate the eggs at fixed intervals, simulating natural hen behavior. This ensured uniform heating and helped improve embryo development during the incubation period. All automation was handled seamlessly by the ESP32, with no manual intervention required once the system was initiated.
The data was validated through testing under realistic incubation conditions. The components responded accurately to sensor inputs, and real-time alerts were triggered promptly. The system demonstrated excellent reliability, user-friendliness, and suitability for small-scale poultry operations.

Overall, the proposed system proved effective in automating the egg incubation process. It minimized manual labor, maintained consistent environmental conditions, and improved the overall hatchability success rate. The system's design is cost-efficient and can be further enhanced with additional features like humidity sensing, AI-based control, and cloud-based dashboards in future versions.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion

The Smart IoT-Based Egg Incubator system provides a reliable, automated, and cost effective solution for enhancing the egg incubation process. By integrating the ESP32 microcontroller with temperature and humidity sensing, relay-controlled actuators, and real-time alert mechanisms, the system ensures a stable and optimized environment for embryo development. The use of a Telegram bot for instant alerts enhances user interaction and responsiveness. Automated egg rotation and environmental control eliminate the need for manual monitoring, significantly improving hatchability success and operational efficiency. The system is highly suitable for small-scale poultry farmers, hobbyists, and educational purposes, offering a scalable foundation for further innovation in precision agriculture.

6.2 Future Work

In future iterations of the Smart IoT Egg Incubator, several enhancements can be made to improve its functionality and performance. These may include:
Integration of a humidity control system using ultrasonic humidifiers and sensors to maintain ideal moisture levels.
Implementation of a mobile application or web dashboard for enhanced data visualization and control.
Use of AI-based temperature prediction and adaptive control algorithms for better stability and accuracy.
Addition of data logging and cloud storage to enable historical analysis and trend monitoring.
Incorporation of voice assistant compatibility for hands-free operation.
Support for battery backup or power failure alerts to ensure uninterrupted incubation.
These future upgrades aim to transform the current system into a more intelligent, data-driven, and user-friendly solution for modern poultry farming and research.

APPENDIX

SOFTWARE INSTALLATION

Arduino IDE

To run and mount code on the Arduino NANO, we need to first install the Arduino IDE. After running the code successfully, mount it.

Sample code

```
#include <WiFi.h>
#include <HTTPClient.h>
#include <DHT.h>

// WiFi credentials
const char* ssid = "PunkK";
const char* password = "123456789";

// Telegram Bot credentials
String BOT_TOKEN = "7542238511:AAEiWqVWQ1na8v0CA3SEvxZREH0EHdHnVEw";
String CHAT_ID = "964596340";

// Pins
#define DHTPIN 4
#define DHTTYPE DHT11
#define RELAY_LED 18
#define RELAY_MOTOR 5

DHT dht(DHTPIN, DHTTYPE);

// Motor timer variables
unsigned long previousMillis = 0;
const unsigned long motorOnTime = 2 * 60 * 1000;   // 2 minutes
const unsigned long motorOffTime = 1 * 60 * 1000;  // 1 minute
bool motorIsOn = false;

// Telegram notification flag
bool tempAlertSent = false;
```

```
void setup() {
  Serial.begin(115200);
  pinMode(RELAY_LED, OUTPUT);
  pinMode(RELAY_MOTOR, OUTPUT);

  digitalWrite(RELAY_LED, HIGH);    // OFF
  digitalWrite(RELAY_MOTOR, HIGH);  // OFF

  WiFi.begin(ssid, password);
  Serial.print("Connecting to WiFi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("\nWiFi Connected!");

  dht.begin();
}

void loop() {
  unsigned long currentMillis = millis();

  // Motor ON/OFF logic
  if (motorIsOn && currentMillis - previousMillis >= motorOnTime) {
    digitalWrite(RELAY_MOTOR, HIGH);  // Turn motor OFF
    Serial.println("Motor OFF");
    motorIsOn = false;
    previousMillis = currentMillis;
  }
  else if (!motorIsOn && currentMillis - previousMillis >= motorOffTime) {
    digitalWrite(RELAY_MOTOR, LOW);   // Turn motor ON
    Serial.println("Motor ON");
    motorIsOn = true;
    previousMillis = currentMillis;
  }

  // Temperature reading
  float temperature = dht.readTemperature();
  if (isnan(temperature)) {
    Serial.println("Failed to read from DHT sensor!");
  } else {
```

```
    Serial.print("Temperature: ");
    Serial.println(temperature);

    // LED & Telegram logic
    if (temperature > 37.5) {
      digitalWrite(RELAY_LED, HIGH); // LED OFF
      Serial.println("LED OFF (Temp > 37.5°C)");

      if (temperature > 40.0 && !tempAlertSent) {
        sendTelegramAlert(temperature);
        tempAlertSent = true;
      }
    } else {
      digitalWrite(RELAY_LED, LOW); // LED ON
      Serial.println("LED ON (Temp <= 37.5°C)");
      tempAlertSent = false;
    }
  }

  delay(5000);  // Delay before next loop
}

void sendTelegramAlert(float temp) {
  if (WiFi.status() == WL_CONNECTED) {
    HTTPClient http;
    String message = "🔥 ALERT: Temperature is " + String(temp) + "°C";
    String url = "https://api.telegram.org/bot" + BOT_TOKEN +
                 "/sendMessage?chat_id=" + CHAT_ID +
                 "&text=" + message;

    Serial.println("Sending to: " + url);  // 👉 Debug URL

    http.begin(url);
    int httpResponseCode = http.GET();
    Serial.print("HTTP Response code: ");
    Serial.println(httpResponseCode);
    http.end();
  } else {
    Serial.println("WiFi not connected.");
  }
}
```

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