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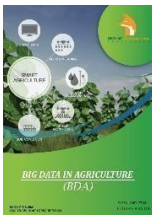

RESEARCH ARTICLE

DESIGN AND DEVELOPMENT OF AN IOT-BASED SMART POULTRY MANAGEMENT SYSTEM FOR REAL-TIME MONITORING AND CONTROL VIA MOBILE AND WEB APPLICATIONS

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ABSTRACT

In recent years, monitoring, maintenance, and control of environmental parameters through the Internet of Things (IoT) have emerged as significant research areas in smart farming. This study presents the design and development of an IoT-based Smart Poultry Management System for real-time monitoring and control of critical environmental factors within poultry farms. Key parameters such as temperature, humidity, and moisture are continuously measured using integrated sensors. A NodeMCU microcontroller is employed to collect data from the temperature, humidity, and moisture sensors and transmit it to a base station via Wi-Fi connectivity. An Android and web-based platform was developed to provide real-time visualization of environmental data through a user-friendly dashboard. The system not only displays temperature, humidity, and moisture levels but also enables remote control of environmental conditions to maintain optimal poultry farm settings. The proposed solution demonstrates how IoT integrates physical devices and sensors, communication infrastructure, and data analytics applications to create an efficient, automated, and intelligent poultry management ecosystem.

KEYWORDS

IoT, Smart Poultry Management, Automated Control, Mobile App

1. INTRODUCTION

The increasing world food security issue is drawing the attention of the world and therefore proper and sustainable livestock production systems are being adopted to meet the soaring protein demand (Shahab et al., 2020; Morchid et al., 2024). The productivity of agricultural and farming processes is essential to increase the yields and cost-effectiveness by using various innovative technologies, e.g., the Internet of Things (IoT) (Shahab et al., 2024; Shahab et al., 2024). The poultry farming is essential in satisfying the protein needs because of its rapid growth, high production and low cost (Doran et al., 2020; Wahyono et al., 2018). The incorporation of the latest technologies in poultry production may also contribute to the increased efficiency of the process, its sustainability, and food supply (Kleen, J. L., and Guatteo, R., 2023; Campbell et al., 2021). The smart poultry management system based on IoT has been envisioned to offer twenty-four-hour control and survey of the essential environmental parameters such as temperature, humidity, and light. This system, through the integration of a network of sensors, wireless connectivity mobile and web platforms, enables us to maintain the ideal rearing environment of poultry thus increasing the increase in productivity as well as the overall efficiency of farm operations. Recent studies have demonstrated that IoT-based smart poultry management systems significantly enhance environmental monitoring, automation, and farm productivity. Researchers have implemented sensor-based systems to monitor temperature, humidity, ammonia concentration, and light intensity using microcontrollers such as Arduino, ESP8266, and Raspberry Pi. Cloud-integrated platforms enable real-time data transmission, storage, and remote monitoring through mobile and web applications, thereby improving operational efficiency and reducing manual intervention (Yang et al., 2021). Automated control mechanisms, including ventilation fans, lighting systems, and feeding units, have been developed to maintain optimal poultry house conditions and minimize mortality rates (Balkrishna et al., 2021). Recent advancements incorporate wireless sensor networks (WSNs), edge computing, and machine learning algorithms for predictive health monitoring and behavioral analysis in poultry farms. Artificial intelligence and sensor technologies in dairy livestock export: Charting a digital transformation. Sensors, (Astill et al., 2020; Neethirajan, 2023). Furthermore, smart poultry frameworks contribute to sustainable production by optimizing energy consumption and environmental regulation (Daraojimba et al., 2023; Tagarakis et al., 2021; Alahmad et al., 2023). Collectively, the literature confirms that IoT-enabled smart poultry systems provide a scalable, efficient, and data-driven solution for modern poultry farming.

The chicken poultry industry is an important industry for food supply in Pakistan (Ahmad et al., 2023; Rahman et al., 2024). Manual process to maintain a normal poultry farm e.g. soil mixture for healthy environment and to control the temperature is most important and labor-intensive tasks. In order to easier maintenance and to replace manual activities smart egg farming is developed. The proposed system is designed in such a way that user can control the system remotely using Android mobile application and on web page. User can also see history and record of all

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the system, for example temperature and humidity along with date and time, when bulb and Fan is ON or OFF. All the record is updated on webpage and on mobile application automatically. We can also set temperature and humidity from webpage and android application. We use Fire Base real time database for this purpose.

The data from sensors is read and directly stored into database, then we retrieve the data and show on webpage and android app. The system is composed of hardware and sensors that are available on cheap price from market. We can also change or replace any hardware object in case of damaged or not working, but in previous systems, if any fault arises in any sensor or hardware whole incubator has to be change.

Goals and Objectives

- The main aim of this particular study is to provide an automated environment that control and maintained Poultry farm using low cost software and commodity hardware.
- This system thoroughly investigates and controls various physical parameters associated with poultry management like temperature, humidity, moisture content, and quality of air
- This system is very helpful to access and control the whole system remotely using your smart phones to reduce human effort and time loss

2. Materials and Methods

The proposed system comprises integrated software and hardware components designed to ensure efficient monitoring and control of environmental conditions within poultry farms. Figure 1 shows the overall methodology of the proposed system.

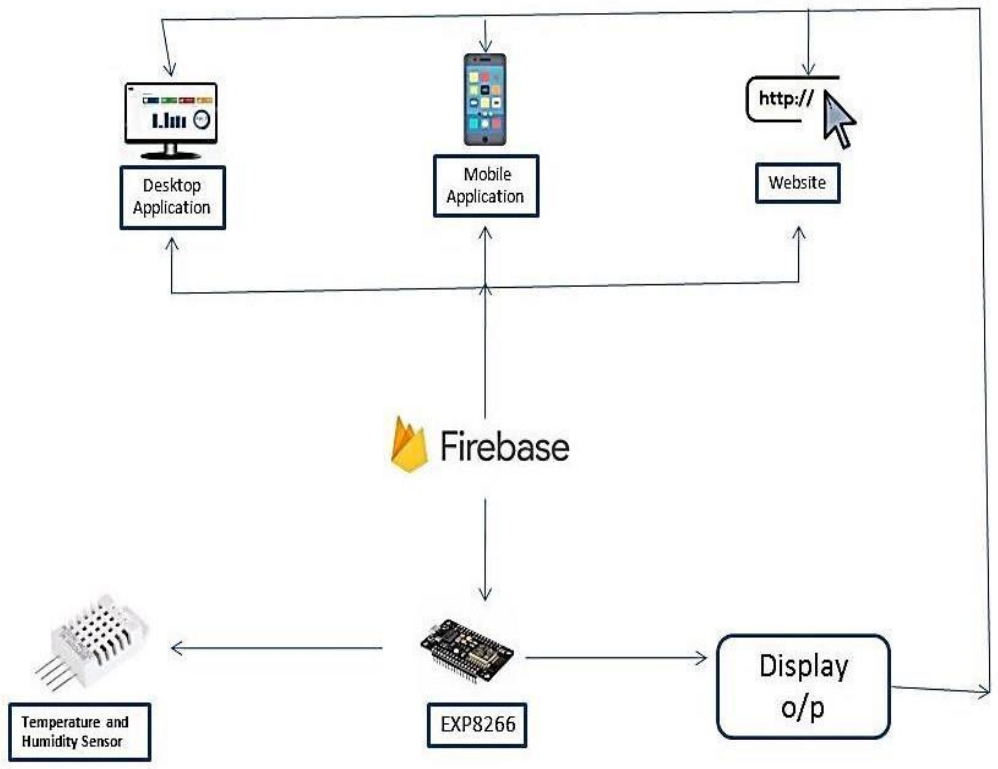

Figure 1: Methodology of the proposed system

The software architecture includes an IoT-based temperature and humidity controller application for real-time monitoring and automated regulation of environmental parameters, the Arduino IDE for programming and configuring the NodeMCU microcontroller, a web server for data storage, processing, and visualization through an online dashboard, and an Android mobile application that enables remote access and control of farm conditions. On the hardware side, the system incorporates a temperature and humidity sensor module for measuring ambient environmental conditions, a photosensitive sensor module (LDR) to monitor light intensity, a cooling fan to regulate internal temperature, a 220V bulb to maintain appropriate lighting conditions, and a relay module that functions as a switching interface between the low-voltage control circuitry and high-voltage electrical devices. Together, these interconnected sensing, processing, communication, and actuation components establish a reliable and automated smart poultry management framework.

Table 1: Software and Hardware Components of the IoT-Based Smart Poultry Management System

Category	Component	Function/Description
Software	IoT-Based Temperature & Humidity Controller App	Real-time monitoring and automated control of environmental parameters
Software	Arduino IDE	Programming and configuration of NodeMCU
Software	Web Server	Data storage, processing, and web-based visualization
Software	Android Mobile Application	Remote monitoring and control via smartphone
Hardware	Temperature & Humidity Sensor Module	Measures ambient temperature and humidity
Hardware	Photosensitive Sensor (LDR)	Detects light intensity
Hardware	Cooling Fan	Regulates temperature inside poultry farm
Hardware	220V Bulb	Provides controlled lighting
Hardware	Relay Module	Switches high-voltage devices based on control signals

2.1 Components Involved

Detail of all the software and hardware components are described here

2.1.1 Arduino Module

Arduino is an open source prototyping platform based on easy to use software and hardware. In this project UNO variant of Arduino is used which is microcontroller based developmental prototyping board, it has chip that uses 5v voltage having clock speed of 10 MHz Arduino is main component used in this project connected to Wi-Fi internet and all other sensors are directly connected to Arduino, and it control all the sensors that connected to it.

2.1.2 Temperature humidity sensor

Environmental condition directly affects the animal livelihood and causes many diseases which leads to death of animals. Therefore, this sensor is used to check and balance the temperature and humidity of poultry farm and send data to ESP.

2.1.3 LDR Sensor

LDR sensor is sensor that is used to detect light, this sensor is connected to 5v Voltage. In this project this sensor is used to detect the amount of light e.g. when there is no sunlight this sensor detects and gives signal to ON the electric bulbs, similarly when there is sufficient amount of light is present bulbs turn OFF automatically.

2.1.4 Cooling Fan

Cooling fan is also attached to our Arduino, it helps in maintaining temperature of the system. When temperature becomes high then cooling fan turn ON and maintain the temperature of the system, the fan is controlled by sensor and turned ON and OFF automatically.

2.1.5 Bulb

Bulb of 220v is also used as heating element to increase temperature, when temperature is low the bulb turns ON automatically. It can also use to spread heat all over the system in order to maintain the temperature.

2.1.6 Firebase Database Server

Firebase is real time cloud hosted database that is used to store data like temperature and humidity. All the sensors share Real time database instances and automatically receive newest data.

2.1.7 Relay

We also use 4-channel array in our project to control heavy current. E.g. we use Bulb of 220v and fan of 12v if we pass direct current to ESP then all our system is burnt, so that's why we use relay to control flow of current.

2.1.8 Webpage View

We develop web page that displays all the data (detail of temperature and humidity) received from the sensors shown in Figure 2. PC is directly connected to Arduino and internet connection, all the data that receives from the Arduino is directly uploaded to our database after every 5 or 10 seconds.

Then that data is retrieved from the database and showed on webpage. Here we can also manage and set temperature and humidity. History of whole system i.e. previous values of temperature, humidity and condition of light and fan can also see on webpage.

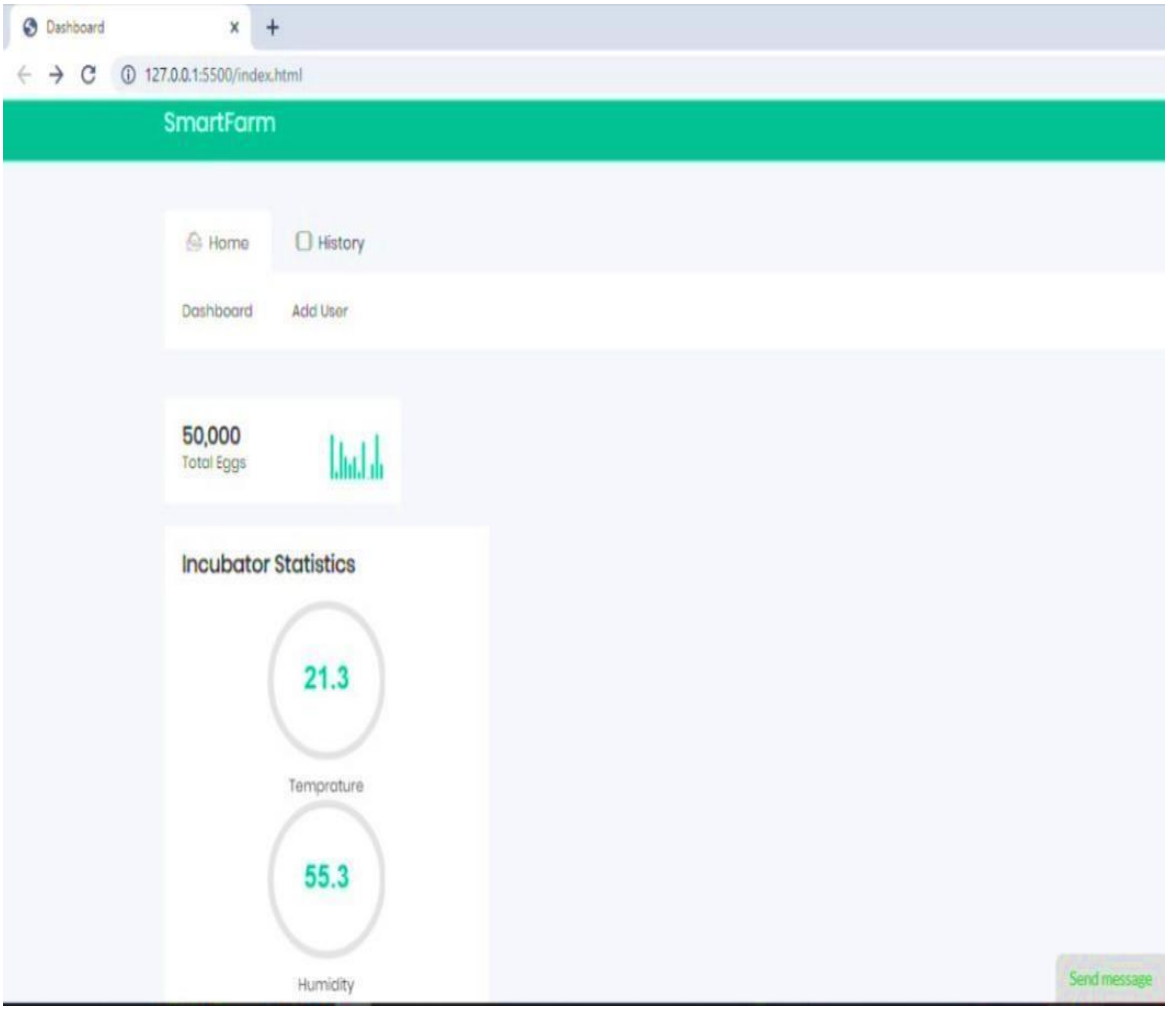

Figure 2: Developed website

2.1.9 Mobile Application view

The control of whole system using Android app that runs on our mobile phone having internet accessibility and is linked to our server that display all the data e.g. (temperature, humidity etc.) after every 5 or 10 seconds. System can also manage and set temperature and humidity using this mobile application, Figure 3 shows the view of developed mobile app. All the history of whole system can also see on mobile app, where we can see previous values of temperature, humidity and condition of light and fan.

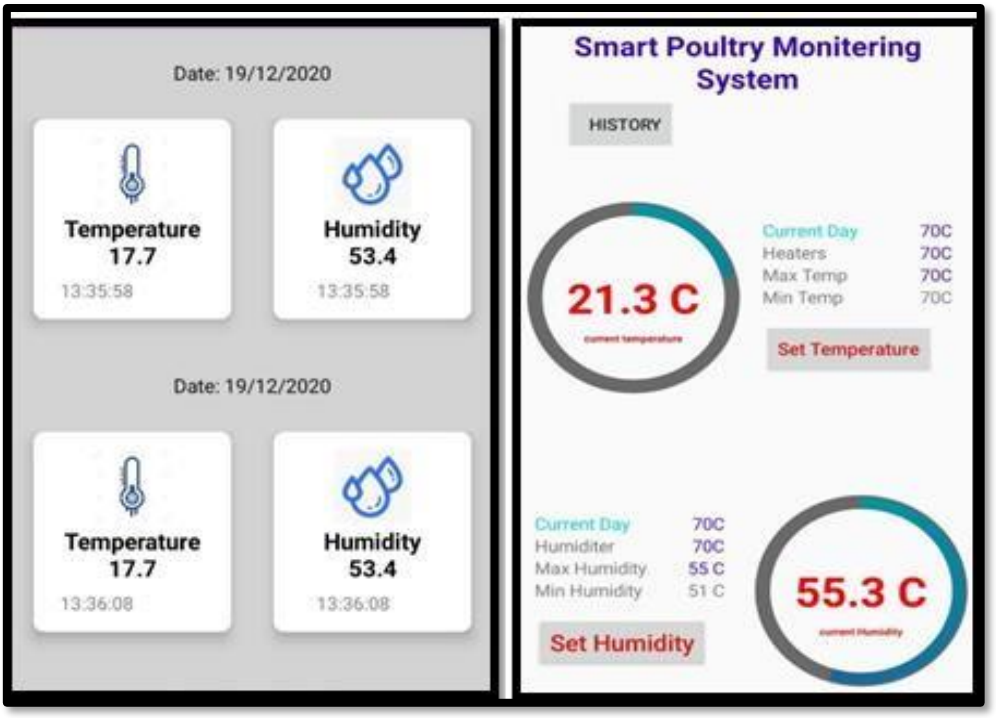

Figure 3: Developed mobile app

2.2 Working Principle of System

EXP8266 (NODE MCU) is main component of our software system. It controls entire system and perform all the functionality. When we supply power using battery or Power of 5V to NODE MCU, it is connects to Wi-Fi internet and get data from online real time Firebase database and starts performing actions according to that data e.g. For which temperature Bulb and Fan Turn ON or OFF. NODE MCU gives instruction to relay that controls Fan and Bulb in our system. Relay also used to control current in our system, it provides power of 220V that is used to turn ON or OFF the Fan and Bulb. We use 4-Channel array it acts as electricity button and turn ON or OFF the specific supply according to the instruction.

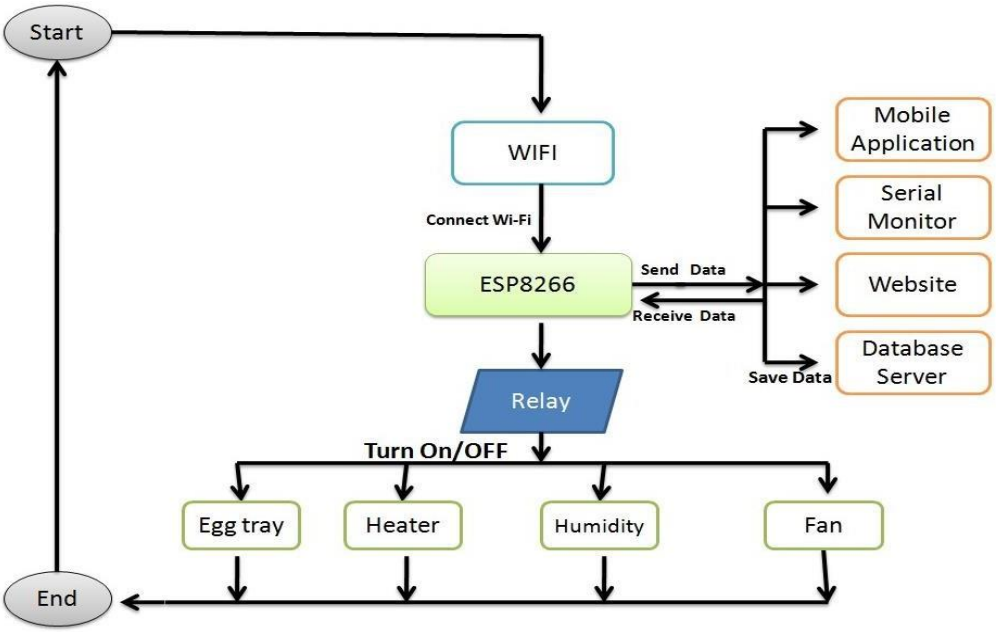

Figure 4: Working Flowchart of system

Node MCU receives data from all the sensors (Temperature humidity sensor or LDR Sensor) and save this data into Firebase Database, after every 5 seconds it update all the data and save newest data into database. We save all the logics or conditions on which we have to perform our work in NODE MCU, on the basis of that conditions it controls whole system. For example, we set condition of temperature in such a way that if temperature is less than 25C then Bulb should be ON, or when temperature is greater than 45C Fan should be ON. We control all the system using Android Mobile application or Webpage. We retrieve all the data that is save to firebase database and shown it on Webpage and mobile application. We can also check and download history of all the temperatures, humidity values and condition of fan and bulb at any time using mobile or computer. We can also control system using mobile or webpage, we can also turn ON or OFF Bulb or Fan using mobile or computer.

2.2.1 Designing of System

The design of the system is very easy, first of all the command from the system is sent to database server. Database server sent this command back to Wi-Fi module. All the sensor are attached with NODE MCU, it measures temperature and humidity of the system.

The command is further move towards relay that controls operations of the system, e.g. if the temperature exceeds the limit the Turn ON the Fan.

If temperature is below the limit then turn ON Bulb. All the data that received from sensor is saved in database and updated previous data after every 5 seconds. Webpage and mobile application are designed in such a way that we can monitor and control all the factors like temperature and humidity along with history of previous data. We can also download history of temperature, humidity and all other factors in different formats.

2.2.2 Implementation of system

After collecting and assembling all the software and hardware components, we have to connect Arduino to Internet through Wi-Fi then we have to connect to Wi-Fi to all the sensors including Temperature Humidity sensor, LDR sensor and Relay. Relay is also connected to different components e.g. Fan, Bulb, Heater and Egg tray as shown in Figure 4. Arduino module is also attached to online Firebase database that is used to store the data received from all the sensors and history of saved data.

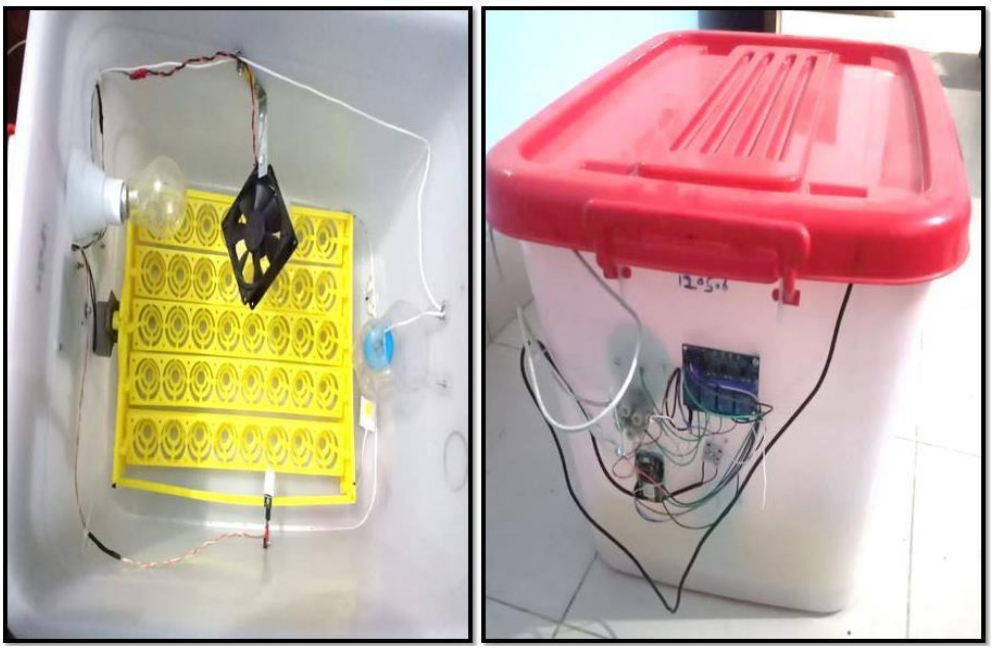

Figure 5: Design of proposed System

3. Comparison and Discussion

The existing systems have fewer features than the proposed system, making the advantage of proposed system. Following Table 2 shows the Comparison of proposed system with other IoT systems. In stark contrast, the system that is proposed herein integrates a multiplicity of sensor modalities, a program of automated environmental regulations, and relies on mobile and web-based interfaces to allow a holistic and geographically dispersed management of the poultry husbandry activities.

Table 2: Comparison of proposed system with other IoT systems

System	Monitored Parameters	Actuation / Control	Connectivity & Platform	Key Feature / Contribution	Reference
Proposed IoT-Based Smart Poultry Management System	Temperature, Humidity, Moisture	Automated control of fans, lights, and environment	Wi-Fi, Mobile & Web Apps	Real-time monitoring, automated control, remote access, precise stage-based environmental management	—
An IoT Based Incubation System	Temperature	None (alerts only)	Wi-Fi + Mobile App	Sends notifications when temperature exceeds thresholds	(Khairina, and Fikry, 2025).
Humidity-Based Poultry Alert System	Humidity	None	Wi-Fi	Alerts when humidity is out of range	(Ong Ai Ling et al., 2023).
A Simple IoT Egg Incubator	Temperature	Relay-controlled heating only	Wi-Fi + Cloud	Maintains incubator temperature; no mobile app	Chigwada et al., 2022
A Light Monitoring IoT System	Light (LDR)	None	Wi-Fi	Monitors light intensity, sends alerts	(Astill et al., 2020).
A Basic IoT Poultry Monitor Using Raspberry Pi	Temperature, Humidity	Manual control only	Embedded web server	Remote monitoring; no automated environmental control	(Akhund et al., 2021).

The review of the existing literature indicates that existing applications of the Internet of Things (IoT) poultry management systems generally track a single physiological or environmental parameter and, thus, provide only a small number of modalities of control, which do not meet the conditions of automation and remote accessibility.

4. Conclusion

Effective poultry management critically depends on maintaining optimal environmental conditions, with temperature and humidity being among the most influential factors affecting poultry health, growth, and productivity. The proposed IoT-based Smart Poultry Management System would provide real-time monitoring and automated control of the relevant parameters, guaranteeing constant monitoring with a sufficient time resolution that even allows identifying the variations on a five-second basis.

The system leverages existing online remote servers to process and analyze data, offering a cost-effective approach by minimizing the need for extensive manual monitoring while ensuring precise environmental regulation.

Optimal conditions were maintained according to poultry growth stages—for instance, a temperature of 37.5°C during days 1–21 and humidity levels of 50–60 mmHg during days 1–18, increasing to 70–80 mmHg after day 18—ensuring a suitable environment for healthy development. With the

help of IoT sensors, mobile and web-based interfaces, as well as automated actuation mechanisms, the system supports not only the process of remote control but also enhances the decision-making in farm management.

Overall, the adoption of this system will allow achieving a high number of improvements in the quality and quantity of poultry production, thus demonstrating its potential as a practical, scalable, and efficient solution to modern smart poultry farming.

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