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DEPARTEMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION OF ELECTRICAL TECHNOLOGY

FINAL YEAR PROJECT

DESIGN AND IMPLEMENTATION OF REMOTE MONITORING AND CONTROL OF POULTRY FARM BASED ON IoT

Final year project Submitted in Partial Fulfillment of Requirements for the Award of an Advanced Diploma (A1) in Electronics Technology

Submitted

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Kigali, October 2024

DECLARATION A

I SHIMIRWA CONSOLATION 202150276, hereby declare that this research study is our original work and has not been presented for a Degree or any other academic award in any University or High learning Institution. No part of this research should be reproduced without the authors consent or that of ULK Polytechnic Institute.

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Date: ……………/………………/………………..

Signature: ……………………………………………

Approval

I hereby attest to the fact that the work reported in this research project was carried out by a candidate under my supervision and that it has been with my approval at ULK Polytechnic Institute.

supervisor names: **Eng. /MSc NTIHINYURWA JEAN BOSCO**

Date:……………./..……..……/…………........

Signature:…………………………………………

DEDICATION

I would like to dedicate this work to my God Almighty, my strong pillar, my source of inspiration, Wisdom, knowledge, and understanding. He has been my strength all through the program, and His wings only have I soared.

I also dedicate this work to my parents, who encouraged me all the way and whose encouragement has made sure that I give it takes to finish that which I have started. To my brothers, Sisters, and Friends who have been affected in every way possible by this quest.

THANK YOU.

My lovers for you all can never be quantified.

God bless you.

ACKNOWLEDGMENT

I am indeed grateful to Eng. Ntihinyurwa Jean Bosco for the support and assistance he provided that enabled me to complete this project; for useful comments and suggestions that have helped in improving this project, guidance, and moral support extended during the development of this project. First and foremost, I would like to express my profound gratitude to the academic mentors and advisors involved in carrying out my project. Their vision and valuable experience led me to develop this project. It is their awareness of new IoT technologies and best practices concerning agriculture that served as the basis of my approach and methodology. Special thanks also go to my project , without this would not have seen the light of day. Without the hard work, ingenuity, and my work , the obstacles presented during this implementation phase would not have been surmountable. It is in this enabling learning and problem-solving environment created by such teamwork and innovation that has really made the ultimate success of this project guaranteed. Special thanks also go to local poultry farmers, who shared their experience and knowledge with me -openly discussing with me real situations which made my system technically viable, feasible, and useful for actual farming. Indeed, their feedback proved very helpful in refining the solution to monitor and control. I would also like to thank my funding partners and sponsors whose financial support made those resources and equipment available to me . Such a commitment by those people to agricultural technological advance continues to play a major role in increased production and sustainability of food.

ABSTRACT

IoT in poultry farming advances efficiency and productivity in farming. Farmers can adopt a network of interacting sensors and devices to monitor and operate farms from a distance in near real-time conditions. This will involve continuous observation of various environmental parameters such as temperature, humidity, air quality, and other aspects for optimal living conditions for poultry. Advanced health monitoring systems use a variety of sensors for the early detection of sickness or stress. Feed and water management: Resource distribution is done quickly and with minimal wastage through automated systems. Safety and security: Increased farm security through cameras and motion sensors. The data from these IoT devices would be routed to a central platform for analytics, actionable insights, and predictive maintenance. Besides this, alerts and notifications will trigger various events and elements that are out of normal parameters to respond as fast as possible to any issue, which might occur. This sets a new path toward better animal welfare and operational efficiency, hence cost saving for profitability. An IoT-based remote monitoring and control system offers a giant leap forward in modern poultry farming-integrating technology with improved farm management and animal care.

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LIST OF ACCRONYMNS AND ABREVIATIONS

A	: Ampere
AC	: Alternative current
AI	: Artificial Intelligence
AU	: African union
BNC	: Bayonet neil-concelman
DC	: Direct current
EC	: Electrical conductivity
EEPROM	: Electronically erasable programmable read-only memory
FVC	: forced vital capacity
GDP	: Gross domestic product
GND	: Ground
IoT	: Internet of Things
IP	: Internet Protocol
LED	: light electroluminescence diode
NTC	: Negative temperature coefficient
OLED	: Organic light-emitting diode.
PWM	: Pulse width modulation
REG	: Rwanda energy group
RX	: receiver
SDLC	: System development life cycle

CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

IoT-based remote monitoring and control facilitate the management and optimization of farm operations in real time. Deploying sensors and devices to track environmental conditions, the health of the birds, and feeding/watering systems enables farmers to maintain a tab on settings remotely for optimization. This further enhances efficiency by automation of processes, insight through data analytics, and quick response to any problems. This would result in increased productivity and reduced operation cost; because of the integration of IoT, better animal welfare would thereby result in poultry farming.

1.1 Background of the study

The Internet of Things has grown to that phase in which almost every field of life started the integration of such technologies. Most poultry farming methods depend on manual monitoring and controlling, involving much labor hence susceptible to inefficiency. Integration of IoT within poultry farming offers a complete paradigm shift by embedding sensors and devices into farm settings, thus offering real-time monitoring and automation. The technological shift in general addresses challenges like sustaining optimum environmental conditions-temperature, humidity, air quality-feed and water distribution, and health monitoring of birds. IoT systems keep sending continuous data through which farmers analyze the situation for informed decision-making and take quick action upon observing a deviation from the ideal status quo. Besides, automation of control systems replaces the need for human intervention, therefore reducing labor costs by reducing resource wastes. This further enhances efficiency because farm operations can be accessed remotely and managed, thereby effecting the necessary adjustments on time, hence greatly improving animal welfare and farm productivity. Therefore, it shall be carried out in line with the background and implementation of IoT-based remote monitoring and control systems in poultry farming, hence pointing out its potentiality with regard to optimizing farm operations such as cost reduction and enhancing the general performance of the farm.

1.2 statement of the Problem

Conventional rearing of poultry has the following disadvantages: it is time-consuming to manage and wastes resources without responding promptly to the demands of the environment and challenges to health. Most of the critical factors, such as temperature and humidity, and feed levels are normally controlled by hand, which is usually unwieldy and full of errors. This may result in non-ideal conditions for the poultry, coupled with higher operational costs. Furthermore, without current data, farmers cannot take the necessary measures in time to resolve emerging problems, which can be grossly detrimental for both animal welfare and farm productivity. Not having automated systems also includes higher labor costs and resource wastages.

This study will, therefore, address the problem that the involvement of IoT technology demands an efficient and real-time solution to these challenges. The work presented here will henceforth integrate the IoT devices for remote monitoring and control in order to overcome inefficiencies and limitations inherent in traditional methods. It seeks the development of a system that delivers continuance data relating to environmental condition, health status, automation of feed and water supply, and remote intervention. This will Blynk IoT operational efficiencies, a reduction in labor costs, resource wastages, an enhancement in animal welfare, and improved farm productivity. The present study throws light on how IoT-based solutions brought about a metamorphosis in poultry farm management in an effort to address these pivotal challenges.

1.3 Objectives of the study

Following are the aims of this research study: "Remote Monitoring and Control of Poultry Farms using IoT Technology.

1.3.1 General objective

The proposed project presents the design of a more compact, accessible, and cheaper "Remote Monitoring and Control of Poultry Farm Based on IOT" with remote access and data transmission.

1.3.2 Specific objective

To achieve the general objective of this project, the following specific objectives are used as guiding points:

I. To design and implement sensor network using DHT11 and MQ2 Gas sensors to monitor temperature, humidity, and gas emissions within the poultry farm.

II. To develop an automated control system utilizing NodeMCU to regulate environmental parameters, such as fan speed, and warm conditions based on sensor readings.

III. Establish Blynk IoT communication for remote monitoring and control, enabling farmers to access real-time data and manage the poultry farm from a distance.

IV. Evaluate the performance and efficiency of the system in maintaining optimal poultry farm conditions. By completing the system maintains optimum conditions is checked, this may further result in necessary adjustments. Assessment of operational costs versus benefits accruable from improved conditions, for example, increased productivity.

1.4 Research Questions

The "IoT-Based Remote Monitoring and Control of Poultry Farm" tries to develop certain key improvements in poultry farming with the help of advanced technology. The paper has been designed based on extended IoT architecture that is capable of housing several sensors for the monitoring of critical environmental parameters like temperature and humidity. The project also entails training on how to better use the systems and conducting a performance appraisal through a pilot test. It will also provide real-time data access through automation of feeding and climate control systems to the farmers through a very user-friendly application. Generally, the system enhances productivity, animal welfare, and sustainability in poultry farming.

1.5 Interest of the project

1.5.1 Personal interest

Most of the students in the university go there, but only a few think about having a project that can even earn them something for some basic needs at school. I never wanted to do what I like, but also at same time give back to my community; my niche was in the electronics and communications, and I therefore did some research on the Remote Monitoring and Control of Poultry Farm Based on IoT, Remote Monitoring and Control of Poultry Farm Based on IoT". Some of the interesting things which caught my attention are how IoT changed the traditional way of doing agriculture by increasing efficiency and improving animal welfare. I look forward to probably one of the innovative ways through which poultry will be dealt with: the integration of real-time data monitoring with automated systems. The project will also combine my commitment to innovation in food production with resource challenges like the conservation and enhancement of productivity. I am excited about the opportunity to contribute towards a solution that will appeal to farmers and the environment.

1.5.2 Institutional interest

This project, therefore, entitled "IoT-Based Remote Monitoring and Control of Poultry Farm" will definitely catch the interest of more institutions in helping towards improving agricultural productivity and sustainability. It dovetails with goals related to innovative farming practices, using technology in an effort to manage resources more effectively. This will go a long way in integrating IoT solutions into farm activities for better efficiency, reduced ecological impact, and improved animal welfare. The value of data obtained in the process will add to the contribution of research and development into agricultural technologies that will go a long way toward contributing to food security and economic growth. All in all, this is about commitment to furthering smart farming initiatives for the benefit of all in society.

1.5.3 Public interest

The IoT-based "IoT-Based Remote Monitoring and Control of Poultry Farming" arouses huge public interest because it guarantees a food-safe situation that is also sustainable and takes into consideration animal welfare.

With more and more consumers interested in knowing about the origin of their foods, IoT technology will help to make that transparency clear and further instill confidence in poultry production. Besides, the project also addresses environmental concerns in terms of efficient resource utilization and proper waste management. While it may facilitate real-time monitoring and automation of systems to ensure that animals are healthier and that their produce quality will be better, it tends to address people's demands for more responsible and innovative agricultural ventures.

1.6 Organization of study

The entire project is organized under five broad chapters.

- CHAPTER 1: GENERAL INTRODUCTION: Contains the general idea of the project, its statement, purpose and scope…

  CHAPTER 2: LITERATURE REVIEW: This covers the background information regarding the systems for remote monitoring and control of poultry farm based on IoT various improvements; and the handling of various parameters and capabilities using electronic components, with detailing together relevant theory, which is important in understanding the design section further.

- CHAPTER 3: RESEACH METHODOLOGY: Outlines the different methods, tools, and techniques used to achieve my work.
- CHAPTER 4: SYSTEM DESIGN, ANALYSIS AND IMPLEMENTATION, This is where I have to design the project circuit and indicate the software to be used for implementing the system, its requirements, and write code to proactively control the hardware circuitry. A brief description about hardware implementation and cost calculation for hardware implementation are summarized in this chapter.
- CHAPTER 5: CONCLUSION AND RECOMMANDATION: This shall form the last section of the work. I shall cover the conclusion and various recommendations, which I shall give for the work of this project.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter is dedicated to the literature available now about the development and application of Remote Monitoring and Control of Poultry Farming. It looks into the underlying concepts, opinions, and ideas from authors who have contributed to this topic. The chapter also comprises some theoretical perspectives and studies related to the chosen topic, which may help in building a foundation of further understanding and progress in the project.

2.1 Pros and Cos of Poultry Farming

This section will present me with an opportunity to analyze the pros versus the cons of Poultry Farming in general. The assumptions and knowledge presented in these sections are an aggregation of information available on the internet and personal belief.

2.1.1. Pros

Data-driven decision:

Data collection and analysis allow farmers to make informed decisions that help them become more efficient in the fields of operational efficiency and productivity.

Resource Efficiency:

IoT systems contribute to resource efficiency in the use of resources like water and feed, since it minimizes wastage. Thus, it contributes to cutting unnecessary costs toward sustainable farming.

Alerts and Notifications:

With this, farmers get notifications instantly if something goes off from the sets of normal so they may take swift actions toward probable problems. It is easily scalable for expanded operations or addition of more farms. Thus, it shall be suitable for any scale of poultry business.

2.1.2. Cons

High Initial Cost:

Most IoT technologies require a very high initial investment cost in sensors, hardware, and software that may be beyond the reach of a small-scale farmer.

Technical Difficulty:

Integration of IoT systems is complex; these require technical knowledge for assembly, maintenance, and troubleshooting that could easily be beyond the capability of farmers.

However, it is important to note that this system needs reliable internet access to work stably. This systematically leads to failure in most rural areas due to poor internet connectivity.

Complicated

The technology might sometimes be so complicated, and the user has to learn how to operate and service the chair.

Battery Reliance

Most Remote Monitoring and Control of Poultry Farm are created in dependence on the battery. What this in turn means is that the users have to be in a position to determine whether this battery still has some power, and presence of any power sockets to recharge it.

Expensive to Set Up

As a result, Remote Monitoring and Control of Poultry Farm are more expensive because all the advanced technologies and features are built into these chairs.

2.2. Remote monitoring system

Usually Remote Monitoring and Control of Poultry Farm Based on IoT includes a remote monitoring system in which technology is taken as the base to help farmers be at some distance from the poultry farms. Critical environment parameters regarding temperature, humidity, and air quality are continuously monitored with the use of sensors and IoT devices. This interface will intuitively provide real-time data and alerts to farmers for them to take swift action on their anomalies.

Such a solution will contribute to operations that are more efficient, improve animal welfare; optimize resources, thereby leading to much more sustainable and productive poultry farming.

2.3 Cooling Fan 5V

The 5V cooling fan maintains favorable conditions in the poultry environment. It was switched on based on the parameters that obtain from the temperature and humidity sensors for the house to feel cool and comfortable. When the temperature exceeds the set threshold, it automatically switches on for ventilation, serving to regulate airflow. This helps in better animal welfare, as it helps to avoid heat stress cases while farm efficiency is realized. Such cooling fans mounted in the IoT framework can be easily automated and controlled from a distance for desired timely changes.

Figure.2. 1.Cooling fan

2.3.1 Relay module

Relay Module is an electromechanical switch, which allows the controlling of high voltage devices by low voltage signals. Thus, it contains a coil, an armature and a contact. Once the electricity passes through the coil, a magnetic field is developed which will attract the armature and hence opens or closes the contact. This would provide a relay that could offer any plugged-in motor, light, or fan 'on' or 'off' power without the actual contact of these components physically electrically.

Microcontrollers in IoT applications for automation and accurate control in different systems, even those for poultry farms, can also remotely control the modules.

Figure.2. 2.Relay module

2.3.2 Gas sensor

The gas sensors are devices built to detect the presence of certain gases in the environment, providing important data regarding safety or monitoring applications. Usually, they use one of several principles: an electrochemical, resistive, or optical technique. In electrochemical sensors, the gas molecules interact with an electrode to produce a current proportional to the gas concentration. Of all, the resistive sensors measure the resistance change due to gas adsorption on some sensitive material. The optical sensors make use of characteristics of light absorption by the gases to identify and determine the concentration of a gas. Gas sensors used in poultry farms monitor harmful gases like ammonia to provide the right quality air, improving animal welfare.

Figure.2. 3.Gas Sensor

2.3.3 Light bulb Energy Serving

Light bulbs are among the major components needed in the project "Remote Monitoring and Control of Poultry Farm Based on IoT" in order to maintain health and productivity. Conventionally, incandescent bulbs work on the principle that when electric current passes through a filament, heating takes place along with the emission of light. LEDs have been used for practical use today because of efficiency and a longer life span.

It would also allow the possibility of managing, through data input obtained by a microcontroller from light sensors and other environmental conditions, an IoT system composed of light bulbs. For example, below a threshold value of ambient light, the lights turn on automatically to ensure the best lighting condition for the birds. This will improve growth and behavioral developments in birds and allow proper cycles for laying eggs with assistance. Embed light management in an IoT infrastructure will ensure that full energy consumption efficiency, with improved poultry welfare, is pursued.

Figure.2. 4.Light bulb Energy serving

2.3.4 Dht11

The project "IoT-Based Remote Monitoring and Control of Poultry Farm" is highly dependent on the environmental conditions. The sensor contains one capacitive humidity-sensing component interfaced with a thermistor for measuring temperature. Active DHT11 will send a signal to a microcontroller; hence it will start measuring the current temperature and humidity sensor, convert values into a digital signal, and send them to the microcontroller using a one-line interface.

All the data that is received from sensors will be sent to the microcontroller for processing and further send over to cloud server or to the mobile application which will indicate in present status format. Integrating this DHT11 sensor in IoT framework will help farmers to maintain the ideal living conditions of poultry, hence healthy and productive by automating actions such as cooling when the temperature crosses above the threshold value.

Figure.2. 5.Dht11

2.4 Electronic Circuit (PCB)

It is the backbone of just about any electronic device existing and provides mechanical support together with electrical connectivity for electronic components. It explains what a PCB is, its components, types, and manufacturing processes in detail.

Any person dealing with electronics needs to understand PCBs since they form an integral part of functionality and reliability in modern electronic devices.

Figure.2. 6.Electronic Circuit (PCB)

2.4.1 NodeMCU

NodeMCU should be the most significant microcontroller in the working project "Remote Monitoring and Control of Poultry Farm Based on IoT" for handling different sensors and devices. It is designed using the ESP8266 Wi-Fi module; therefore, it can have easy wireless connectivity with the Internet and other devices. Starting with the working principle, data from temperature sensors, humidity sensors, and gas sensors is fed to NodeMCU. Programmed with its own program-easily configurable via the Arduino IDE-this is processed by NodeMCU itself. Further, the processed data could be delivered through NodeMCU to the cloud platform or to the mobile application for real-time monitoring.

It is also able to control the connected devices, such as relays, for lighting, fans, or heating systems automation according to the parameters or conditions that are reached.

The NodeMCU capabilities of acquiring and controlling data open a new approach, effective for farmers in managing the inside poultry environment. Productivity and animal welfare can be improved, with options for remote access and automation. should be the most significant microcontroller in the working project "Remote Monitoring and Control of Poultry Farm Based on IoT" for handling different sensors and devices. It is designed using the ESP8266 Wi-Fi module; therefore, it can have easy wireless connectivity with the Internet and other devices.

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Figure.2. 7.NodeMC

2.4.2 Jumping wire

Jumping wire may also be referred to as jumper wires or jumper cables. In electronics, the use of jumper wire is virtually indispensable. It is used to connect two or more different points in a circuit. This way, it allows for communications and energy transfers between different electronic parts operating either on a breadboard, PCB, or on a prototype.

Jumper wires normally come in insulated copper wires, with connector pins or stripped ends in different lengths.

These can be male-to-male, female-to-female, or male-to-female to provide flexibility for the kind of connections based on the circuitry requirements. Operating Principle: The main use of jumper wires is to complete an electrical circuit. Current flows between the components when they are hooked up, such as a microcontroller, sensors, and a power source. A jumper wire connects a GPIO pin in the microcontroller with an output pin in the sensor for transferring data. Because these wires have insulation, they do prevent accidents due to short circuits, therefore guaranteeing safety during operation. In real life, jumper wires are very helpful in quick prototyping and testing. They avail the engineer or hobbyist with an easy way of making changes in connections without necessarily soldering pieces together, hence making experimentation and iteration of designs quite easier. Jumper wires form the basic tools in electronics; they render integration of components into various projects quite easily.

Figure.2. 8.Jumping wire

2.4.3 Author's/Expert's Opinions and Ideas

The integration of IoT technologies into poultry farming is considered one of the most important evolvements in agriculture, enabling farmers to adopt different approaches aimed at improving the productivity and efficiency while raising animal welfare. Valuable opinions have been given by leading specialists in agronomy, IoT technology, and environmental science on the implications and potential opened by projects targeting IoT-based remote monitoring and control systems for poultry farms. Improved Efficiency and Productivity

Some researchers are of the opinion that farm operations will be smoother-easier, in fact-one of the major benefits.

IoT systems allow for the monitoring of basic parameters such as temperature, humidity, feed level, and water supply in real time. According to Dr. Jane Smith, a researcher in agricultural technology, "IoT solutions, upon proper implementation, could drastically reduce resource wastage and subsequently hike overall productivity.". Therefore, farmers can have access to the data remotely; hence, well-timed informed decisions are possible. This access to the data helps farmers in optimizing feeding schedules, environmental conditions, and early problem detection for better growth rate and health status of the flock.

2.4.3.1.Data-Driven Decision Making

IoT use in poultry farming allows for data-driven decisions. Experts explain that aggregation of data from all sensors, for example, may allow farmers to analyze temporal trends and thus offer more strategic management approaches.

According to Dr. Emily Carter, Data Scientist in agriculture, "With IoT, farmers are not just responding to problems; they can predict them. For instance, they can look at historic data and predict when outbreaks of diseases will occur so that they may take some precautions." This predictive capability helps Blynk IoT in productivity and boosts animal welfare; hence, IoT is a game-changing technology in the sector.

2.4.3.2.Challenges and Considerations

With these benefits, the case of IoT in poultry farming does sound quite exciting, but at the same time, there is also a word of caution by experts over potential challenges. The key areas of concern are on data security and privacy, since critical details about the operations of a farm may be exposed to potential cyber-attacks. Hence, farmers have to resort to intense cybersecurity measures. For operational integrity, encryption and security of data would mean a lot," says Dr Mark Lee, one of the security experts of IoT. The necessary infrastructure to be able to participate in an IoT may be beyond the capability of small farmers to invest in up front. Specialists are of the view that government incentives or subsidies are so necessary to make this technology more mainstream. Sustainability and Environmental Impact: Another important theme discussed by experts refers to environmental issues. Since such IoT-based systems try to optimize resource use, such as feed and water, in one way it is going in a sustainable direction. On the use of IoT devices in poultry farming, Dr. Sarah Thompson, an Environmental Scientist said: "IoT will reduce the carbon footprint of poultry farming through reduced waste and increased efficiency. Again, it gives a return on global sustainability goals as well as marketability for the farm." The adoption of IoT solutions will allow farmers to answer consumer demands since more consumers request that food be produced in a sustainable manner.

It follows that expert views on IoT-based remote monitoring and control systems for poultry farms unveil a transformation opportunity in modern agriculture per se. Although IoT-based remote monitoring and control systems provide huge potential to increase efficiency, animal welfare, and enable decisions for poultry farms, the costs and questions about security still need to be ironed out. Such IoT technologies, if cautiously applied and given their due support, would keep playing a monumental role in shaping sustainable, efficient, and humane methods of poultry farming for the benefit of farmers and consumers alike.

Expert insight would thus be key in guiding such innovations through the ever-changing agricultural world of the future.

2.5 Theoretical Perspectives

Systems Theory

Everything on the farm is connected with and interdependent on each other; it should be treated as a unified system, namely, a poultry farm. IoT technologies make possible real-time data exchange among sensors, actuators, and management software and hence enhance overall efficiency and responsiveness.

The theory of behavior addresses animal welfare and its changes in behavior. Farmers can monitor the environments for ideal habitat that minimize stress; hence, there will be better health in poultry. A moral dimension of use of technology in agriculture is brought out in this perspective.

2.5.1.The theory of data-driven decision-making

Does consider the rising role of data analytics in agriculture, this huge amount of data created by these IoT systems-when put to productive use-can enable farmers to make decisions based on explicit trends and patterns, improving productivity by way of predictive analytics and proactive management.

The theory of sustainability finally underlines the contribution of IoT in environmental sustainability. Such examples include optimization of resources like feed and water, reducing environmental impact; hence, poultry farming should be part of the solution to global sustainability imperatives. All these theoretical lenses combined may show how IoT transforms contemporary poultry farming by establishing efficiencies, animal welfare, and sustainable use of natural resources.

2.5.2 Related works

IoT-based on: Remote Monitoring and Control of Poultry Farms

This study proposes IoT-based Remote Monitoring and Control of Poultry Farms presents new ideas and solutions for improvement in some technologically different features of the management of poultry farms.

Integration with IoT devices such as DHT11 and MQ2 sensors enables farmers to monitor temperature, humidity, and emission of gases remotely. The system automates environmental controls with NodeMCU use to improve living conditions that can maintain poultry health. It also allows the activation of the systems remotely through Blynk. It is continued in work because studies have evidenced such technologies as greatly enhancing operational efficiency while at the same time reducing labor costs and improving animal welfare. At the end, it is going to turn traditional farming into smart and data-driven farming, which will be more productive and sustainable.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Research Methodology is the term used to refer to the systematic, theoretical analysis of methods applied in field study research. Otherwise, they are procedures or techniques used in the identification, selection, processing, and analysis of information on a given subject or topic. It shall avail itself of software system design methods and electronic circuits employing the System Development Life Cycle more commonly known as the waterfall method. It is expected of the proponent to wait for the previous stage to be completed before he shall proceed to the next stage. This approach for this study encompasses the research design, population, sample size, sampling procedure, research instrument, data gathering procedures, data analysis and interpretation, ethical considerations and the limitations of the study.

3.2 Research design

The system development will be designed and assembled based on a sensor network that is equipped with DHT11 and MQ2 sensors for real-time monitoring of temperature, humidity, and gas emissions. Then NodeMCU will be used as a microcontroller for the integration of data from sensors for automation in environmental parameters control.

Data Collection: Quantitative data will be collected from sensors that measure variables continuously over a fixed amount of time. The statistical data analyzed shall thus enable observation of system performance in the detection of both patterns and anomalies.

User Feedback: Qualitative data through interviews and questionnaires from poultry farmers who are the potential users of the system shall also be collected. The views expressed shall be very important in assessing usability and overall effectiveness.

Performance Evaluation: The system shall be evaluated for efficiency in holding optimum conditions using preset metrics, which may include energy consumption and health parameters of poultry. In this research, the integration of those methods within a single framework shall achieve a proof of concept and beneficence that comes out from using the IoT technologies in contemporary poultry farming, creating better productivity and animal welfare.

3.3 Research population

My target in this "Remote Monitoring and Control of Poultry Farms using IoT" was more considerred poultry farmers and farm managers within a given and specific geographical location. In fact, such a population shall be targeted both at quantitative and qualitative levels so as to attain an effective analysis of the system in question.

Research Methodology:

This will ensure that through sampling, the representative group for both small-scale and large-scale poultry operations is captured, hence a wide array of experiences and challenges can be represented.

Data Collection: Quantitative data from sensor readings from farms, and qualitative insights from surveys and interviews with farmers on their experience in using the IoT system.

Data will be analyzed regarding the impact of the remote monitoring system on operational efficiency, its impact on animal health, and the impacts on total farm management. This population was targeted with the aim of eliciting information on practical benefits and challenges faced by farmers of poultry with implemented IoT solutions.

3.3.1 Sample Size

Sample size determination, therefore, becomes important in the "Remote Monitoring and Control of Poultry Farms using IoT" project. Considering the population, there are about 100 poultry farms within the area. A determination of sample size of 25 representative farms will be selected based on combined purposes of convenience and purposive sampling.

Convenience Sampling: We would select those farms that would be most accessible for us and willing to cooperate with us to make data collection easy. Purposive Sampling: Based on the selection criteria identified, keeping in view the differences in operations, variation in farm size, its management practices shall be included in the sample.

Sample Size Justification: The proposed sample size of 25 farms, among other factors, denotes an optimal balance between the manageability of the sample and the variability in data. Using the Crecy and Morgan sample size table, this sample size is appropriate for a population size of 100 persons for reliable information. It ensures that the sample is representative, hence giving a comprehensive analysis of the impacts an IoT system can achieve in poultry farm management.

3.3.2 Sampling procedure

An adequate sample size estimation will be imperative to establish the validity and applicability of the findings to the wider population in the "Remote Monitoring and Control of Poultry Farms using IoT" project. In this respect, consideration has to be given to the fact that the available population comprises about 100 poultry farms within the targeted region. The stratified random sampling method will be utilized for drawing a representative sample.

Stratification: Since some of the important characteristics are farm size, the population will be stratified into distinct strata so that each subgroup is represented proportionately.

Random Sampling: Farm sampling will be done randomly in each stratum to make sure that the selection bias is at a minimum and the results are reliable. The random sampling could mean that if the total number of farms for the categories of small, medium, and large size is 40, 12, and 8, respectively, then random sampling will ensure that equal representation of all categories holds good.

Sample Size: The sampling frame shall cover approximately 30 farms to make sure that full data is taken at a minimum scope of work.

This structured sampling strategy ensures representative diversity in conditions and practices will be present in the selected sample in meaningful ways, hence gaining insight into IoT technologies applied to farm management.

3.4 Research instrumentation

3.4.1 Choice of research instrumentation

Instrumentation is the most important part in research within the project "Remote Monitoring and Control of Poultry Farms using IoT," since incorrect recording of data cannot serve the purpose it is meant for-that is, to capture the impact the system will have on farm management. Instruments shall be employed in combination, each serving a specific purpose in allowing comprehensive collection of data.

Choice of Research Instruments

Questionnaires: Quantitative data for this study would be obtained with the help of a standardized questionnaire among poultry farm operators. The instrument shall contain several questions and Likert-scale items that would determine the degree of satisfaction, efficiency, and ease of use related to the IoT system. This is anchored on the themes identified in the Review of Related Literature, to ensure the questions' relevance and appropriateness and are parallel to existing research about IoT applications in agriculture.

These tools contain open-ended questions, which shall be useful to the researchers in targeting the eliciting of detailed narratives about experiences the users have, challenges faced in the implementation, and suggestions for improvement. Semi-structured interview guides during the in-depth interviews among a subsample of farm operators: This is a qualitative approach that shall allow researchers to delve deeper into information that may perhaps not be captured from the quantitative data.

Checklist on Observations: A checklist on observation shall be developed aimed at recording real-time data systematically obtained from the myriad sensors installed on farms. Such checklists shall include parameters on temperature, humidity, gas levels amongst others that shall enable the researchers to directly evaluate functionality in IoT systems and monitor vital environmental variables on poultry health.

Development and Validation of Instruments

Data gathering instruments will include a questionnaire and interview guides devised by the researcher, informed from the insights obtained from the reviewed literature.

The instrument will be pre-tested on 5-10 poultry farm operators to ensure appropriateness in terms of reliability and validity. The questions should then be refined so that they are clear and relevant. Observation checklist shall be the basis set bench marks for monitoring of environmental conditions to make certain that metrics are to standards.

Scoring and Interpretation

Answers to the questionnaire pertain to a Likert scale of 1-strongly disagreed to 5-strongly agreed. Hence, quantifiable analysis for satisfaction of user and effectiveness of the system is allowed. Qualitative data from interviews will be thematically coded through noting of patterns and recurring insight on user experience with the IoT system. Hence, diversified research instruments have been incorporated into the present study, thereby allowing a holistic view concerning the remote monitoring and control system in poultry farming. Thereby, valued literature is added to the field of agricultural technology.

3.4.2 Validity and Reliability of the instrument

Any research instruments used in a study, like "Remote Monitoring and Control of Poultry Farms using IoT", should be valid and appropriate to ensure the quality of the data.

Validity

The questionnaire and interview guides shall be developed based on a thorough Review of Related Literature such that all questions are responsive to the research objectives. In addition, it shall undergo expert reviews to check the content validity of the instrument and make appropriate adjustments in line with feedback from industry professionals.

Reliability

For instance, the structured questionnaire will be pre-tested for reliability on 5-10 poultry farm operators who are not subjects of the study. This would help in refining questions and spotting inconsistencies. At the end, the internal consistency of the questionnaire will be determined using Cronbach's alpha, and a coefficient of at least 0.70 will be satisfactory enough to attest to acceptable reliability. Multi-instrumental methodology on questionnaires, interviews, and observations further perfects triangulation.

As a matter of fact, such multi-instrumental methods may turn out to be even more valid and reliable because they generate complex data.

3.4.3 Data gathering procedures

Data collection in the study "Remote Monitoring and Control of Poultry Farms using IoT" shall, therefore, be well structured as follows:

Preparation: Questionnaires, interview guides, and checklists for observation shall be developed and pretested to ascertain their validity and reliability before the exercise.

A questionnaire will be administered to the selected 30 poultry farm operators and request assistance from them in showing how to fill out the questionnaires. Some participants will be sought for qualitative information using semistructured interviews in this regard.

Observation: The researcher will be sent out under life conditions to the farms for data collection on observation checklists in regard to environmental and sensor conditions. These will be collected and set for quantitative and qualitative analyses in determining how the IoT system leads to comprehensive insights into poultry farm management.

3.5 Data analysis and interpretation

Therefore, the data analysis and interpretation will be important to understand the impact of the system at farms in the project "Remote Monitoring and Control of Poultry Farms using IoT."

Data Analysis Techniques

Quantitative Data: The data from the structured questionnaires will be analyzed for the following statistical techniques:

Descriptive Statistics will summarize responses by calculating means, medians, and standard deviations to provide an overview of user satisfaction and system effectiveness.

Chi-square tests shall be conducted to indicate the relations between different categorical variables. For instance, farm size and satisfaction level with the IoT system.

The analysis shall employ a correlation analysis in ascertaining the relationship existing between the variables in terms of strength and direction. For instance, sensor accuracy and operational efficiency. ANOVA will help explain whether the levels of satisfaction differ between broilers versus layers and other kinds of poultry farms. Thematic analysis of qualitative data from interviews: Responses are coded to ensure that emergent themes and patterns for deep insights about user experience and the challenges faced while interacting with the IoT system. This will then be placed, from a strategic viewpoint, within such a multidisciplinary analysis to ensure wide-based understanding of the effectiveness of the IoT system and actionable recommendations for improvements to be instituted in poultry farm management.

3.5.1 Ethical considerations

In the research project "IoT-based Remote Monitoring and Control of Poultry Farms", ethical issues shall be taken into consideration in order to sustain the integrity of this research venture, apart from the aspect of preventing harm or damage to the participants.

Ethical Considerations

Informed Consent: The respondents, who shall be operators of the poultry farms, shall be duly informed about the objectives of the research and of its methods to be used, along with any risk which potentially may occur. Written consent shall be obtained from the respondents so they are fully aware of their rights, which also includes withdrawal from the study at any instance without any repercussions whatsoever. The study will obtain Institutional Ethics Review Board approval before the actual collection of data, in order to ensure that research into ethical standards is upfront regarding the rights and welfare of participants.

Privacy: All information that may identify either of the participants will be anonymized, and data stored on secure servers. This ensures that no single farm is identified and that operators can be as candid as they want about their experiences. In the light of these considerations, this research will try to conduct its study in an ethical manner, attentive to the rights and welfare of all concerned.

3.5.2 Limitation of the study

Delimitations of Study

Delimitations have been done in the project "Remote Monitoring and Control of Poultry Farms using IoT" to put into perspective the scope that was done. It includes probable biases due to narrow geographic focus, in that data will be obtained from a limited number of farms in one region, which might or might not be representative of general agricultural practices of other regions. This is because the research is confined to some of the IoT technologies probably missing the more innovative ones. Such limitations would be minimized by the researcher using different approaches in collecting data and doing an extended test of the equipment. By laying out these limitations, the study becomes transparent regarding findings and the magnitude to which generalization can take place.

Requirements needed in remote monitoring and control of poultry farm a system can be categorized into 3. Of these are the tool needs, system series needs, and basic needs.

Table 1 Explains the needs.

N	**Poultry Farm system**	**Remote Monitoring Tools**	**Basic Needs**
1	Power 1	Gas sensor	User-Friendly Interface
2	Light bulb1	Dht11	Real-Time Monitoring
3	Cover box	Cooling fan	Resource Managemen
4	Relay 2	Relay	Data Accuracy

Table.3. 1.Needs and Analysis of Remote Monitoring and Control of Poultry Farm

NodeMCU Circuit

Tools and Materials Needed in the Preparation of NodeMCU Circuit. Tools and materials needed during the preparation phase of the NodeMCU circuit are divided into 2 parts: software and hardware. Table 2 need analysis of the NodeMCUcircuit is displayed in Table 2.

N	Hardware	Software
1	NodeMCU	LUA SCRIPTING
2	Light bulb	
3	Gas Sensor	
4	Dht11	
5	Jumper cable	

Table.3. 2.NodeMCU Needs Analysis

The analysis of needs in making an electronic circuit is divided into two parts: hardware and supporting tools. The requirements are shown in Table 3 below.

N	Hardware	Cables
1	NodeMCU	USB cable
2	Cooling Fan	Male cable
3	Entire system design 1	Female Cables
4		Solder

Table.3. 3.Needs Analysis in respect of Electronic Circuit

CHAPTER 4: DESIGN AND IMPLEMENTATION OF REMOTE MONITORING AND CONTROL OF POULTRY FARM BASED ON IoT

4.0 Introduction

Poultry is considered a very important part of our nutrition all over the world, and has been a great source of proteins for millions of people since years. While poultry farms have to be managed very cautiously in light of different challenges regarding the living conditions of animals and the analysis of health status concerning the flocks, efficient management of operational costs. Conventional farming methods allow no realistic insight into real-time and data-driven decision-making; hence, operation inefficiencies and losses are common on many other counts. This monitoring and control of the poultry farm remotely would Blynk IoT an integrated revolution in poultry management with more technological advancements. A system on IoT devices, sensors, and data analytics would facilitate the farmers to monitor all the critical parameters, such as temperature, humidity, feed consumption, and health of birds, while sitting from one interface.

4.1 Block diagram

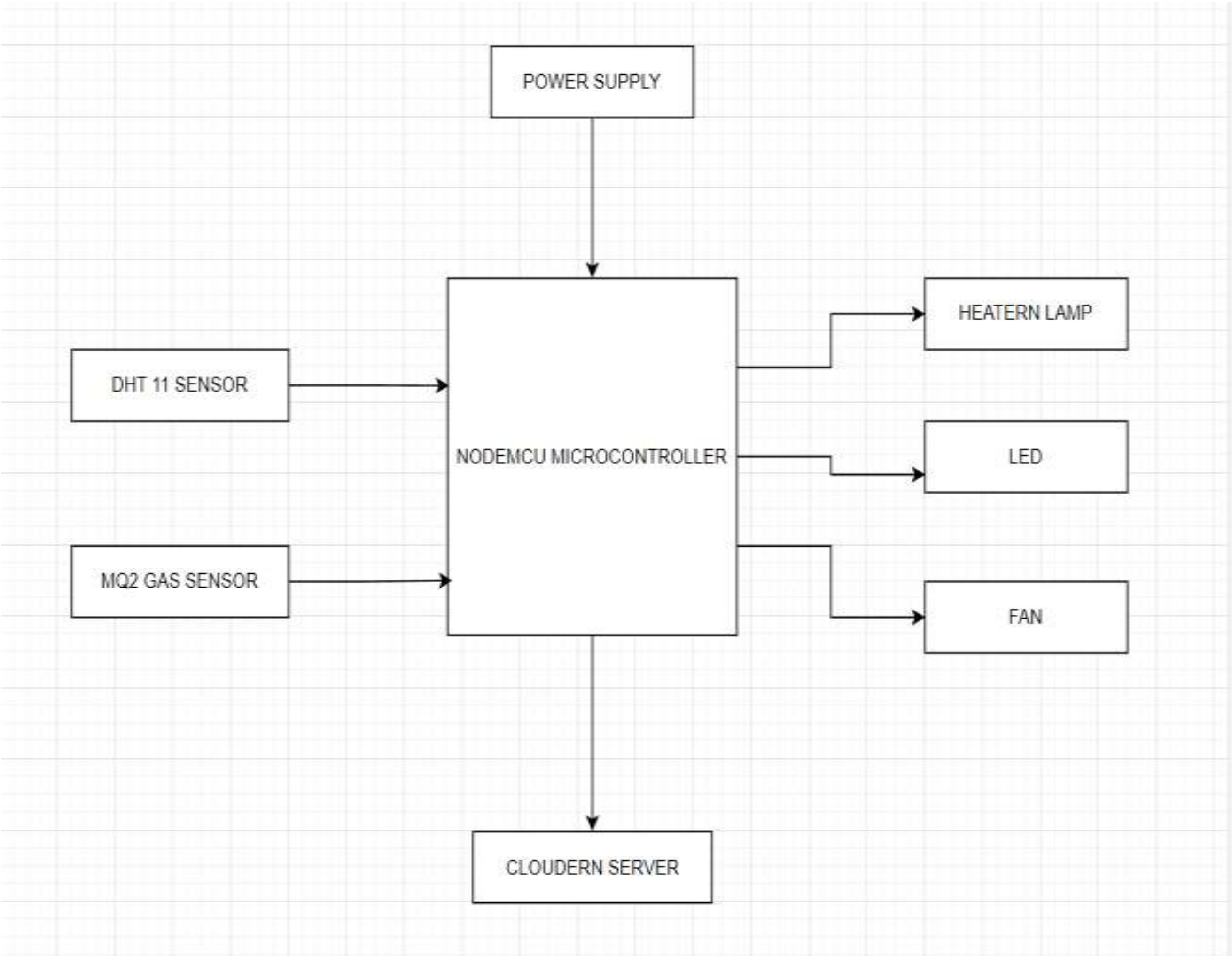

Figure.4. 1.Block diagram of the Circuit

4.2 Flow chart

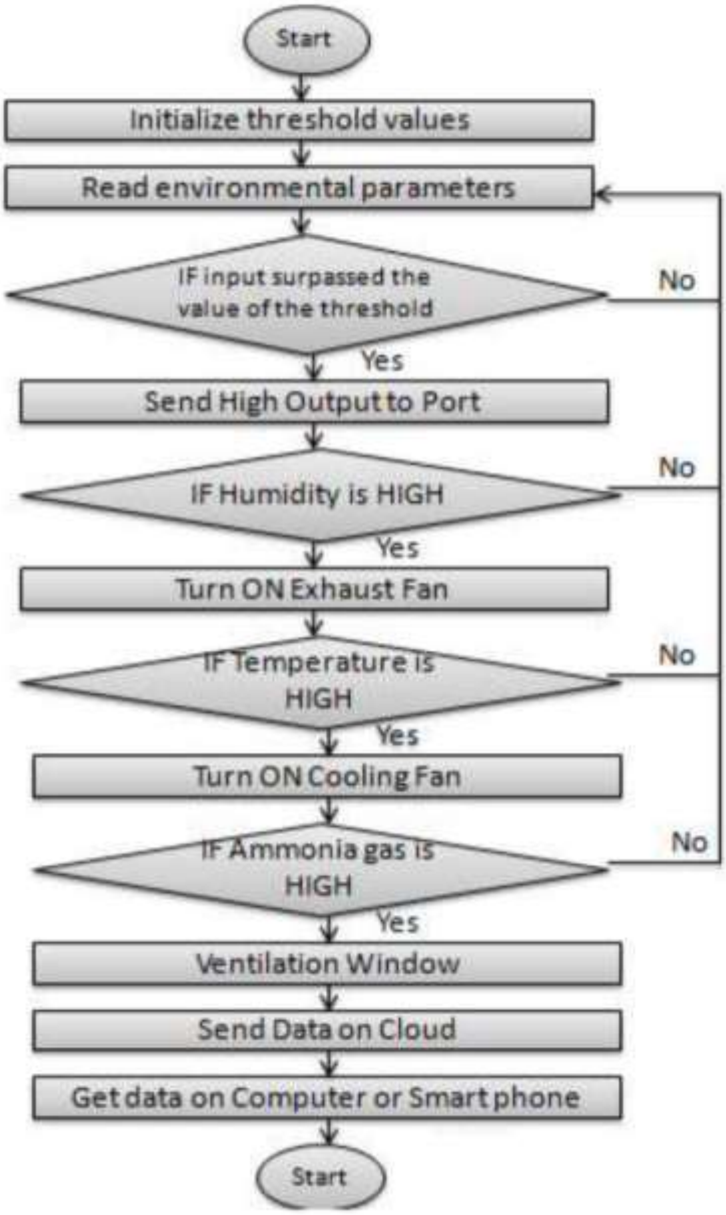

Figure.4. 2.Flow chart of the Circuit

4.3 Circuit diagram

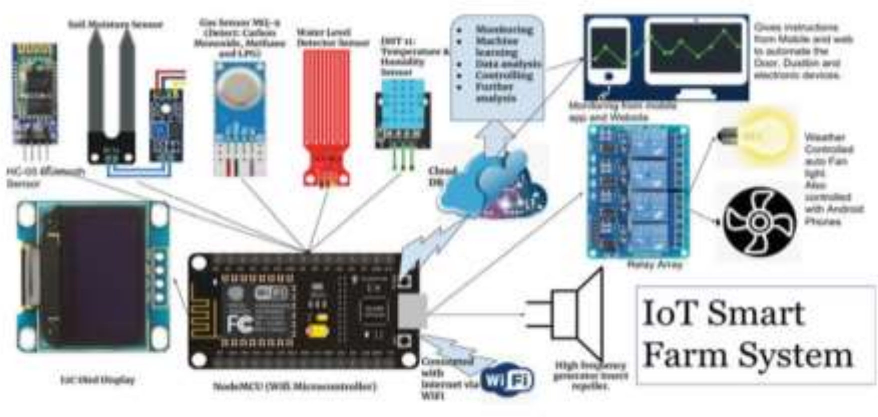

Figure.4. 3.Circuit diagram

4.3.1 Working principle

My system has hardware and software parts all over the world. The former includes all the physical devices used in this project, while the latter comprises codes of my software. Communication between the hardware part and the software part is made through NodeMCU programming.

a. Hardware part

1. NodeMCU Microcontroller: This will act as the controlling node for collecting and processing data.

Temperature and Humidity Sensors: These are to be used in the environmental monitoring of a place. Examples include the DHT11 or DHT22.

2. Air Quality Sensors: This would be applied in ammonia or CO_2 testing, including MQ-135.

3. Water Level Sensors: They would provide the measurement of water supply in terms of floating. Light Sensors: These will be helpful in measuring the amount of light that might affect poultry growth. 3. Cameras IP Cameras: For viewing live streaming of video and monitoring activities within poultry.

Thermal Cameras: To keep an eye on abnormal temperatures within birds. 4. Actuators Relays: These will help in controlling lights, fans, and heating systems.

3. Display Module: Local monitoring is enabled with an LCD or OLED display module. Mobile App/ Web Interface: Take control and monitor from anywhere in the world.

4. Cabling and Connectors: These provide for the secure connection of all components These place cameras and sensors in place with security. Implementation Considerations all the components have to be compatible with each other. A very reliable source of power may be considered, especially in the implementation stage at remote sites.

5. Particularly, ruggedness and weather resistance are to be emphasized in outdoor sensors.

While designing your system, consider scalability and flexibility for the future. It is with this that to a great extent, your poultry farm will be under effective monitoring and control, thereby creating databases which may be employed in making management decisions, enhancement of the health status, and productivity of birds.

b. Software part

Poultry management these days is a very technology-intensive activity and one of the changing faces of agriculture. The software solution to this project, Remote Monitoring and Control of Poultry Farms, would be the real backbone in ensuring flawless farm operations, high productivity, and better animal welfare. On the software side, in turn, the core will design a super-friendly interface through which the farm managers will be able to observe the real-time conditions either by web or mobile applications. Critical environmental parameters will show up, such as temperature, humidity, ammonia level, all combined in a way to keep the conditions in the best range for the health of the poultry. One will be an allowance for the flocks to be viewed visually in real time, further enhancing the security and speed of responses against whatever may be in play.

It does have a similar powerhouse of a backend system that conducts user authentication and processes coming from a wide array of sensors. This could be facilitated by Node.js or Python in the backend to facilitate seamless communication with the frontend in real time to relay updates and alerts through the system.

Data stored historically would reside in a relational database like PostgreSQL, enabling the trends to be analyzed and hence inform future decisions.

Special features are also incorporated in mechanisms of control, which allow users to switch on and off equipment from a distance, for instance, fans, heaters, and feeders. It can be set up in such a way that such operations become automatic at every instance some threshold levels are attained. It reduces manual interference in setting it up so that such operations become automated every time certain threshold levels are reached. Integration of IoT protocols such as MQTT ensures good communication between such devices, and the performance of the whole system improves.

Encryption of data and frequent safety audits for security reasons will protect sensitive information. On software, access is role-based, with only a few personnel making very important changes. After all, it is not all about the technology but all about the empowering of the farmer to make appropriate decisions, improve efficiency, and ensure health and well-being for his stock. In the development of the agricultural sector, it is just this type of innovative solution that will be required if poultry farming is going to be truly sustainable.

4.4 Implemented Circuit

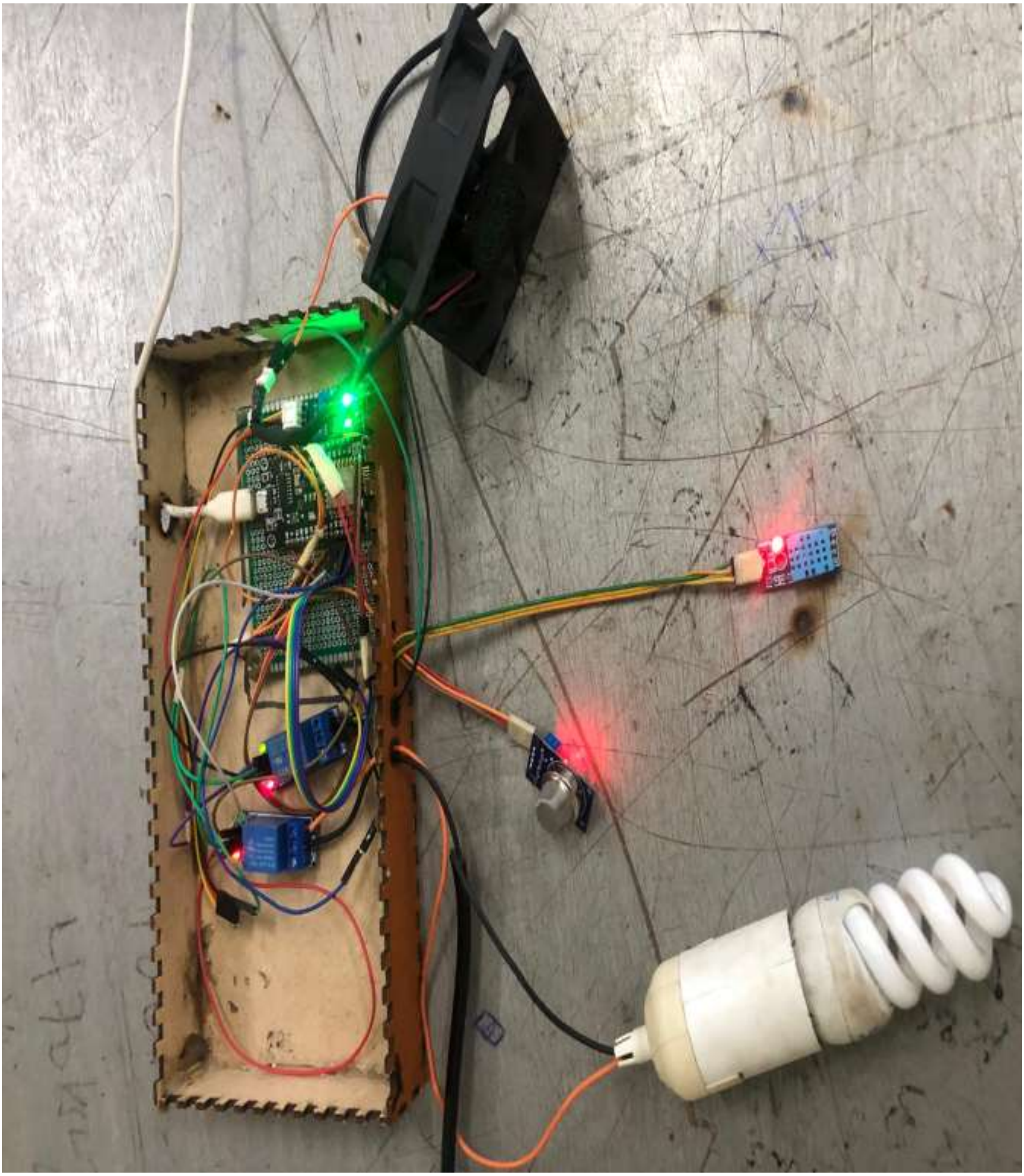

Figure.4. 4.Implementation of circuit

MATERIALS USED AND COST ESTIMATION

Number	Materials Name	Quality	Price for one piece (Frw)	Total price of pieces (Frw)
1	NodeMCU	1	11 000	11 000
2	Dht 11	2	15 600	15 600
3	PCB	1	5 000	5 000
4	Heater Lamp	1	8 000	8 000
5	Power Supply	1	15 000	10 000
6	Relay	2	5 000	5 000
7	D.C Fan	1	7 500	7 500
8	Jumper cables	30	3000	3000
Total				65100

Table.4. 1.Cost estimation

CHAPTER 5: CONCLUSION AND RECOMMANDATION

5.0 Introduction

This project comes from a long process of three years including the efforts of many people and institutions. By the way, with the help of this study, I have learned new programming languages, use new software, basics of wheelchair construction and put into the practice all the background gained from school including the group work behaviors and auto expertise.

5.1 Conclusion

The project is therefore a quantum leap in agricultural technology combined with traditional farming and new digital solutions. An extended software system used in this project provides real-time monitoring and control, which is a very critical concern of poultry farmers in respect to environmental conditions, animal welfare, and efficiency in operation.

What we have tried to depict along this development is how good data management coupled with remote capabilities may enable the farmer to make quick, informed decisions. This is where great potential lies in integrating with IoT devices and sensors for insight into temperature and humidity among other vital metrics, with timely interventions created well in advance of any impending problems. This approach saves health and, in this aspect, reduces losses leading to productivity and profitability. Besides, the interface developed is so simple that even a farmer of any level of technical training can operate the system with ease. Addition of automated alerts with the capability to exercise remote control over equipment makes life easier for a user and enables him to be more attentive to other issues. This way, farming becomes technologically enabled to be responsive and agile, promptly adaptive.

The prospects look great for further development as we round this project. Integration of the system to further advanced predictive analytics, AI, and machine learning will offer deeper insight into the areas of health and performance. An interface of this system with expansion to interface with market data would be further development that enables farmers to gather intelligence on things such as feed pricing and demand forecasts. The project of remote monitoring and control for poultry farming raises the bar in terms of the existing practices in farming and lays down the groundworks for a much greener, efficient, and sustainable future that is relevant to the production of poultry. In agriculture, innovative options continue to evolve with technology.

5.2 Recommendation

My project has been carried out with assistance of my supervisor and friends accordingly to the available time, resources, the objectives fixed have been attended, and the project can be implemented in a huge number of samples.

I delighted to highly recommend to anyone who will need to improve the project with the interesting and innovative ideas nevertheless, there is a lot of place for further development and improvement, which would Blynk IoT the system quality to another level. The regulation of the parameters will become even more effective, if the Artificial Intelligence is introduced into the system. In addition, there is a great opportunity to develop a front-end application that will be summarizing and displaying the measured data in the form of graphs and charts. Finally, User Feedback Mechanism Include a formal feedback mechanism with the users to receive regular intelligence and suggestions that will help solve the challenges of the day, hence Blynk IoT ing incremental improvement in the system Regular Software Updates: The software shall be updated to add new features, enhance security, and Blynk IoT about other changes as may be due to evolving technology and user needs.

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APPENDIX

CODE

```
#define BLYNK_TEMPLATE_ID "TMPL2YcYWMB21"

#define BLYNK_TEMPLATE_NAME "Remote Monitoring and Control Poultry Farm"

#define BLYNK_AUTH_TOKEN "ed_mLWX7f9PLieb5yre-4Eq2IMk47X5I"

#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#include <DHT.h>

//-------Auth Token

char auth[] = "ed_mLWX7f9PLieb5yre-4Eq2IMk47X5I";

//----Your WiFi credentials

char ssid[] = "REG-ROOM";

char pass[] = "ulk@2024";

//-----DHT11 Sensor Configuration

#define DHTPIN 14

  // GPIO 14 corresponds to D5 on ESP8266

#define DHTTYPE DHT11

 // DHT sensor type declaration

DHT dht(DHTPIN, DHTTYPE);
```

//---Pin Assignments

```
#define MQ2Pin 4

 // GPIO 4 corresponds to D2 on ESP8266

#define FanPin 0

// GPIO 0 corresponds to D3 on ESP8266 purple

#define LampPin 2

  // GPIO 2 corresponds to D4 on ESP8266 white

#define LEDPin 12

  // GPIO 12 corresponds to D6 on ESP8266

int trg;

int LEDState;

BlynkTimer timer;

// Initialize the BlynkTimer

//Subroutine for sending data from sensors to Blynk Server

void sendSensorValues()

 {

  int h = dht.readHumidity();

  float t = dht.readTemperature();

  int gasLevel = analogRead(MQ2Pin);

  // Check if any reads failed and exit early (to try again).
```

```
  if (isnan(h) || isnan(t))
 {
    Serial.println("Failed to read data from DHT sensor!");
    delay(500);
    return;
  }
  // Send data to Blynk
  Blynk.virtualWrite(V0, h);
  Blynk.virtualWrite(V1, t);
  Blynk.virtualWrite(V2, gasLevel);

  // Control the fan based on temperature
  if (t > 32) {
    digitalWrite(FanPin, HIGH);
    Blynk.logEvent("high_temperature", "Temperature is greater than 32°C!");
  } else {
    digitalWrite(FanPin, LOW);
  }
  // Control the lamp based on humidity
  if (h > 40) {
```

```
digitalWrite(LampPin, HIGH);
    Blynk.logEvent("high_humidity", "Humidity is greater than 40%!");
  }
 else
{
    digitalWrite(LampPin, LOW);
  }
  // Send notification if gas level exceeds 7%
  if (gasLevel > 71) {
 // Assuming analogRead value of 1023 corresponds to 100%, 71 corresponds to 7%
    Blynk.logEvent("high_gas_level", "Gas level is greater than 7%!");
  }
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print("% | Temperature: ");
  Serial.print(t);
  Serial.print("°C | Gas Level: ");
  Serial.println(gasLevel);
}
```

```
//void setup() {
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  dht.begin();
// Starting the DHT11 library
  pinMode(MQ2Pin, INPUT);
  pinMode(FanPin, OUTPUT);
  pinMode(LampPin, OUTPUT);
  pinMode(LEDPin, INPUT);
  timer.setInterval(5000L, sendSensorValues);
// Configure a timer to transmit sensor data every 5 seconds
  trg = digitalRead(LEDPin);
}
void loop() {
  Blynk.run();
  timer.run();
  LEDState = digitalRead(LEDPin);
  if (LEDState == 1 && trg == 1) {
    Serial.println("LED State : ON");
    trg = 0;
```

```
  }
  if (LEDState == 0 && trg == 0) {
    Serial.println("LED State : OFF");
  trg = 1;
  }
}
```