Automation Of Temperature, Humidity Regulation And Feeding System In Broiler Farming using IOT

Subhra Debdas
School of Electrical Engineering
KIIT Deemed to Be University
Bhubaneswar, India
0000-0003-1620-9370

Sthitprajna Mishra
School of Electrical Engineering
KIIT Deemed to Be University
Bhubaneswar, India
0000-0002-5132-6217

Siddhant Saha
School of Computer Engineering
KIIT Deemed to Be University
Bhubaneswar, India
0000-0001-9636-2679

Anindya Bag
School of Computer Engineering
KIIT Deemed to Be University
Bhubaneswar, India
0000-0002-8669-8336

Nilay Shukla
School of Computer Engineering
KIIT Deemed to Be University
Bubaneswar, India
0000-0002-0925-2963

Abhishek Kumar
School of Computer Engineering
KIIT Deemed to Be University
Bhubaneswar, India
0000-0002-2315-7532

Abstract—In recent years Internet Of Things (IoT) has become a major turning point in many parts of our day-to-day life and is being actively used in countering everyday problems. Various sectors such as healthcare, agriculture, home appliances, etc. are being optimized with the utilization of IoT. One of such sectors that have drifted towards advancement is poultry farming. There are various types of poultry farming such as Broiler poultry farming, layer poultry farming, and country chicken farming, However, in this paper, we exclusively deal with broiler poultry and the problems encountered in farming them. It is essential to constantly monitor and regulate Temperature and Humidity to keep the chickens in a favorable environment. It is also highly required to ensure proper and timely feeding of chickens and controlled management of litter.

To achieve this and overcome problems faced in these parameters we utilize IoT which is more efficient in gathering this real-time data and meeting the requirements in a more conducive way which is difficult for a poultry farmer to collect manually. The gathered data is stored and then processed and then measures are taken to increase the efficiency of the farm. And hence, the farmer becomes successful in operating and maintaining the farm at a desired and optimum condition.

Keywords- Internet of Things (IoT), Sensor, Feeding System, Smart Window.

I. INTRODUCTION

Poultry farming refers to the rearing of birds domestically or commercially, primarily for meat and eggs. Chickens, Turkeys, Ducks, and geese are of primary importance. Chicken farming is subdivided into 3 types namely Broiler Farming, Layer Farming, and Country Chicken Farming. In this paper, we are exclusively dealing with Broiler Chicken Farming. Poultry meat is an important source of high-quality protein, minerals, and vitamins which are essential to balance the human diet. Availability of broilers with trades such as quick growth and high feed conversion efficiency are rising [1]. Broiler farming can be the main source of family income or can provide gainful employment to farmers. Poultry manure can also be used for increasing the yield of crops because it has a high fertilizer value. Several advancements have been made in the recent years by the poultry industry in order to meet the ever increasing demand for inexpensive and safe supply of meat. The share of the poultry industry in the world meat production increased from 15% three decades ago to 30% currently (FAO,2006a). In the last three decades, India has made remarkable progress in broiler production and the broiler population in the country stood at 2300 million during 2011-12 [4].

Currently, India has an annual production of 2.47 million MT and has emerged as the fifth largest producer of broiler meat in the world. This growth has been brought upon by structural changes that occurred within the sector and has been supported by the emergence of industrial farming [3]. Structural changes within the sector brought upon growth which was supported by emergence of industrial farming establishments, intensification and concentration of poultry operations specialized and more integrated facilities, and optimized nutrition and new production technologies [5]. Despite all this, there are several problems that farmers encounter in the process of broiler farming. Some important challenges to the sector include scarcity of poultry feed and their high prices. Another major problem faced in broiler production is climate change. Under high temperatures, feed intake decreases, and carbohydrates metabolism and protein synthesis efficiency are disturbed. Also, the high prices of veterinary services and harsh environmental conditions concerning thermal stress are some of the challenges that hinder the optimal growth of the birds [2]. Here, IOT plays an important role in overcoming these problems and helping the farmers achieve desired results. Smart broiler farming is primarily associated to the work done on data that is gathered from various sources in the management

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taking place in a poultry farm [1]. Smart farming deploys hardware(IoT) as well as software(SaaS) to provide executable action plans to maintain all operations on the poultry farm. The purpose of making a poultry farm advanced is to improve the quality, sustainability, and the number of broilers in farming. Smart poultry farming is also important to counter the problems faced during broiler poultry farming. The IoT application here has been devised for smart broiler farming by using Wireless Sensor Networks(WSN) such as temperature regulation, humidity regulation, and automatic feeder system. To devise an IoT-based broiler farming, some interests are to be delivered precisely [9]. Firstly, specific sensors (temperature sensors, humidity sensors, etc.) vital for IOT application are to be chosen. The IoT-based methods devised here include using smart windows for temperature regulation, a humidifier for smart humidity regulation, and an automatic feeder system for automation of the feeding cycle. Next, the sensor should be adjusted according to poultry farm requirements, then a wireless communication system is established to link the sensors as per demand[3].

II. METHODOLOGY

A. Temperature And Humidity Regulation

In the proposed system we aim to achieve and maintain an efficient system to regulate the temperature and humidity of a Broiler Poultry Farm. To attain this, initially, we construct a greenhouse of dimensions 40-50 ft. Wide, 400-600 ft. Long, and sidewalls of 8 ft. Height which is eventually converted into our broiler poultry farm[4]. The purpose of this greenhouse is to maintain an ideal temperature and humidity conditions to better raise the chickens. The greenhouse will provide sufficient warmth by trapping the sun's heat during the daytime and keeping the inside warm in the nighttime. However, too much is unnecessary and if left unchecked can have adverse effects on the growth and well-being of the poultry even leading to death in some cases. The same is the case for too little heat or freezing temperatures. Hence

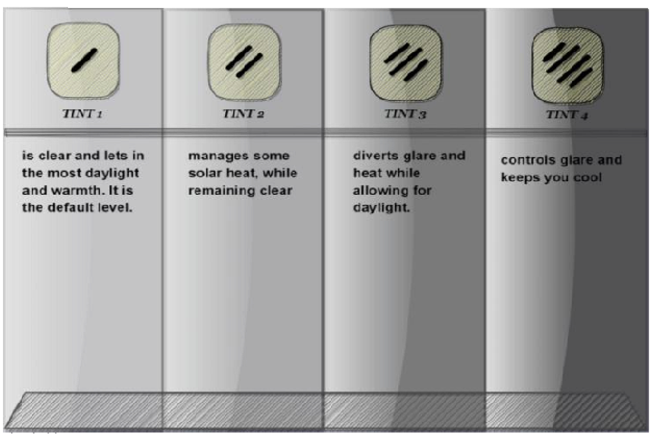

Fig 1 : Smart Window

an average temperature of 32ºC for larger chickens and 29ºC for chicks is constantly maintained [10].

We construct this greenhouse with smart windows which allow the farmer to regulate the heat and light transmission properties of the window (Fig.1). This window works on the principle of electrochromism i.e., the dual-band electrochromic material blocks the light of certain wavelengths such as UV and near Infrared light instantaneously when a voltage is applied [7]. The amount of heat energy required in different seasons can be regulated, which eventually increases the energy efficiency of the farm. Some metal oxides such as tungsten trioxide(WO_3) exhibit electrochromism which conducts both electricity and ions. This octahedral structure has a nanoporous arrangement with "tunnels" in three dimension between each octahedral segment allowing dissociated ions to move through the substance in presence of an electric field [5]. Commonly used ions for this objective are Li^+ and H^+. Two flat, transparent electrodes on either side of the ion containing layers are used to generate an electric field. The oxide is penetrated by the ions due to a charge difference brought on by a voltage applied across the electrodes. An electron moves between two metal ions when photon reaches the oxide layer. Hence, the movement of an electron is caused due to the energy provided by the photon which results in the absorption of the photon. Other oxides such as Molybdenum, titanium, and niobium oxides can also be used, although these are less effective optically [7].

Seven layers are required for a functional smart window which exhibits electrochromic characteristics. The first and last layers are clear glass that is made of silica. The voltage is applied by two electrodes. This applied voltage pushes or pulls the Li^+ ions from the storage layer of ion which brings them into the electrochromic material through the electrolyte[6]. If a voltage of 4 Volt or more is applied, the lithium ions are pushed into the electrochromic layer which deactivates the electrochromic material thus, making the window fully transparent. If we apply a voltage of 2.5 Volt, the concentration of Li^+ ions in the electrochromic layer decreases, thereby activating near-infrared active tungsten oxide [8]. The infrared light is reflected, thus decreasing the greenhouse effect, which in turn reduces the amount of energy required for air conditioning.

Another important factor that needs to be kept in constant check is humidity. Both increased or decreased humidity is unfavorable and also severely impact the health and growth of Broilers, which too leads to death in some cases. An ideal relative humidity range of 60-80% for larger chickens and 40-60% for chicks is desirable. Hence, to regulate and maintain these conditions we use a humidifier to increase humidity and a dehumidifier to decrease humidity.

An Evaporative humidifier is the most commonly used humidifier. For the most part, this type of

humidifier is simple as it is self-regulating. A reservoir holds cold water and dispenses it into a basin. The water is absorbed by a wicking filter from the basin. Air is blown through a moistened filter by a fan.
Some of the water is evaporated there as air passes through the filter[7]. As humidity increases, the humidifier's water-vapor output naturally decreases. It is harder to evaporate water from the filter when the relative humidity is higher which is why a humidifier is self-regulating.
The dehumidifier works on 2 steps principle:
Extracting moisture out of the air: Fanning the moist air in the house and running it over a cold coil (Evaporator) which condenses moisture out of that air and collects the water into a water tank via a drip tray. Thus, we obtain cold but dry air [4].
Heat the dry air back up: Run the cold but dry air over a hot coil (Condenser) to bring it to room temperature. The dry air is fanned back into the house [5].

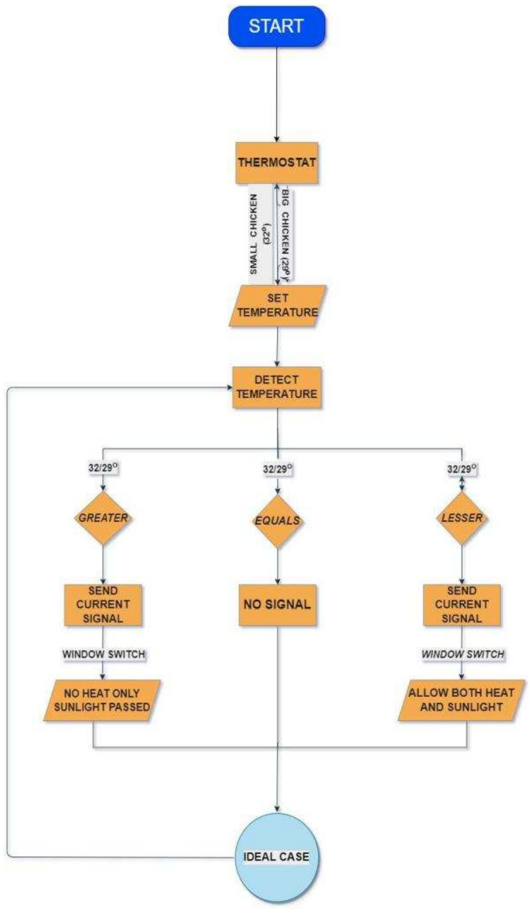

Fig 2 : Layout of Temperature Regulation

The method proposed involves connecting 2 sensors; one for temperature sensing and another for humidity sensing; to the smart window that will perform their respective tasks of detecting the external temperature and humidity respectively to regulate them to keep the internal environment at an ideal state. To automate this process, a smart plug comes into play. The software of this device is modified using IFTTT (If This Then That) which allows the user to set an ideal parameter that will operate based on conditional statements. Both the sensors are paired to the internal hub of the smart plug that receives the signal sent from the sensor. The smart plug then treats this as input, compares it with the ideal user set parameter, and regulates it accordingly, giving us the desired output [8]. In our case, the plug is set to a temperature of 32^{o}C and humidity of 60-80%. these values are treated as ideal and are to be maintained accordingly. When the external temperature exceeds or lowers this value, the change is detected by the sensor which sends this information to the smart plug. It then checks the ideal values given by the user and either regulate the smart window to allow only light but block heat or switches it to allow both heat and light as required [12]. If the signal from the sensors matches the input given to the smart plug by the user, then no action is taken(Fig.2).
The same applies to humidity regulation as well where the action executor is the humidifier or dehumidifier depending on the requirement(Fig.3).

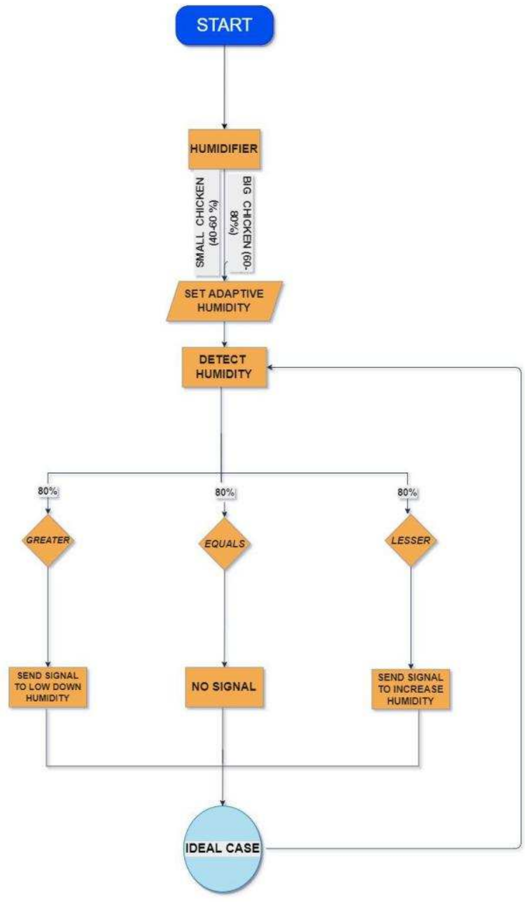

Fig 3 : Layout of Humidity Regulation

B. Automatic Feeding System

Feeding the broiler chicken is essential for their survival. The food needs to be provided in a timely and orderly manner with fixed portions to avoid overfeeding and underfeeding. Generally, people in charge of maintaining the farm are assigned this duty which leaves space for error, such as incorrect portions or untimely feeding of chickens. In the proposed system, we aim to eliminate the possibility of these errors with the help of IoT by automating the feeding process by installing an Automatic Feeder System made by utilizing Arduino. In the proposed mechanism we are utilizing a 17*4 LCD to display the time using DS3231 RTC MODULE with Arduino UNO, which is used to set the time and date on which the chickens need to be fed. A PIR sensor is used to set an alarm. A servo motor is also used to provide the food and a 4*4 matrix keypad to manually set up the feeding time. The container opening duration according to the quantity of food to be served can also be set. To control the working of servo motor, LCD 17*4, DS3231 RTC module, and 4*4 matrix keypad we define various libraries like :

"#include <DS3231.h>" to control RTC module

"#include <servo.h> " to control Servo motor

"#include <LiquidCrystal.h>" for LCD

"#include <keypad.h>" for matrix keypad

We assign A4 and A5 pins of Arduino to connect the pins SCL and SDA of DS3231 [2]

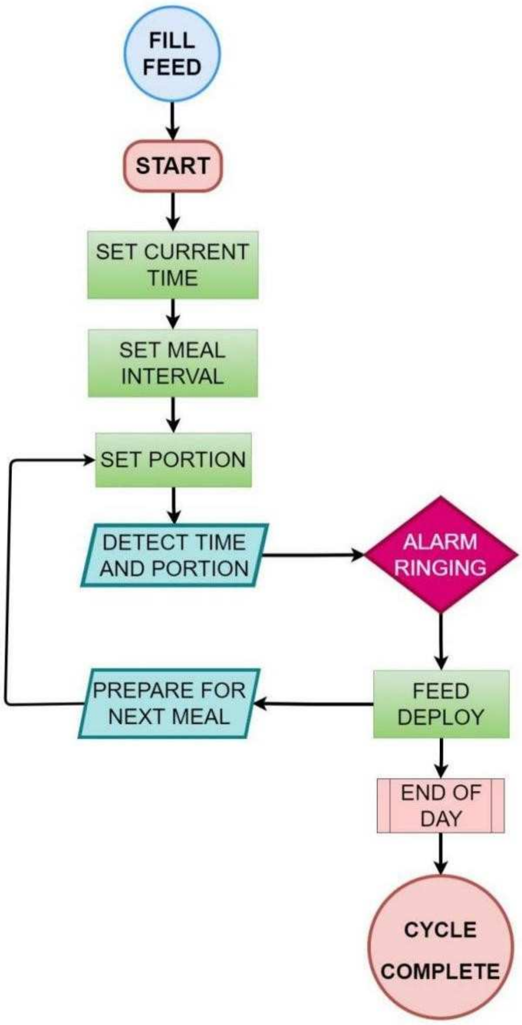

Fig 4 : Layout of Automatic Feeding System

In the same way, we use commands like "button press", "if " statements to set the function of feeding time which then compares real-time with entered time to release the feed with the help of the Servo motor which rotates an angle of 105 degrees and comes back to initial position after a delay of 2-3 seconds [9].

In this way, we can determine meal portions and meal times and the entire system will function without the need for human interference. In the suggested method, firstly the chicken feed is fed into the machine and the automatic feeder is turned on. Next, the current time is set. This needs to be done when the system is newly installed to maintain the mealtime intervals. Next, the meal times are fed into the system, which is stored in the system memory and remains unchanged until done otherwise. The mechanism is similar to set multiple alarms in an alarm clock. Then the user fixes the meal portions and saves these data onto the system[6]. Once the required data has been provided, a digital clock starts running while displaying the time at any given instant [10].

Once the mealtime arrives, a built-in alarm goes off and the set portion of feed is released. After release, the system restarts and prepares itself for the next meal interval. This cycle repeats until the end of the day when all the meal times are over. The system is however ready for the next day and the cycle continues until changes are introduced manually (Fig.4).

III. RESULT ANALYSIS

The proposed system, as presented in this paper discusses the working of a smart broiler poultry farm. We gather the related essential data of change in humidity and temperature of the broiler poultry farm from respective temperature and humidity sensors and the data is thereby processed and the outcome is obtained in the form of graphs and an output signal to the cloud of a smart switch, through these sensors (Fig.5).

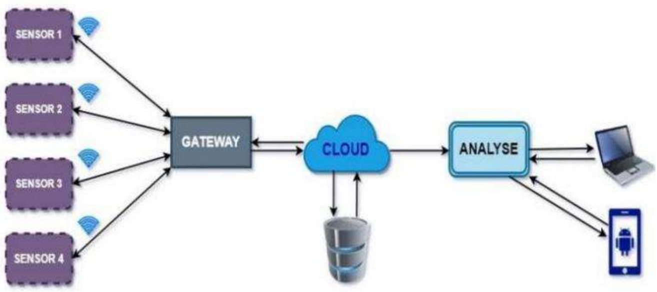

Fig 5 : Layout of Flow of Data

This control of humidity and temperature through a smart switch is completely based on controlling IOTs through conditional statements [11]. We manipulate the internal software of the smart switch manually by using conditional statements (if and else) and then we feed the values of temperature and humidity i.e., 30℃ and 60% respectively. If temperature and humidity either increase or decrease from the set value, the smart switch automatically regulates the smart window, humidifier, and dehumidifier.

After including the conditional statements, the data from sensors are stored in the cloud of the smart switch and the output graph of temperature and humidity change is sent to the user's device that is paired with the cloud of the smart switch and the smart switch operates according to this output and hence, the temperature and humidity inside the Broiler Poultry Farm remain at the required level [5]. For proper and timely feeding of broiler chickens, we use an automatic feeder that is based on Arduino (machine learning) software. Arduino has DS3231 RTC MODULE that controls date and time. For DS3231 RTC , servo motor, LCD and matrix keypad we define libraries using "#include <_.h>" in Arduino[12]. The working of this feeder requires clusters of libraries, functions, and commands in Arduino. After getting defined libraries and functions, the command runs, and the machine starts working and releasing the given portion of feed in the Broiler's feed bowl at a given time interval [3].

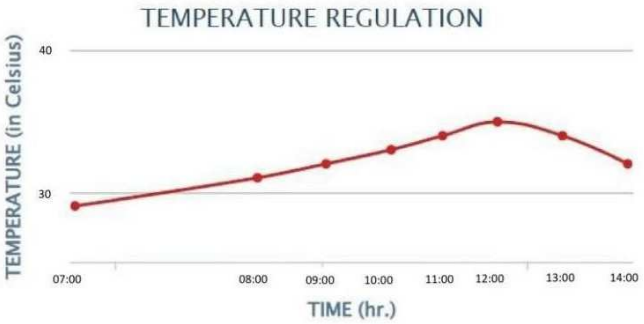

Fig 6 : Data of Temperature detected over time

From the above graph (Fig.6), we can observe the data recorded by the temperature sensor. The interval of data recorded is from 07:00 am to 02:00 pm on the 15th of May 2022. The sensor first recorded the temperature at 07:00 am, which was 29°C. As the day progresses, the temperature reaches its peak at approximately 12:00 pm which was 36°C. Then, the temperature decreased and the final recorded data was obtained at 02:00 pm which was 32°C. This collected data from the sensor is sent to the cloud which is then extracted for the functioning of the smart window.

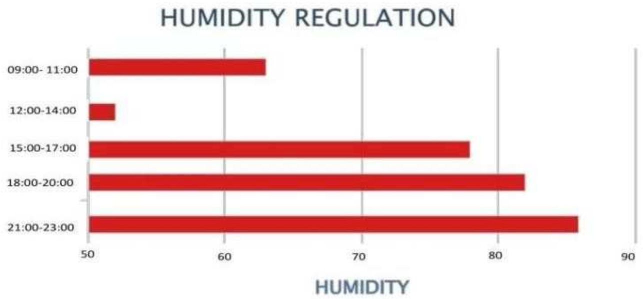

Fig 7 : Data of Humidity detected over time

From the graph shown above (Fig.7), the data recorded by the humidity sensor is observed. The data obtained was recorded on the 15th of May 2022 in the time interval of 09:00 am to 11:00 pm. Humidity was detected by the sensor every two hours. The first data recorded was from 09:00 am to 11:00 am which was 63%. The humidity was observed to be at its minimum i.e. 52% during the interval 12:00 pm to 02:00 pm. Moving forward into the day, the humidity gradually increased to 78% from 03:00 pm to 05:00 pm then to 82% in the interval 06:00 pm to 08:00 pm, and finally achieved its maximum value of 85% from 09:00 pm to 11:00 pm. This recorded data collected by the sensor is sent to the cloud which is then used in humidity regulation by the humidifier as well as the dehumidifier.

IV. CONCLUSION

This paper suggests the idea of smart temperature-humidity regulation and automatic feeding of Broilers in Broiler Poultry farms with the aid of Internet of Things (IoT) and Machine learning. The smart system collects data such as temperature, and humidity and also controls the time and portion of feed for broilers. The collected data gets stored in the cloud and then processed and analyzed by specific algorithms and commands. The proposed system comes up with the proper study of the temperature and humidity and helps the farmers to take the necessary measures required for the production of a large number of Broilers.The provided algorithms and commands are first evaluated, where real-time data of temperature and humidity recorded by the sensors is compared to the factual data. The provided commands and algorithms also control the time, portion of feeding, and display time in the LCD of the automatic feeder. The graphs plotted in accordance with the data are visualized here. Now, according to the analyzed data, successive measures such as changing the layout of the smart window, switching on and off the humidifier and dehumidifier, and setting the time and portion of feed are accomplished. For application of this work in the near future, advanced litter management using a suction pump can be done. The collected litter can be converted to organic manure which can be used for treating the fertility of the soil. The system described here is efficient and user-friendly. Installation of these systems aids in the optimization of the broiler poultry farm and hence helps to reduce the possibility of human error, thus making the maintenance of the farm easier and more efficient, thus taking a step forward towards converting the farm into a smart farm.

REFERENCES

[1] J. de Bruyn, “Reviewing the roles of family poultry in food and nutrition security. Healthy chickens, healthy children? Exploring contributions of village poultry-keeping to the diets and growth of young children in rural Tanzania,” 2017.

[2] A. Botta, W. De Donato, V. Persico, and A. Pescapé, “Integration of cloud computing and internet of things: a survey,”Future generation computer systems”, 2016.

[3] Adrian Batuto, Timothy Bryan Dejeron, Paolo Dela Cruz, Mary Jane C. Samonte, “E-Poultry: An IoT Poultry Management System for Small Farms”,2020.

[4] M.S. Farooq,S. Riaz, A. Abid, K. Abid, and M. A. Naeem, “A survey on The role of of IOT in agriculture for the implementation of smart farming”, 2019.

[5] G. Corckery, S.Ward, C. Kenny, and P. Hemmingway, ”Monitoring environmental parameters in poultry production facilities”, in Computer Aided Process Engineering-Cape Forum 2013. Graz, Austria: Institute for Process and Particle Engineering, Graz Univ. Technology, 2013.

[6] Rupali B. Mahale, Dr. S. S. Sonavane, “Smart Poultry Farm Monitoring Using IOT and Wireless Sensor Networks”, International Journal Advance Research in Computer Science, Volume-7, 2016.

[7] M. P. Archana, S. K. Uma, TM Raghavendran Babu, “Monitoring and Controlling of Poultry Farm Using IOT”, International Journal of Innovative Research in Computer and Communication Engineering, Vol. 6, 2018.

[8] P. Kundu, S. Debdas, S. Kundu, A. Saha, S. Mohanty and S. Samaanta, "Cloud Monitoring System for Agriculture using Internet of Things," 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), 2020, pp. 617-622, doi: 10.1109/ICECA49313.2020.9297405.

[9] S. Debdas, S. Mohanty, B. Biswas, A. Chhangani, S. Samanta and S. Chakraborty, "IoT Based Fog and Cloud Analytics in Smart Dairy Farming," 2021 International Conference in Advances in Power, Signal, and Information Technology (APSIT), 2021, pp. 1-6, doi: 10.1109/APSIT52773.2021.9641456.

[10] S. Debdas, S. Chakraborty, B. Biswas, S. Mohapatra, Y. Gupta and T. Dutta, "Smart Farming using IoT and LoRaWAN," 2021 IEEE 2nd International Conference on Applied Electromagnetics, Signal Processing, & Communication (AESPC), 2021, pp. 1-5, doi: 10.1109/AESPC52704.2021.9708497.

[11] S. Debdas, S. Mohanty, S. Kundu, S. Mohanty, B. Biswas and A. Pal, "Short-Term Load Forecasting Using Time Series Algorithm," 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), 2021, pp. 1518-1524, doi: 10.1109/ICAIS50930.2021.9395948.

[12] S. K. Barik, S. Mohapatra and S. Debdas, "Multi-Neuron Functional Link Artificial Neural Network: A Novel Architecture and its Performance for Wind Energy Prediction," 2022 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS), 2022, pp. 447-451, doi: 10.1109/ICSCDS53736.2022.9760812.