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ORIGINAL RESEARCH ARTICLE

CLOUD-BASED IOT MONITORING SYSTEM FOR POULTRY FARMING IN NIGERIA

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ABSTRACT

The monitoring of environmental parameters of poultry farm using IoT applications is no longer a new research area in the field of engineering. However, the cost of implementing most of the reviewed research work seams unaffordable to rural farmers in Nigeria. This could limit the adoption and usage of such devices. In this paper, we present a cost-effective cloud-based IoT monitoring system for poultry farming. The system uses two vital weather parameters- temperature and humidity. The methodology adopted, employed the use of DHT11 sensor (a temperature and humidity sensor) to note every change in temperature and humidity data of the farm environment. The sensed data were extracted, sampled and processed by the microcontroller before transmitting the data to a remote cloud server through the WiFi module. The cloud server (Thingspeak) received the sensed data, analysed the data and plot the data graphically. The plotted graph is viewed from a computer or any smart devices. The result indicates that temperature and humidity values range between 33-38°C and 31-33mmHg respectively. Furthermore, the results show that the device is efficient in monitoring the two environmental parameters. Therefore, the efficiency of the system will no doubt provide much quicker and accurate information about change in temperature and humidity data of farm environment.

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1.0 Introduction

Nigeria is becoming sufficient in poultry meat due to government policies. Recently, poultry farming is one of the fast paying and a very attractive job in Nigeria with a net annual worth of 250 billion naira (Pagani et al., 2008). Poultry chicken provides nutritious food rich in high animal protein, low cholesterol and fat, and a lower amount of energy than any other kinds of poultries. However, several environmental factors limit the growth and mass production of these chickens. These factors may cause extremely high loss of birds before they reach maturity if not properly managed. Environmental factors such as temperature, humidity, carbon IV oxide (CO_2) concentration and Ammonia concentration (Wu et al., 2011) determines the health condition of poultry birds. These environmental factors could be altered by installing a device that monitors the changes in these parameters. Traditional methods employed in managing these parameters involves close observation using trial and error method and may increase human efforts and time. These methods may not be effective when compared with the proposed method. The introduction of internet of things (IoT) has brought real-time surveillance, information analysis as regards to health conditions of the birds, remote device control, and decision and policy support for poultry farmers (Bhavanam, 2018) which improves the efficiency and reduce labour intensity.

In this paper, a cloud-based IoT monitoring system for poultry farming which can generate real-time environmental-based information on maximum and minimum temperature and humidity of poultry farm to a remote server daily was proposed. The system is internet-oriented, cost-effective due to the available online remote server and has a remote sensor for collection of data which can be viewed on the cloud. The optimum driving factors of this system is that it is noise-free, cloud-based analytic and offers IoT-based data collection. The system analyzes samples data in every five (5) seconds. The device, of course, has little or no impact on the daily activities of the chicken and can be installed in any poultry farm to monitor environmental parameters.

Several research works have been done on IoT-based monitoring. However, Li et al. (2015) implemented a remote monitoring system for the henhouse environment based on IoT technology using a MySQL server. The system was designed to record all the parameters such as temperature, humidity and ammonia concentration of the henhouse. The records of all the parameters were uploaded on the MySQL database. The accuracy of this system was compensated and corrected using a data loss recovery strategy software to recover data missing during transmission. The deployment of wireless sensor and mobile phone in monitoring and controlling the environmental parameters of poultry was proposed by Sneha et al. (2016). The research employed all the environmental parameter sensors including the MQ135 sensor module for monitoring air pollution level within the poultry farm. The results of all sensed parameters were sent to the mobile phone through the computer system using the internet. The limitation of this research is in the event of network failure or limited coverage area of the network as regards to the location of the user. The automation of poultry feeding using IoT was also implemented (Rupali and Mahale, 2016). The implementation of this research has greatly reduced the effort of going back and forth to check if the food is enough for the birds. The use of a Raspberry-Pi approach to building a cost-effective monitoring device was proposed by Ibrahim et al. (2015) who used a coded python programming language on a single-board of Raspberry-Pi to control and monitor the environmental conditions of the poultry farm. The information from the sensors was uploaded directly to the internet where it can be viewed and accessed any-where and any-time. The system can also be used to detect earthquakes through an assembled seismic sensor. The monitoring of water, food level and environmental parameters of a poultry farm were also investigated (Bai et al., 2006). The system notifies the poultry manager about the internal condition of the farm through the use of wireless sensor and GPRS network (Jindarat and Wuttidittachotti, 2015). The system can also be adopted for controlling and monitoring of humidity in Agricultural, Science and Engineering fields (Palle et al., 2016). The adoption of CC3200-based cloud IoT for measuring humidity and temperature was proposed by Ms. Minal Goswami (2017). CC3200 is the first Simple-link WiFi internet-on-chip launch-pad developed by Texas instruments for measuring humidity and temperature graphically. The result of the measurements was sent to the cloud server for onward analysis. The research work of Goud and Sudharson (2015) elaborated more advanced technique of using SMS to query the system using wireless sensor and mobile network. The system can be used to automatically monitor and control the environmental parameters of the poultry. One particular feature of the system is that it only receives a command from a registered mobile number. The best industrial practice was adopted in measuring all the parameters with emphasis on the welfare of the birds (Corkery et al., 2013).

The reviewed work above has no doubt brought advancement in technology. However, the cost of implementation of all these reviewed works might not be economically viable. Most especially, in the rural areas of developing countries like Nigeria where social amenities like electricity, good roads and water are not available. Therefore, a cloud-based IoT monitoring system for poultry farming was proposed. The system has less protocol in programming and employed the services of a cloud-based server 'Thingspeak' for ease of data computation and analysis. This would reduce the cost of implementation and real-time access to information on the health conditions of the poultry birds on the farm.

2.0 Materials and Methods

The implementation of the system was based on the general knowledge of IoT applications which involve five (5) sections namely; Sensing unit, Microcontroller unit (MCU) embedded with WiFi, the display unit, the cloud services (Thingspeak database) and the power unit as shown in Figure 1.

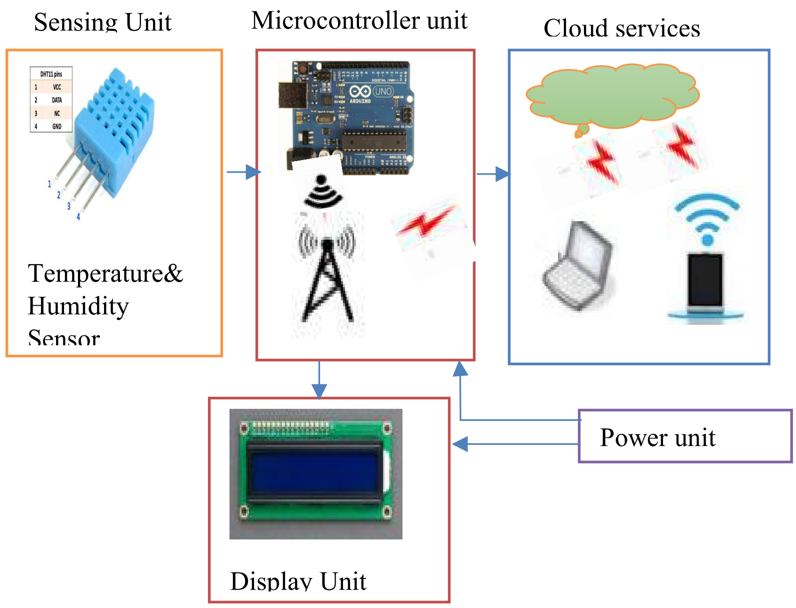

Figure 1 Schematic Diagram of Cloud-Based IoT Monitoring System

Each of the specified sections were embedded together to form a functional modular system. The cloud-based IoT monitoring system was set up and powered using a 3-5.5V battery bank on a school farm located in Tunga area of Minna. The sensing unit comprising of humidity and NTC temperature modular component (DHT11) powered-on and allow to initialized to undergo the unstable stage. The sensor was then calibrated with an accurate humidity calibration. The calibration coefficients were stored in the OTP memory as a program used by the sensor's internal signal detecting process to set the data single-bus to a high voltage level. This establishes a communication platform between the MCU and the sensor component (DHT11) which takes about 20-40μs. The sensor senses the temperature and humidity of the poultry farm, and sends the information to the MCU for further processing.

The MCU processes the sent information and transmits it to the Wi-Fi module through the universal synchronous receiver/transmitter (USART) for onward transmission to the database on the cloud using specific communication protocols. The MCU used, is an ATmega 328P programmable IoT-oriented application component, initially configured to interface with the sensing unit, Wi-Fi module and the display unit.

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The cloud database received the data collected from the MCU, analyzed it and plot the data graphically in real-time. The database uses API to stock and recalls data from things using Hypertext transfer protocol (HTTP) over the internet (The MathWorks, 2018). The document is a plain text-file with special markup tags that uses a web browser to interpret and displays information on the device screen. The webpage of the database can be implemented by logging-on to the website (The MathWorks, 2018) as illustrated in Figure 2, 3, 4 and 5. The cloud services employed for the research is Thingspeak. The selection of Thingspeak was based on the cost-effectiveness, open-source access of the database, analysis and data computation of the sensed data and easy implementation for visual monitoring of the poultry from any remote location.

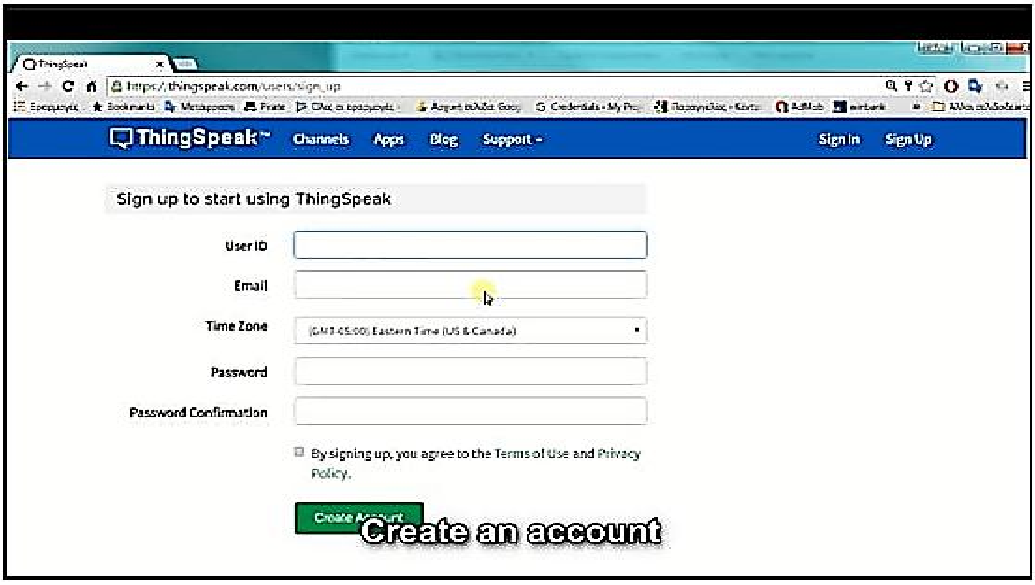


Figure 2 Creating an Account in Thingspeak [The MathWorks, I. (2018)]

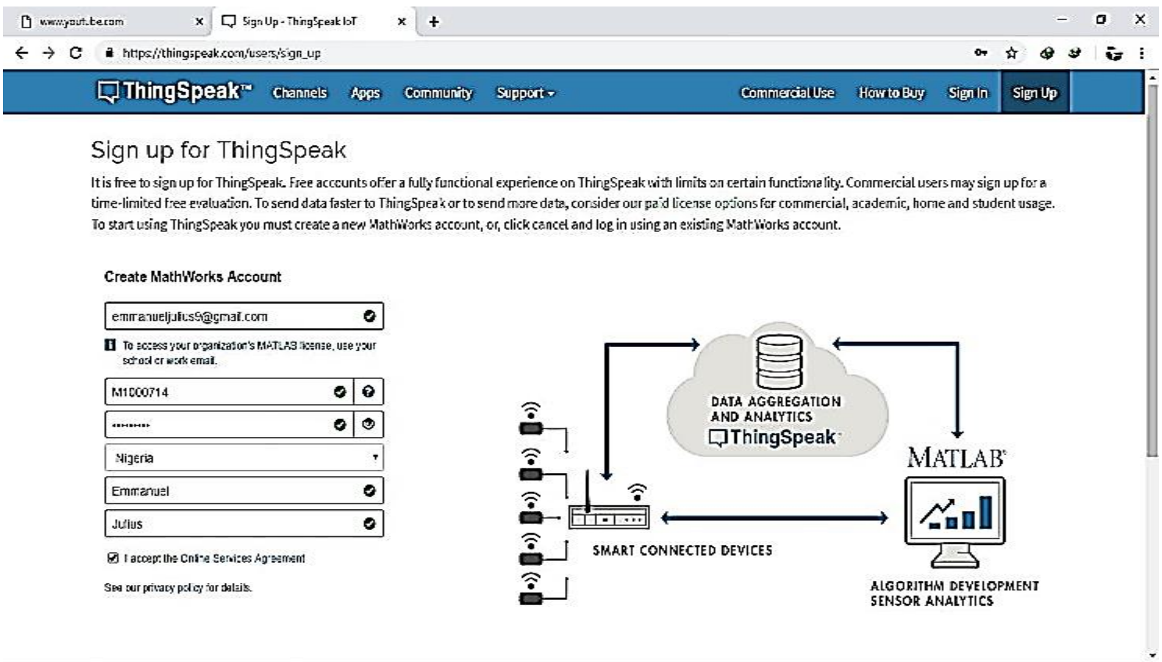


Figure 3 Login into the account created [The MathWorks, I. (2018)]

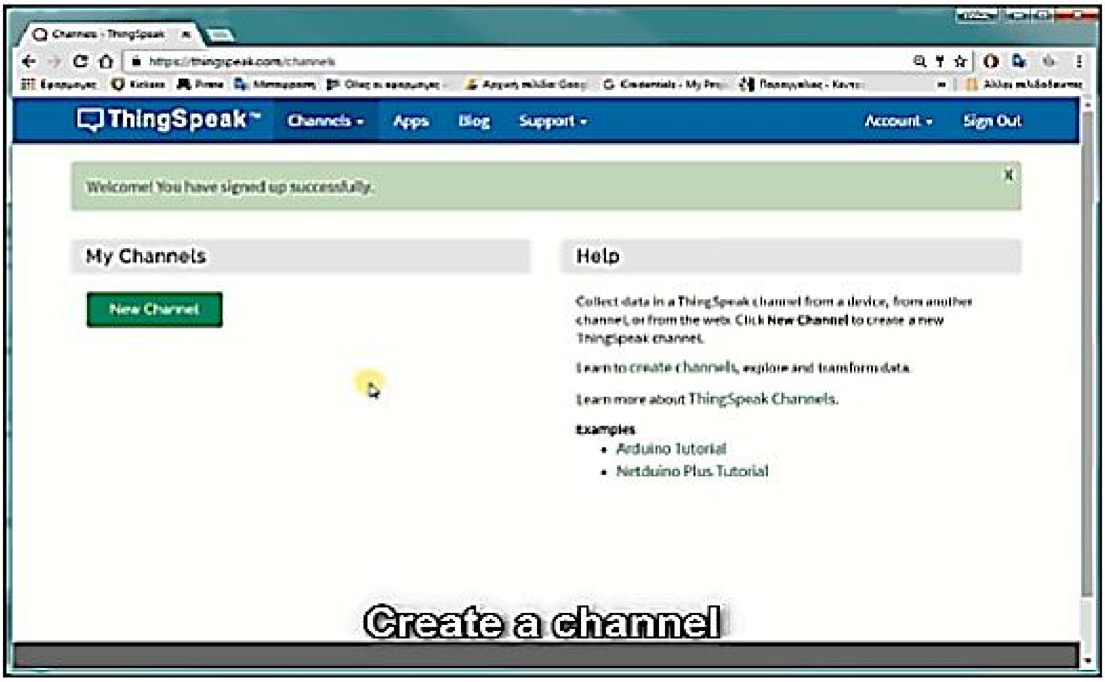
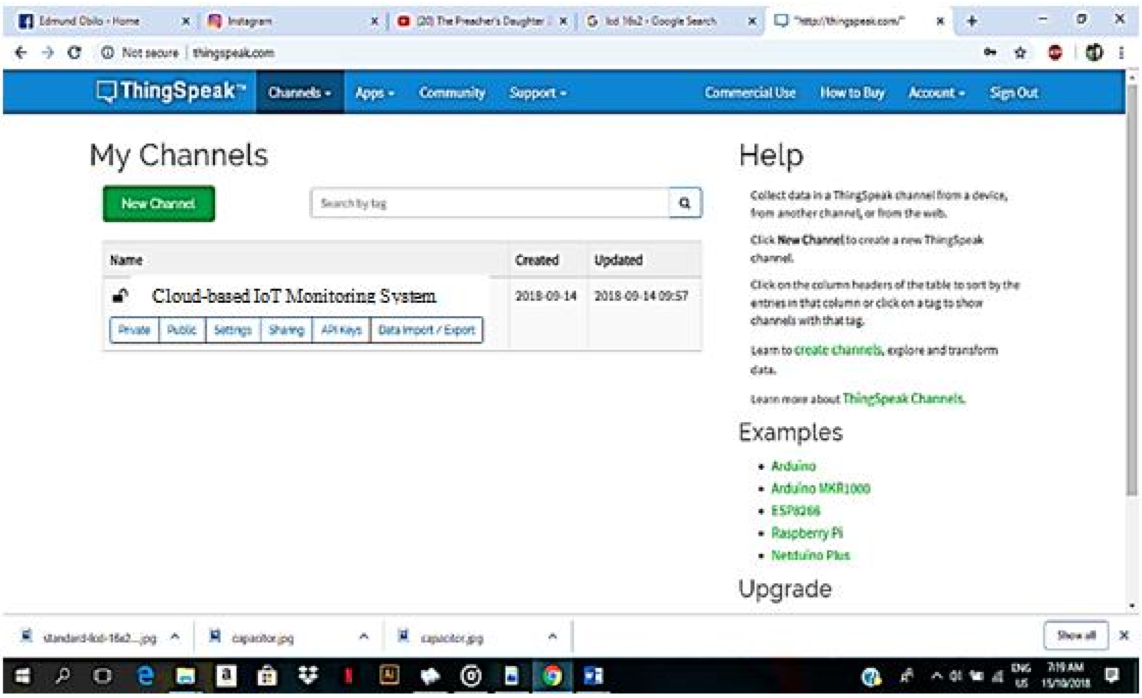


Figure 4 Creating of Channel [The MathWorks, I. (2018)]



The display unit displays the sensor reading on a 16 x 2 liquid crystal display (LCD). The configuration of the display unit involves interfacing with the MCU in a four (4) bit modes as well as with the power supply as illustrated in Figure 6. The power supply was connected to the VDD of the LCD and grounded through the VEE pin. The VEE pin was used to vary the contrast of the LCD screen. Pins of LCD namely, RS, EN, D4, D5, D6 and D7 are all connected to Arduino digital PIN 14, 15, 16, 17, 18 and 19 respectively which ensures the LCD output the sensor readings as displayed in Figure 10. The entire circuit diagram was designed using Proteus 8 professional.

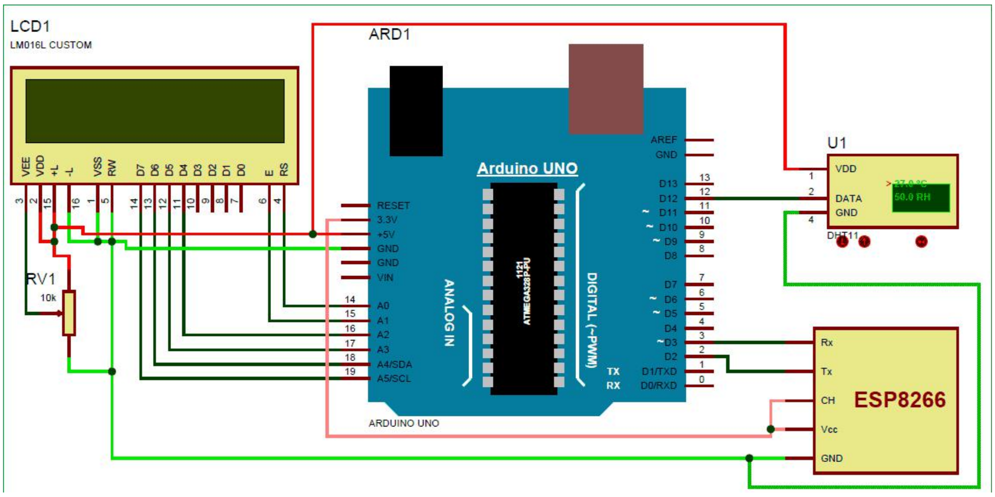


Figure 6 Circuit Diagram of Cloud-based IoT monitoring system

The DC power supply was a source from the USB lithium battery pack with 2800mAH. The choice of the power source was due to the portability and reliability characteristics of the battery bank. The sample diagram of the power supply is illustrated in Figure 7.

Figure 7 12V/5V DC (USB) Rechargeable 2800mAH Lithium-Ion Battery Pack

3.0 Results and Discussion

The results from the prototype system were obtained after successful connection of various components of the proposed cloud-based IoT monitoring system to the network. The manager or the user can log-on to the designed webpage (www.thingspeak.com) with the created username and password to view the plot in the variation of both humidity and temperature as shown in Figures 8 and 9 respectively. The information was also displayed on the display unit (LCD) as depicted in Figure 10.

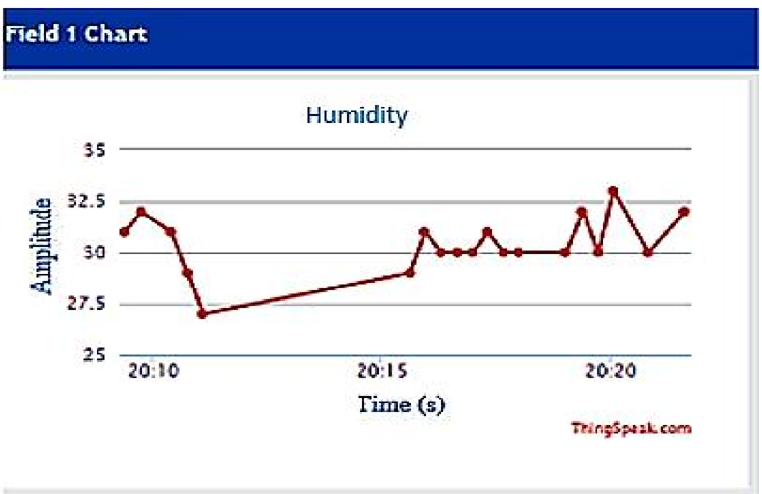


Figure 8 Plot of Humidity variations

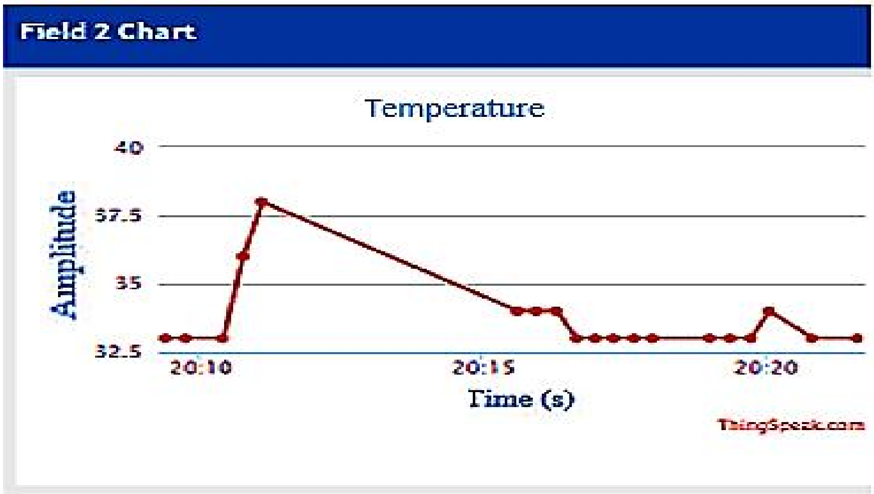


Figure 9 Plot of Temperature variations

Figure 10 Prototype of the Described System

The plot in Figure 8 shows the fluctuations in the value of humidity within the farm environment. The data were plotted within an interval of 5s which is an indication that the sensed data are sampled, collated and transmitted in every 5s. The value of the humidity varies from 31-33mmHg as indicated in Figure 8. It was also observed that; as the humidity increases from 31 - 32mmHg, the temperature of the poultry farm remains largely constant within the value of 33°C of the said value range of humidity.

The fluctuations in the value of the temperature were also observed within the same interval of 5s time. The value of 38°C was recorded as observed in Figure 9 as the highest temperature value. The straight-line graph observed within the first 5s in both Figure 8 and Figure 9 was due to the failure in power. The complete prototype of the proposed system is displayed in Figure 10. The results above were view on a thingspeak webpage in real-time. The proposed system has been able to measure and analyze the humidity and temperature of a sample poultry farm. This proves the reliability and efficiency of our system in monitoring temperature and humidity parameter within any poultry farm in Nigeria.

4.0 Conclusion

Humidity and Temperature are one of the important variables for the proper performance of any poultry farm. Therefore, the monitoring of these parameters is of utmost importance. The research “Cloud-based IoT monitoring system for poultry farming” has been achieved. The research work has brought in a more cost-effective system for monitoring the condition of poultry birds on the farm. The system is cost-effective because it uses an already installed on-line remote server that can analyze and compute data graphically aside from the reduced cost implication associated with managing poultry farm. The results obtained from the system indicate that temperature and humidity have the value between 33-38°C and 31-33mmHg respectively. It can also be deduced from Figures 8 and 9 that, the temperature remains constant with a value of 33°C for a value range of 31 – 32 mmHg of the measured humidity. Therefore, if the temperature and humidity of the poultry farm are maintained and monitored with the aid of the system, it will enhance the quality and quantity of chicken produced. Thus, guaranteed the health of the poultry birds which could reduce the cost, time and intensive labour spent on the farm.

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