SMART POULTRY FARMING USING INTERNET OF THINGS (IoT)

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SMART POULTRY FARMING USING INTERNET OF THINGS (IoT)

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Abstract

In tropical areas like Nigeria, some forms of ventilation are needed to moderate the temperature and ensure adequate supply of oxygen, removal of carbon dioxide and other waste gases and dust from poultry houses. In this work, the focus is on the automatic control of the environmental parameters of a poultry pen, employing sensors and using internet of things (IoT). The temperature and humidity were monitored and controlled remotely with the help of sensor modules connected to a microcontroller. Sensor values were acquired using a Wi-Fi module and then uploaded to the cloud. The cooling fans, together with light bulbs, were switched on or off, without any human intervention, based on the threshold values set for these devices.

Keywords: Smart Poultry, Internet of Things, Sensors, Environmental Control, Arduino

1.0 INTRODUCTION

Nigeria currently has the second largest *chicken population* in Africa, with a standing stock of about 180 million. With over 550,000mt of poultry meat per annum and 700,000mt of eggs per annum, the poultry sector contributes about 25% of the agricultural gross domestic products (FAO, 2019 and Netherlands Enterprise Agency,2020). The **poultry sub-sector is also the most commercialized of all Nigeria's agricultural sub-sectors with a current net worth of N1.6 trillion (Awojulugbe, 2019).** Poultry production is practiced at all levels ranging from subsistence to large scale commercial operations. In spite of this, Nigeria is far from meeting her domestic demand. The Nigerian poultry sector is poorly capitalized and it is characterized by smallholdings owned by many peasant farmers (Oyeyinka *et al* ,2011). **P**roduction costs are generally high due to lack of integration and absence of automation in the sector. In addition, the internal environmental conditions of the poultry house are generally not controlled (Ugwuoke,*et al* 2017, Olaniyi, *et al* 2014). It is therefore expected that livestock production and husbandry practices and livestock value chains in Nigeria will be markedly improved (FAO, 2019).

Housing in modern poultry is an important input accounting for a major component of the initial capital investment. The structures are constructed and designed in consideration of bird welfare and efficiency of production. Poultry houses, especially those in tropical areas, need some form of ventilation to ensure adequate supply of oxygen, removal of carbon dioxide, other waste gases and dust (Alloui *et al* 2013). Tunnel ventilation is the most effective for large houses in hot weather; with exhaust fans placed at one end or the middle of the shed, air is drawn through the length of the house removing heat, moisture and dust. Greater efficiencies are achieved when these fans are automatically controlled.

The most important factor controlled in a poultry farm is the temperature of the hen-house and this depends on the age and the purpose for which the chicken is kept. In a review article, Igbokwe (2018) outlined the effects of environmental heat stress on reproduction in chickens and the associated physiological changes. The article then identified the role of certain measures in the management of heat stress and suggested that researches in this area are necessary to support increased productivity of chickens. Generally, the ambient temperature in the range 16 ^{o}C to 24^{o}C is considered optimal (Li *et al* (2015) and Haixia *et al* (2012)) for poultry production.

Real-time monitoring and control of the environmental parameters of farms have been of interest for many researchers. The temperature and water status were monitored and controlled by Liu, *et al* (2007), Kotamaki *et al* (2009) and Orazio and Brischetto,(2011) for green houses . Roham *et al* (2019) described a wireless sensor network in the greenhouses, where web application on a smartphone analyse the climatic parameter values and suggest the preventive measures for the corresponding environmental conditions.

With the integration of wireless sensors and mobile system, the control of environmental parameters such as temperature, relative humidity, air impurity levels on poultry farms have been reported. Rupali and Sonavane *(2016)* and Sravanth and Sudharson,(2015) explored an Intelligent System integrated with Smart Phone for monitoring chicken farm and for control. The system monitors the water, feed level, temperature and humidity. It was possible to send SMS back to the system and if the system does not receive command from registered mobile number, then it will automatically perform its action.

There is the need to study the application of smart technologies to the management of poultry farms for enhanced production efficiency on the farm and food security in Nigeria. Specifically, the study explored the monitoring and control of temperature and humidity remotely with the help of sensors and microcontrollers, bearing in mind applicability to the conditions of Nigeria weather and farming practices.

2.0 METHODOLOGY

The block diagram showing the key components of the hardware used for this work is shown below. ADUENO and Raspberry Pi used here have been used extensively for building monitoring systems on Smart farms (Siwakorn and Pongpisitt (2015), Sravanth and Sudharson, (2015),

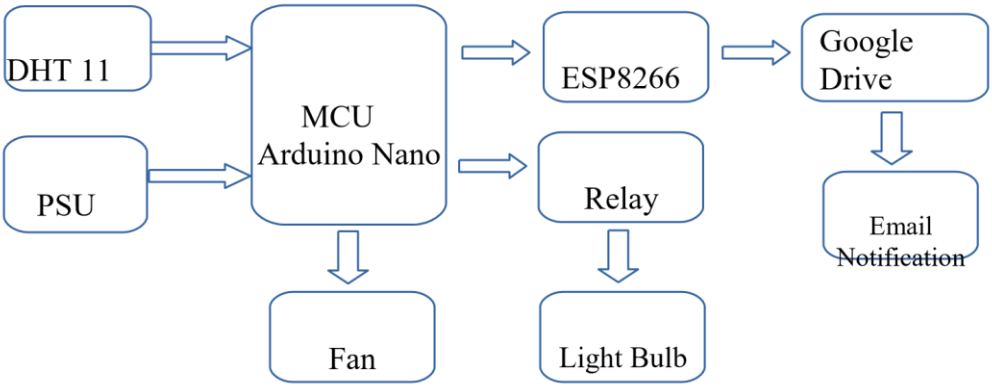

Fig. 1: Block diagram of smart based poultry farm using IoT.

The microcontroller receives the current temperature and humidity data from the sensing unit, and then sends it to the cloud. It also initiates the commands that control the actions of the fan which is aimed at reducing the temperature and the relay. The Atmeg328p Microcontroller present on the popular Arduino development board was used. The Microcontroller was used majorly because of the ease with which the Arduino allowed users to flash the microcontroller with the firmware.

Fig. 2 Arduino Uno Atmeg328p Microcontroller

The sensing unit is in-charge of getting the temperature and humidity data from the environment and sending to the microcontroller. For this project, the DHT11 temperature and humidity sensor was selected as the primary temperature and humidity sensor.

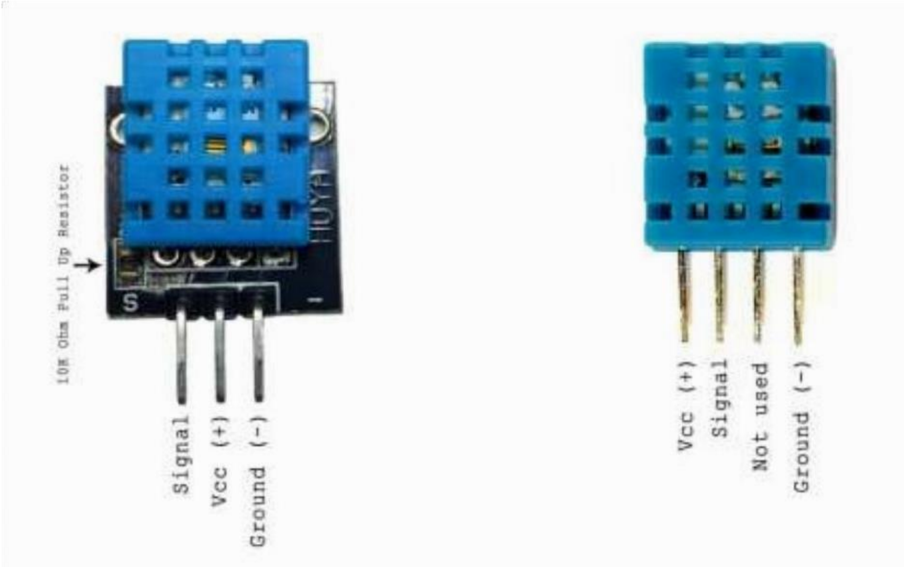

Fig.3: The DHT11

The DHT11 detects water vapor by measuring the electrical resistance changes between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. An IC mounted on the back of the unit converts the resistance measurement to a relative humidity estimate and also stores the calibration coefficients, and controls the data signal transmission between the DHT11 and the Arduino.

The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermistor) built into the unit The DHT11 uses just one signal wire to transmit data to the Arduino. The capacity for communicating over the internet and the capability needed to send the data collected to the cloud was based on the ESP8266 Wi-Fi module. The system is designed to be powered by a 5-12V DC either provided by a battery or plugged in. It also provides an easy interface for AC current which is needed to power the actuators connected to the relay.

The actuating unit performs an action that helps control the temperature and humidity of the environment around the poultry. The two elements in the actuating system include a Fan and a light bulb. This could be any other thing as the circuit was implemented with a 30A relay which will allow for easy change or swap of actuators. A 30A 5VDC relay was used to interface between the Microcontroller and the actuators since they will be AC based actuators. The 5VDC triggered relay was used to enable easy integration with the micro controller circuitry.

The microcontroller firmware which was written in C programming language was developed using the Arduino IDE. The firmware controls all the actions of the microcontroller from reading the data from the temperature and humidity module to connecting to the internet via the

Wi-Fi module to post the data and control the actions of the actuator. Figure 4 is a circuit diagram for the implementation of the proposed scheme.

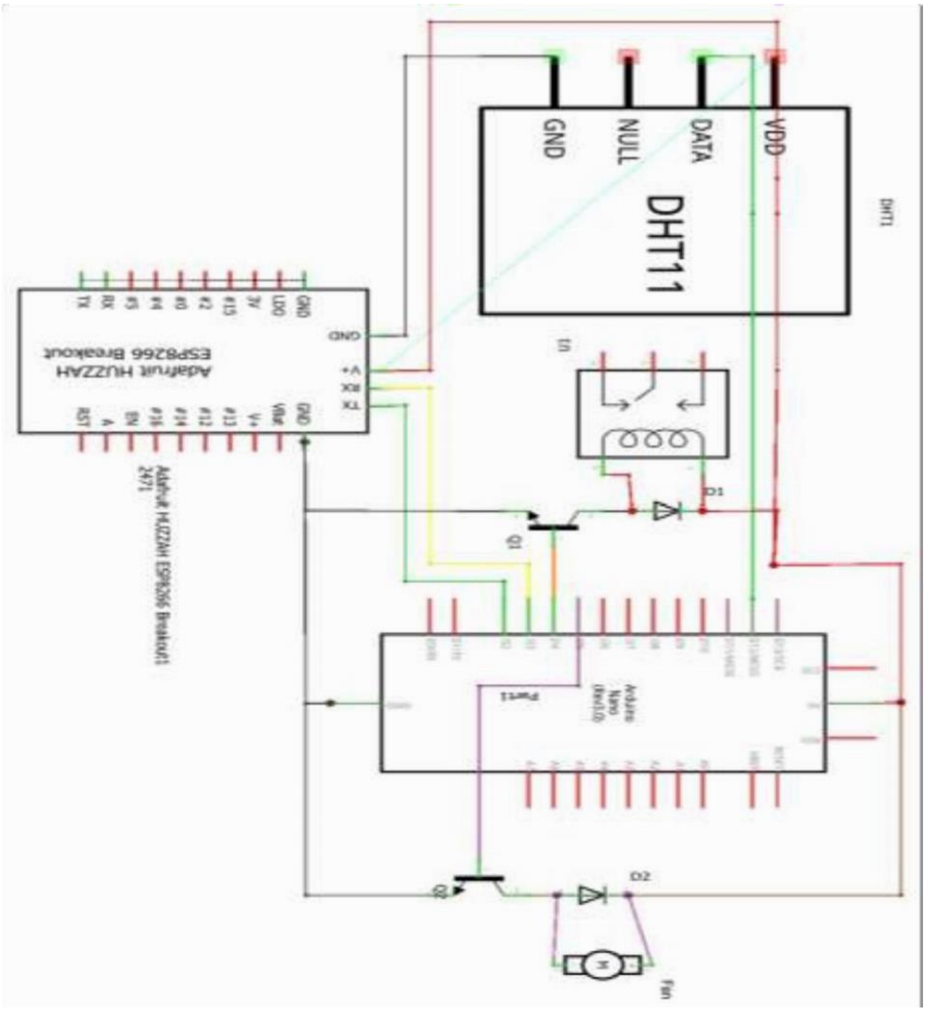

Fig.4: The circuit diagram

3.0 RESULTS AND DISCUSSIONS

The designed control system was thoroughly tested in the laboratory. Thresholds were set for the maximum temperature, minimum temperature and the humidity values, and responses properly evaluated. The systems could respond to any setting of these parameters: starting on or switching off heater bulbs or fans as expected.

The exposure of chicken to high temperature has been reported to hinder the performance in chickens (Oloyo, 2018 and Holik, 2009). During hot weather, poultry birds maintain thermoneutral temperature by losing heat mainly through conduction, convection, radiation and evaporative cooling (Bhadauria et al 2014). As a result, moving of air over birds enhances heat loss from the birds and also the removal of heat trapped within the poultry house, thus reducting of the effect of high humidity. A temperature of 30–32°C has been recommended for day old chicks. For other categories of chicken, a range of 20-32 is generally considered adequate. On humidity, Oloyo (2018) reported that laying birds during brooding and after brooding require a relative humidity range of 60–80 and 50–70% respectively for optimum performance. Based on this, the system was deployed in a real poultry house and the following parameters were set for it

Table 1: Parameters and responses obtained in a real poultry house

Parameters	Threshold Value	Response / action Performed
Max Temperature	T. Max > 32^0C	Cooling Fan turned ON, Heating bulbs remain OFF data uploaded to cloud and e mail sent
Min Temperature	T. Min < 20^0 C	Cooling Fan turned OFF , Heating bulbs turned ON , data uploaded to cloud and e mail sent
Humidity	Above 60%	Cooling Fan turned ON, data uploaded to cloud and e mail sent

4.0 CONCLUSION

In this paper, an IOT based smart control system for a poultry farm was designed and constructed. The system has the ability to monitor and control various environmental parameters in real time, in the poultry house, with no human intervention. Besides, it could generate a report which is uploaded to the cloud and also send a text message to the farmer about the conditions of his farm on a registered phone number. Climate exerts constraining influences on livestock production through its associative effects of humidity, temperature, precipitation and air movement, hence the need to properly monitor these parameters.

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