# IoT Based Smart Monitoring System for Efficient Poultry Farming

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*Received September 23, 2021; Accepted December 18, 2021*
*ISSN: 1735-188X*
*DOI: 10.14704/WEB/V19I1/WEB19270*

## Abstract

This paper presents a smart system using Internet of things (IoT) for monitoring and controlling environmental conditions of poultry farming. Environmental parameters such as temperature, humidity, and air quality in a poultry house which are vital for the survival of poultry birds were monitored in order to adequately nurture poultry birds, reduce mortality rate and improve production. The system utilizes ESP32 microcontroller which has embedded Wi-Fi function, DHT11 temperature and humidity sensor, the PIR motion detector sensor, and MQ135 gas detector sensor. In addition, a buzzer was added to alert the farmer in the event of an intruder, while the integrated Wi-Fi unit would send a message to the farmer. Furthermore, the proposed system controls the brightness of a lamp inside the poultry house to either increase or reduce its temperature. This work which is a prototype, was implemented in a small poultry house. All the tests carried out illustrated that the designed system is sufficient and that the aim has been achieved.

## Keywords

Poultry Monitoring, IoT, Microcontroller, Temperature, Humidity Air Quality.

## Introduction

In recent years, poultry production and consumption has increased worldwide (Escobedo del Bosque et al., 2021) (Arrieta & González, 2019), and the demand for poultry meat is on the increase due to its high protein, low sodium, and low cholesterol (Resurreccion, 2004). Global demand for poultry meat will be more than double what it was in 2005 by 2050, and the demand for chicken eggs will be almost 40% higher (Smith et al., 2015). The increase in demand could bring about problems in meeting the demands of poultry produce. For the most part of the world, chicken production has increased due to standardized farming management systems and good manufacturing practices (Sitaram et al., 2018) (Mahale & Sonavane, 2016). There has been a rise of awareness regarding the safety of poultry, as well as a higher demand for good quality poultry (Petracci et al., 2015).

The environment of the poultry house is a crucial factor in production that may be monitored and optimized to produce good quality chicken and chicken eggs. Among the environmental inputs are: temperature, air velocity, ventilation rate, litter quality, humidity, and gas concentrations, including carbon dioxide and ammonia (Dallimore, 2017) (Astill et al., 2020).

Nowadays, Internet of things (IoT) plays a fundamental role in real time monitoring. This paper focuses on using IoT in collaboration with sensors to monitor environmental parameters such as temperature, humidity, gas quality, and security of a poultry house which are vital to the survival of poultry birds.

## Hardware Design

This section describes the hardware design aspect of the Poultry Monitoring System. The system utilizes ESP32 microcontroller, WIFI unit, DHT11 temperature and humidity sensor, the Passive Infrared sensor (PIR) motion detector sensor, and MQ135 gas sensor.

ESP32 Microcontroller acts as the brain of the electronic circuit which receives data from all the sensors connected to it, processes it and sends the information to the farmer via Wi-Fi unit integrated in its architecture. ESP32 is a low-cost, low-power system on chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth. The single-core RISC-V microprocessor includes built-in antenna switches, RF balun and power-management modules.

For monitoring the air quality, a gas sensor, MQ135 is used. It measures the level of $NH_3$, NOx, alcohol, Benzene, smoke, $CO_2$ in poultry house. Since the air quality in a poultry farm greatly affects the overall health of the birds, MQ135 sensor was employed to read and measure the air quality of the ambience. This sensor offers a wide detecting range because of its fast response, high sensitivity, stability, and long life. It is mostly used to control air quality in offices, buildings, and residences.

PIR is a low-cost motion sensor which can detect the presence of human beings or animals that are around the poultry house. Birds in the poultry house, especially the young birds are vulnerable to predatory animals such as cats, dogs etc., they are also vulnerable to theft from human beings hence, the need for PIR motion detector to monitor unwanted presence around the poultry house.

The temperature and humidity sensor used here is the DHT11 sensor. **DHT11** is used to constantly monitor the temperature and humidity level of the poultry house. If the temperature exceeds or goes below the threshold of 20ºC or 70ºF, the chicks would die (Henriksen et al., 2016). Also, the humidity could affect the breathing of poultry birds. The ideal humidity range for poultry birds is from 60% to 80%. The sensor includes a dedicated NTC for temperature measurement and an 8-bit microcontroller for serial data output of temperature and humidity values. The sensor is factory calibrated, making it simple to connect to other microcontrollers.

Finally, Lithium batteries, a family of rechargeable batteries with high energy density and commonly used for portable electronics and electric vehicles etc. is used to supply power to the designed system, while voltage regulator was used to regulate the VCC to the required 5 V and relay was employed as a switch. Figure 1 shows the circuit diagram of the suggested poultry monitoring system.

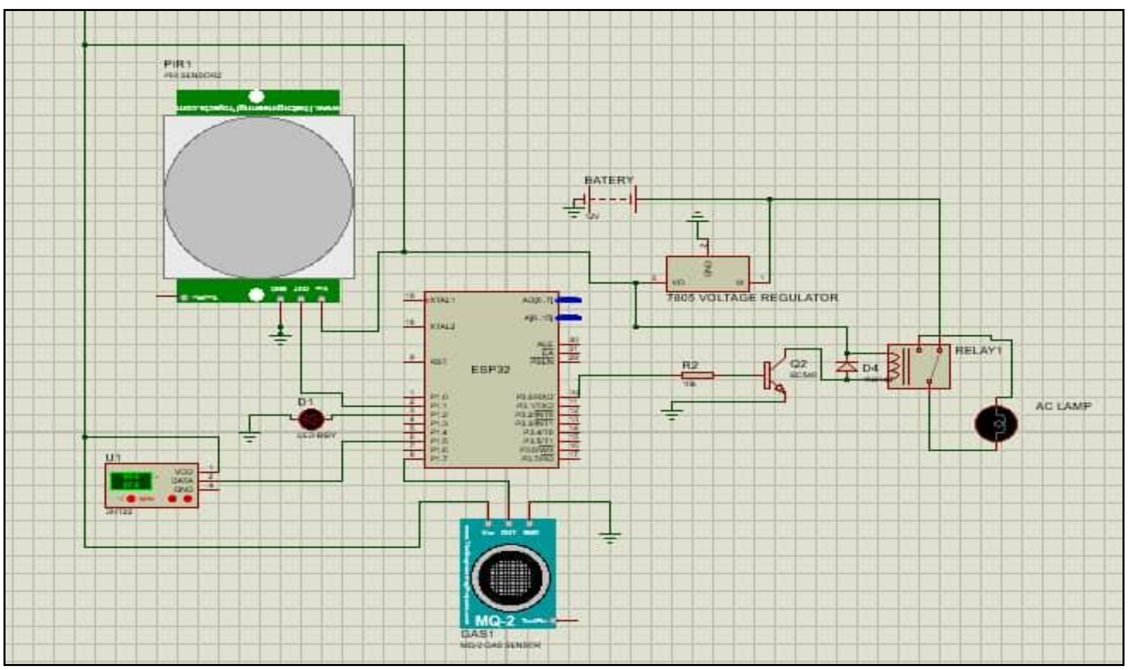



**Figure 1 The Designed System Circuit Diagram**

Algorithm, Flowchart and Software Development Process

The system algorithm is as follows:

- Step 1: Start
- Step 2: Initialize ESP32 microcontroller, MQ135 sensor, PIR motion sensor, and DHT sensor.
- Step 3: Check user Wi-Fi credentials and authentication,
- Step 4: Verify and authenticate the user Wi-Fi credentials, if True, move to step 5, else go back to step 3.
- Step 5: Check sensors, if active proceed to step 6, else go back to step 2.
- Step 6: Read sensor values (DHT11, PIR, MQ135).
- Step 7: Send sensor data to Blynk via Wi-Fi unit of ESP32.
- Step 8: Send notification to Blynk if PIR detects motion, else go back to step 6.
- Step 8: End

The flowchart of the system as illustrated in figure 2. portrays the visual representation of the different types of actions or sequence of steps stated in the algorithm above.

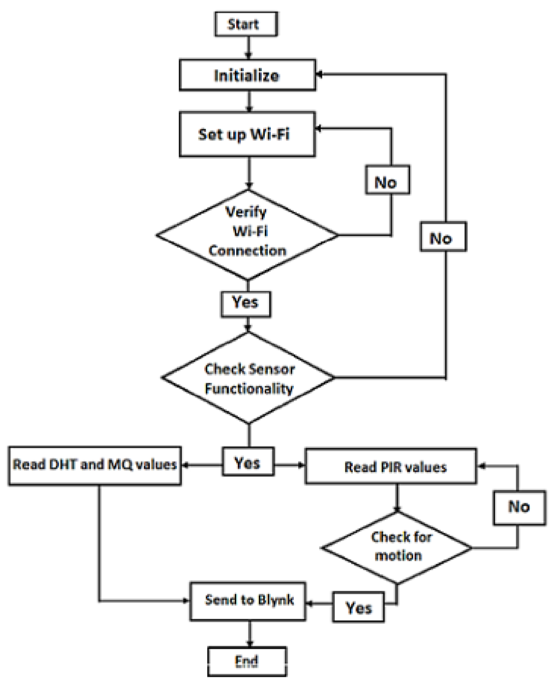



**Figure 2 The Flowchart of the Designed S*ystem***

For the software development process of this project, ESP32 microcontroller was programmed using embedded C++ programming language, thus the system was implemented using embedded C++. Before powering ESP32 microcontroller, physical inspection is done on the board to check if the board is in good condition with no obvious signs of damage after which we proceed to the installation process. Set up the toolchain, a set of programs for compiling codes and building applications. Getting Arduino IDE, i.e., installation of ESP32-specific API (software libraries and source codes). Interface modules via GPIOs and through serial port and start a project and run it. Serial ports have patterns in their names such as "COM6" for windows operating system. Build, debug and flash the project into the ESP32 microcontroller. The serial monitor is used to visualize and diagnose the functionality of the project. Set up login details on the Blynk app and start a new project. Set up Modules for Temperature, Humidity, Air quality, motion, and lamp. Connect the ESP32 to Blynk through the internet. Figure 3 illustrate the embedded C++ development environment.

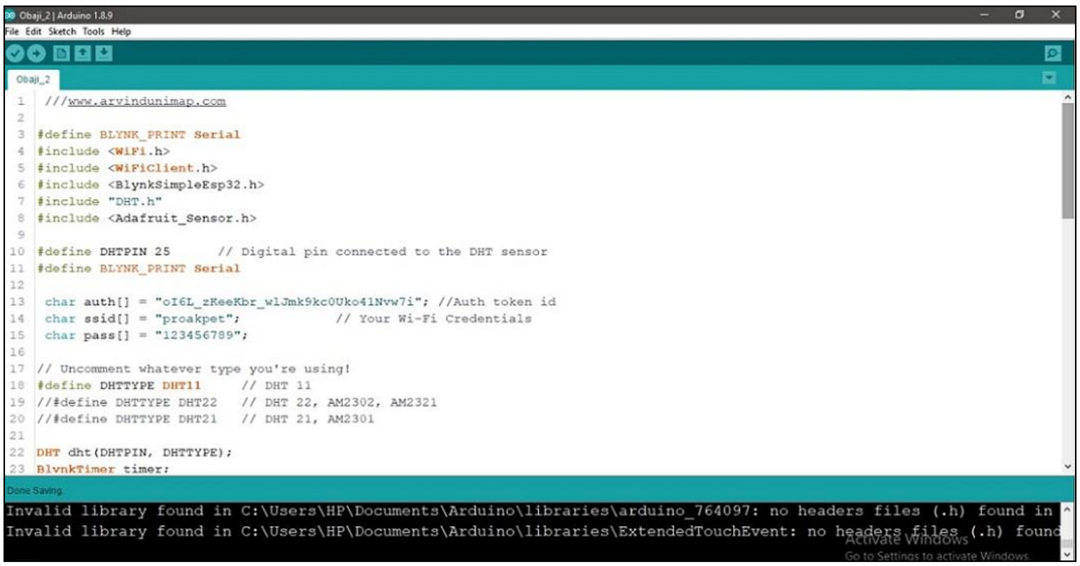



**Figure 3 ESP32 Embedded C++ Development Framework**

## Testing and Discussion

The following tests were carried out after design and construction of the project:

### Humidity Test

Humidity is a measure of water vapor in the atmosphere, hence, DHT11 measures the level of moisture in the air. This was tested by spraying fine droplets of water inside the poultry house. The increased humidity was measured by DHT11 sensor and outputted the value 76% as shown in figure 4 (a). After a while, the water vapor dissipates and the temperature increases thereby reducing the humidity in the air as presented in in figure 4 (b). DHT11 senses this change and hence its output values reduce to 71.

### Temperature Test

The system was tested for its accuracy and reliability in measuring the temperature of the system. It was increased by switching ON the lamp, this in turn increases the temperature of the air inside the poultry house. As shown in figure 4 (a) and (c), the temperature rises from room temperature of 28.4°C to 30.9°C, at which point the bulb was turned OFF because the temperature is higher than required. This proves the systems capability of monitoring and regulating the temperature.

## Air Quality Test

There are several gases that affect the air quality of the system, but for this project work, we used Butane. Butane gas was manually induced into the poultry house. This impurity was measured by the MQ135 sensor and outputted a value of 365 as shown in figure 4 (b). The value outputted increases with the concentration of impure gasses in the air, and reduces when this concentration reduces.

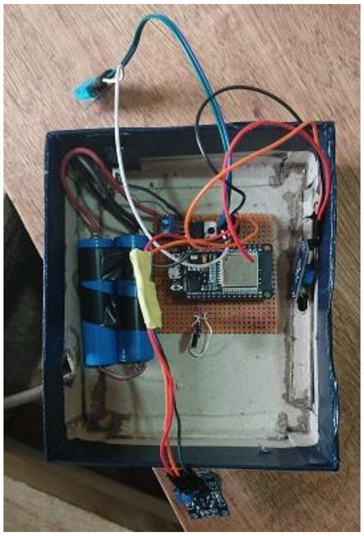
## Motion Detection Test

The system's ability to detect motion in the vicinity of the poultry house was tested. The PIR sensor in front of the poultry house detects motion in the vicinity of the poultry house and then alerted the farmer by triggering the buzzer as shown in figure 4 (d).

The lamp inside the poultry farm is also tested by remotely turning ON by the ON button on the Blynk app as shown in figure 4 (a).


**Figure 4 Blynk app interface, (a) ON Lamp / humidity test, (b) Air Quality/temperature test, (c) Air quality test, (d) Motion detector test**

The entire components were carefully coupled in a chassis as shown in figure 5(a) and mounted inside the poultry house as shown in figure 5 (b) below



(a)

(b)

**Figure 5 System Hardware: (a) System Coupled in Chassis, (b) System Mounted Inside a Poultry House**

Studies has shown that the poultry birds thrive between a temperature range of 22°C to 23.8°C and a humidity range between 65% to 75%. By clicking on the ON switch on Blynk, the farmer can remotely control the temperature and humidity in one direction, i.e., when the temperature falls below 22°C, and humidity goes above 65%, the farmer can switch on the lamp which acts as a heating element in other to restore the temperature and humidity back within the desired range. When the air quality is low, the farmer may manually open up the windows of the poultry house. The windows are strategically positioned to provide cross ventilation for the birds.

## Conclusions

The system is inexpensive and very affordable for poultry farmers and anyone who wishes to run a poultry farm. Poultry farming in the past years was difficult and yet environmental parameters were not monitored even though it played a crucial role. But now, the smart monitoring of different environmental parameters by using sensors network gives a better understand of poultry health and production. Now, farmers can accurately monitor environmental parameters in the poultry house in other to control them to bring them back within an acceptable range in which the poultry birds will thrive. Farmers are to tell what temperature optimizes poultry health and production and hence make accurate predictions for the future.

## References


Arrieta, E.M., & González, A.D. (2019). Energy and carbon footprints of chicken and pork from intensive production systems in Argentina. *Science of the total environment*, *673,* 20-28. https://doi.org/10.1016/j.scitotenv.2019.04.002.

Astill, J., Dara, R.A., Fraser, E.D., Roberts, B., & Sharif, S. (2020). Smart poultry management: Smart sensors, big data, and the internet of things. *Computers and Electronics in Agriculture, 170*. https://doi.org/10.1016/j.compag.2020.105291.

Dallimore, K. (2017). *Canadian poultry - precision livestock farming.* https://www.canadianpoultrymag.com/health/precision-livestock-farming-30052.

Escobedo del Bosque, C.I., Spiller, A., & Risius, A. (2021). Who wants chicken? Uncovering consumer preferences for produce of alternative chicken product methods. *Sustainability, 13*(5). https://doi.org/10.3390/su13052440.

Henriksen, S., Bilde, T., & Riber, A.B. (2016). Effects of post-hatch brooding temperature on broiler behavior, welfare, and growth. *Poultry science, 95*(10), 2235-2243. https://doi.org/10.3382/ps/pew224.

Mahale, R.B. and Sonavane, S.S. (2016). Smart Poultry Farm Monitoring Using IOT and Wireless Sensor Networks. *International Journal of Advanced Research in Computer Science, 7*(3), 187-190. http://www.ijarcs.info/index.php/Ijarcs/article/view/2665.

Petracci, M., Mudalal, S., Soglia, F., & Cavani, C. (2015). Meat quality in fast-growing broiler chickens. *World's Poultry Science Journal, 71*(2), 363-374. https://doi.org/10.1017/S0043933915000367.

Resurreccion, A.V.A. (2004). Sensory aspects of consumer choices for meat and meat products. *Meat Science, 66*(1), 11-20. https://doi.org/10.1016/S0309-1740(03)00021-4

Sitaram, K.A., Ankush, K.R., Anant, K.N., & Raghunath, B.R., (2018). IoT based smart management of poultry farm and electricity generation. *In IEEE International Conference on Computational Intelligence and Computing Research (ICCIC),* 1-4. IEEE. https://doi.org/10.1109/ICCIC.2018.8782308.

Smith, D., Lyle, S., Berry, A., Manning, N., Zaki, M., & Neely, A. (2015). Internet of animal health things opportunities and challenges. *Internet of Animal Health Things.* https://cambridgeservicealliance.eng.cam.ac.uk/system/files/documents/2015JulyCaseStudyIoAHT_HQP.pdf