Real-Time Temperature and Humidity Monitoring Testing Approach in Poultry Farm

Nik Azimah Zainab[1], Noraimi Shafie[2], Suriani Mohd Sam[3], Mohamad Zulkefli Adam[4], Azizul Azizan[5]

[1,2,3,4,5]Razak Faculty of Technology and Informatics
Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia
[1]nikazimahzainab@graduate.utm, [2]mynoraimi.kk@utm.my
[3]suriani.kl@utm.my, [4]mzulkefli.kl@utm.my,
[5]azizulazizan@utm.my

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*Corresponding author
mynoraimi.kk@utm.my

Abstract

The advancement of technology eases human daily life in various aspects. Currently, the world is moving from conventional methods to an internet-based system called the internet of things (IoT). The IoT system allows real-time monitoring and response which are efficient and produce reliable results. Managing poultry farm is a massive works where many variables like temperature and humidity need to be controlled to ensure stable production of meat. In this project, a concept prototype of real-time monitoring poultry farm system was developed. Thus, this paper discussed the result of experimental prototype of an IoT-based monitoring system in a poultry farm.

Keywords: *poultry farm, monitoring system, IOT*

1. Introduction

In 2020, the Food Agriculture Organization (FAO) of the United Nations (UN) reported 40.6% of meat available in the global market is from poultry products approximately 337 million tons. Poultry farming is commonly focused on chicken but includes turkey, ducks, and geese to produce eggs and meats for daily food. There are two types of poultry methods which are layer and broiler where the layer technique is known for egg production because of the tier in the farm for the birds to lay the eggs while the broiler is to raise the birds in an open space for meat. In this project, a concept prototype of real-time monitoring poultry farm system was developed. The system measures the temperature and humidity inside the farm and sends notification messages through telegram if the value is out of the threshold set in addition to ringing an alarm to alert workers on site. All readings are stored in the cloud for easy access and further analysis.

2. Literature Review

B. Ramteke and S. Dongre designed an automated IoT-based poultry management system to provide a continuous balanced diet and water and enhance healthcare management of the birds on layer poultry [7]. From the research, the authors concluded that the optimum temperature for layer poultry is between 20 to 24 degrees Celsius. This is because increasing in the temperature above 24^{o}C causes a declining in the

* Corresponding author. mynoraimi.kk@utm.my

weight and thickness of the eggshell and decreasing in the temperature to below 20 degrees Celsius causes the birds to have more feed per day. W. Sarachai, et al., developed a notification system for fan failure detection in poultry farm [8]. The researchers placed sensors to read the signal wave of the fans and processes the signal using Raspberry Pi 3B to determine the readings of the fans are within the threshold value. When the signal wave gives a value out of the threshold, the system sends a notification through either a phone call, SMS, or LINE messenger accordingly.
M. N. Elham, et al., studied the implementation of the Internet of Things to strengthen the monitoring system in poultry farm [9]. The system measure temperature and humidity in the poultry farm and store information using blockchain. The authors agreed that data transfer using blockchain is more secure and transparent than standard data transfer with all transactions can be traced by the users later.

K. A. Sitaram, et al., proposed a smart management system for poultry farm including a monitoring system, automated response, and data presentation [10]. The system monitors the temperature, humidity, ammonia, water level, and feeder sensor where if the value measured is out of the threshold set, the cooling fan, exhaust fan, ventilation window, water pump, and DC motor reacted respectively to the sensor. All measurements will be sent to the web server through the general packet radio service (GPRS) module for internal monitoring and the current measurement will be displayed on LCD on site. M. M. Islam, et al., constructed a prototype of an automated poultry farm system with anti-stealth and anti-arsenal features together with data storage on the website [11]. A sensor is placed at the main gate to detect movement to prevent trespassing by outsiders into the farm while the authors believed having an anti-arsenal feature in this farm is a good safety feature due to the high density of electricity cables lighting and other electrical equipment could cause sparks in the farm. This system also provides temperature, humidity, light intensity, and gas monitoring where all are stored and displayed on “ThinkSpeak” website.

3. Methodology

A DHT11 sensor is used in this experiment to measure the temperature and humidity of the surrounding. The data later will be processed by Raspberry Pi and stored in the Firebase cloud management for future reference. If and only if the temperature and humidity values are out of the threshold given, it will activate the alert system which is available physically on-site and real-time notification through Telegram.

3.1. Hardware and Software

Figure 1 shows the overview of the system consisting of raspberry pi, DHT11, firebase, and telegram.

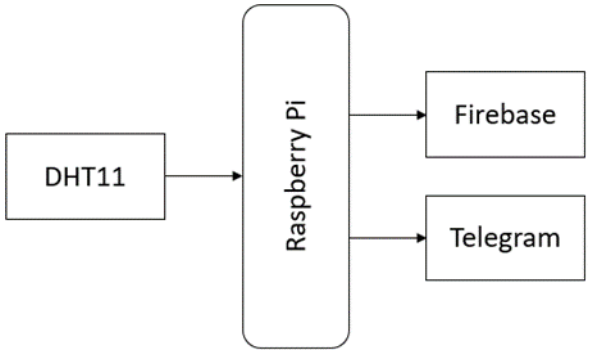

Figure 1. Overview of the system

- Raspberry Pi
  Raspberry Pi is a single-board computer introduced by UK's Raspberry Pi Foundation to encourage youngsters to experience computing and digital technologies [2]. It can be plugged with a monitor, mouse, and keyboard to function as standard computer and support programming languages like Scratch and Python. It is widely used in the development stage to demonstrate idea of a system.
- DHT11
  DHT11 is a temperature and humidity sensor. It has the accuracy of +/- 1% to measure temperature between 0 to 50 degrees Celsius and humidity rate up to 90% operating at 0.3mA on 3.3V~5V power supply [3][4]. Hence, using the DHT11 is acceptable to measure temperature and humidity in this project.
- Firebase
  Firebase is an open-source platform developed by Google that provides tools such as analytics to manage web services and mobile applications [5]. It is handy and easy to explore suitable for beginners to start the IoT application.
- Telegram Bot
  Telegram Bot is an account operated by software where it can interact with users to teach, play, search, broadcast, remind, connect, integrate with other services, or even pass commands to the Internet of Things [12].

3.2. System Architecture

The flow chart in Figure 2 illustrates the overall operation of the system. The temperature and humidity sensor, DHT11 was set up to measure the temperature and humidity at one-minute interval frequency and send values to the system. The Raspberry Pi analyzed the information to determine whether the reading was within the threshold or vice versa. In this experiment, the threshold was set between the lowest of 25 degrees Celsius and the highest of 30 degrees Celsius also 70% to 90% temperature and humidity rate respectively. If the reading is beyond the threshold value, an alert alarm alongside with telegram bot notification to an accredited telegram account was activated. All readings will be uploaded to the Firebase for data collection and analysis in the future.

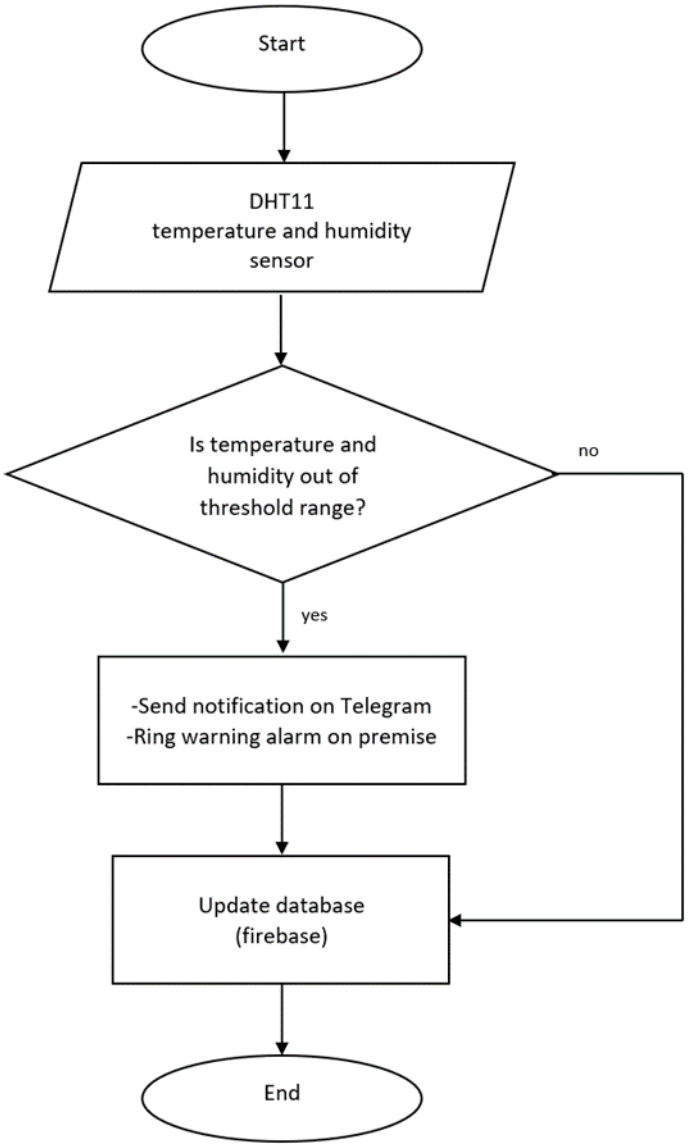

Figure 2. Flowchart of the system

3.3. Implementation

In this study, a transparent box was used as an illustration of a closed space in a poultry farm show in Figure 3. The DHT11 sensor was placed inside while other operating devices like Raspberry Pi and buzzer were installed outside the box to describe the real-life situation, where only the temperature and humidity are measured inside the farm and the control system is placed outside of the farm for monitoring purposes. A telegram bot called “Temp-Humid Monitor- MAN211021” was created for real-time notification of alarming situations inside the farm to the accredited account. Any off-limit threshold reading activates the buzzer on site as well as message notification to the smartphone. Figure 4 show the real time notification using the telegram apps.

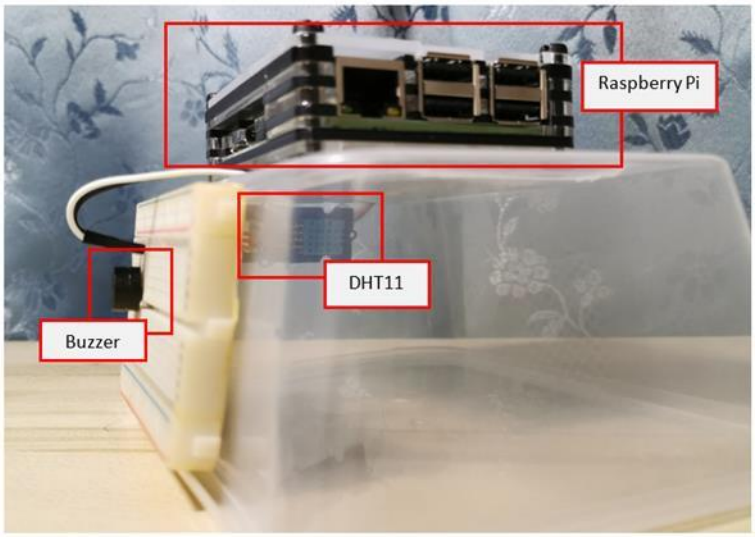

Figure 3. Prototype concept of the system

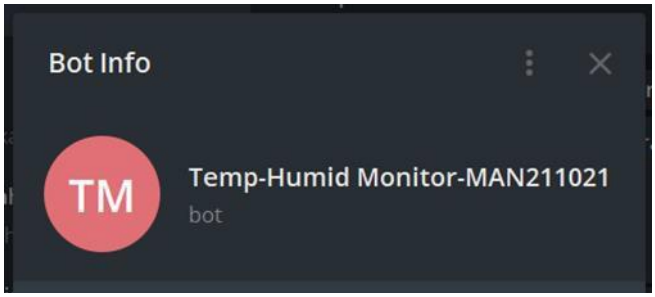

Figure 4: Telegram Bot

4. Result and Discussion

This project was broken down into two stages: functionality testing and performance testing. The functionality testing was to investigate the process of detecting, sending, and receiving data from DHT11 to the system accordingly while the performance testing was experimenting the system in natural environment input and out to observe the overall execution of the system.

i. Functionality testing

In this stage, I wanted to investigate operability of the DHT11 to read temperature and humidity where there were four variables of threshold value: high and low temperature value, and high and low humidity level. Also, to experiment send and receive data from the raspberry pi to the telegram bot notification.

Figure 5(a) shows result of the DHT11 was left in room temperature with low humidity level where only humidity notification was sent to the telegram bot and later the sensor was placed in refrigerator to get low temperature and low humidity conditions as shown in Figure 5(b). Then, the surrounding was set in low humidity and high temperature by using hair dryer results in Figure 6(a).

Lastly, Figure 6(b) represents results when the sensor was put in front of hot water

vapor to give high temperature with high humidity environment. All in all, the system was successfully experimented under four environment conditions: room temperature with low humidity, low temperature with low humidity, high temperature with low humidity and high temperature with high humidity and gave favorable outcome.

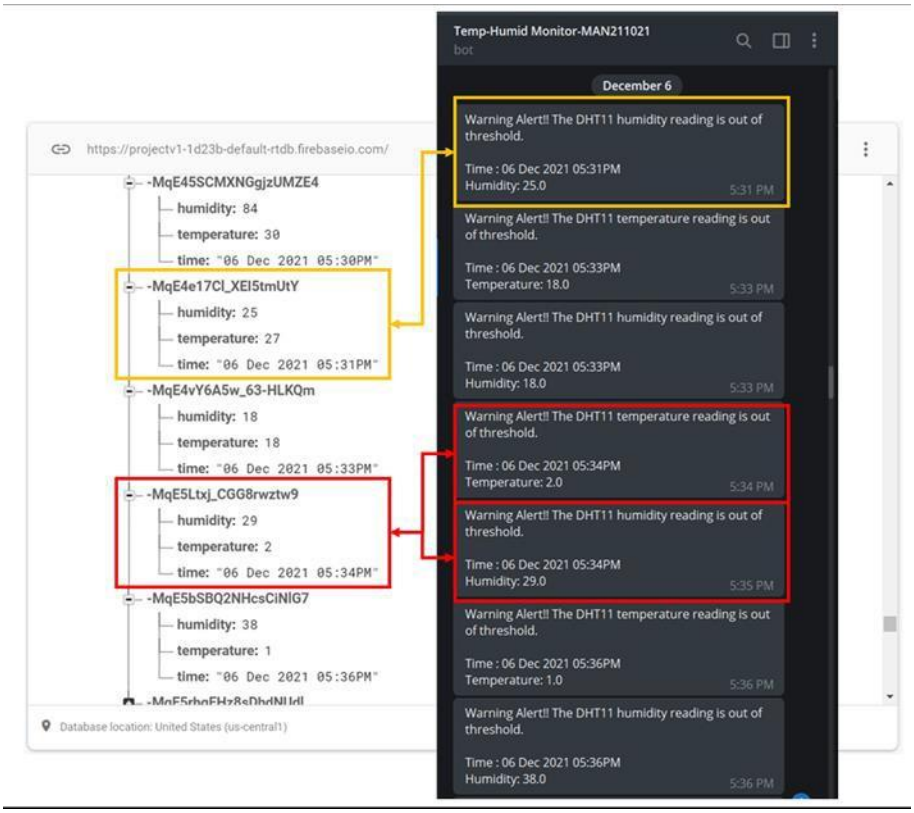

Figure 5(a). Yellow Box: DHT11 reading and Telegram notification for optimum temperature with low humidity. Figure 5(b). Red Box: DHT11 reading and Telegram notification for low temperature with low humidity

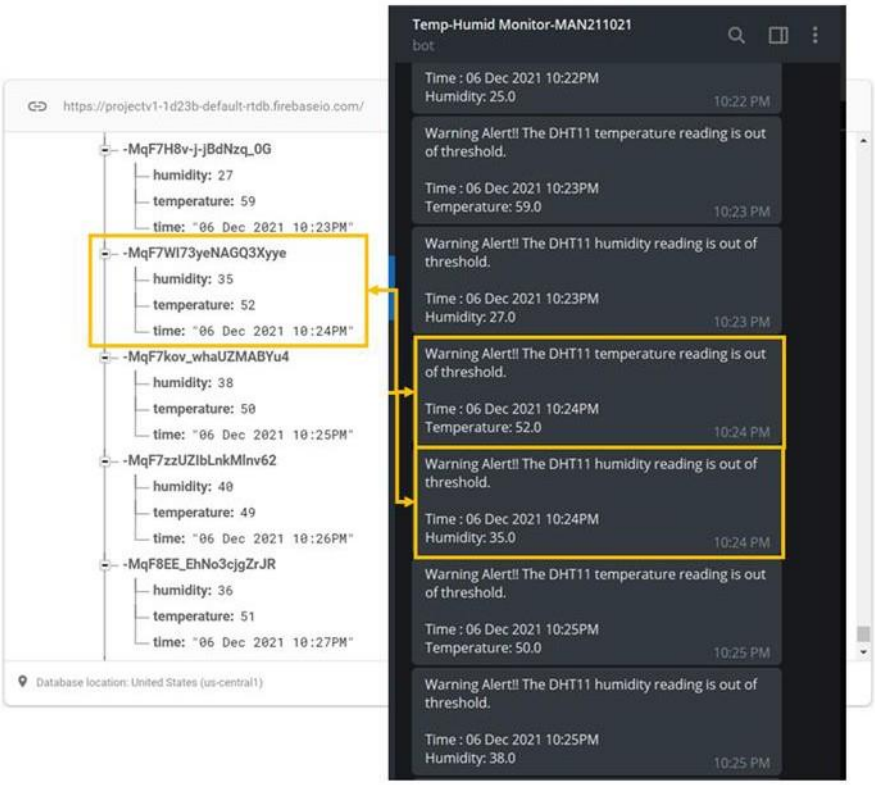

Figure 6(a). DHT11 reading and Telegram notification for high temperature with high humidity

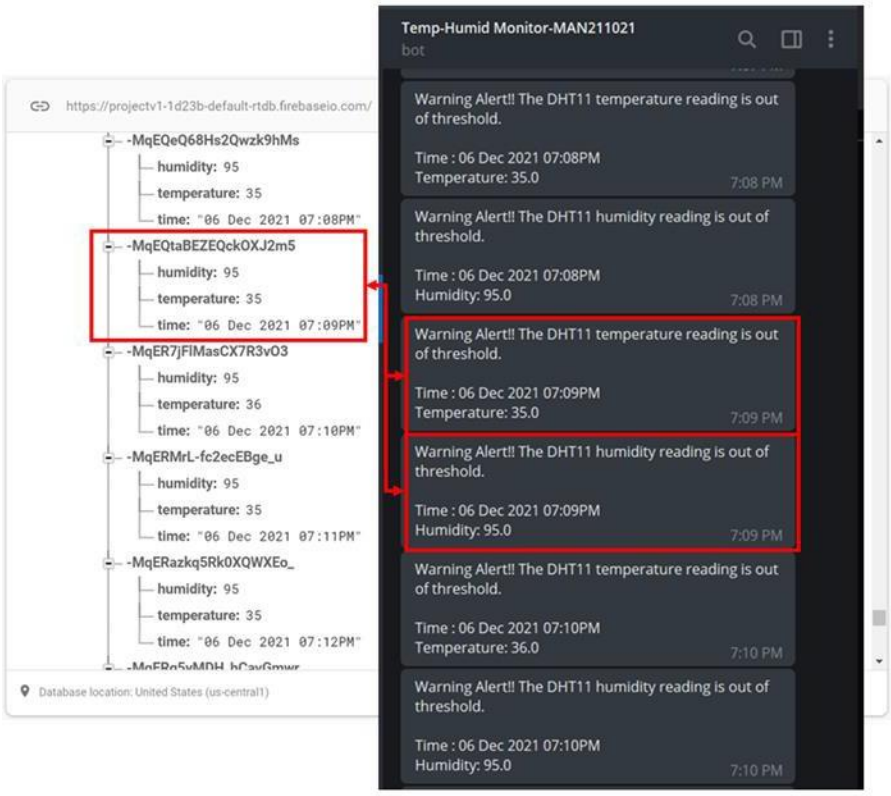

Figure 6(b). DHT11 reading and Telegram notification for high temperature with high humidity.

2. Performance testing

Later, the system was operated in natural environment for one hour on December 5th, 2021, at 11 A.M. to study the reliability of the system as if in real situation and the system was set up to update the reading at one minute interval. Table 1 displays result of one hour experiment where temperature varies from 30 degrees Celsius to 40 degrees Celsius with 46% to 78% of humidity. In short, based on the outcome it is acceptable to conclude that this system was sensitive to detect small changes in temperature and humidity at one minute interval as programmed. his experiment was conducted in Malaysia which is a tropical country with mean temperature of 26 degrees Celsius throughout the year [6]. In addition, high humidity level in closed area would enhance reproduction of virus and bacteria like E.coli and Influenza that are harmful to human. Therefore, it is crucial to monitor temperature and humidity in poultry farm to keep fresh air and optimum condition for the birds to grow.

Table 1. Daily Reading DHT11

Time	Temperature (ºC)	Humidity (%)	Time	Temperature (ºC)	Humidity (%)
11.32 A.M.	36	59	12.03 P.M.	37	54
11.33 A.M.	38	56	12.04 P.M.	37	56
11.34 A.M.	39	52	12.05 P.M.	36	56
11.35 A.M.	40	50	12.06 P.M.	37	56
11.36 A.M.	40	49	12.07 P.M.	37	56
11.37 A.M.	41	50	12.08 P.M.	37	56
11.38 A.M.	40	49	12.09 P.M.	37	55
11.39 A.M.	39	51	12.10 P.M.	37	54
11.40 A.M.	38	53	12.11 P.M.	38	55
11.41 A.M.	38	55	12.12 P.M.	38	53
11.42 A.M.	37	55	12.13 P.M.	38	52
11.43 A.M.	37	56	12.14 P.M.	38	52
11.44 A.M.	37	56	12.15 P.M.	39	52
11.45 A.M.	37	55	12.16 P.M.	40	51
11.46 A.M.	37	55	12.17 P.M.	41	49
11.47 A.M.	37	55	12.18 P.M.	41	49
11.48 A.M.	37	55	12.19 P.M.	41	48
11.49 A.M.	37	55	12.20 P.M.	41	48
11.50 A.M.	38	54	12.21 P.M.	41	47
11.51 A.M.	38	54	12.22 P.M.	42	46
11.52 A.M.	38	53	12.23 P.M.	42	46
11.53 A.M.	39	53	12.24 P.M.	42	46
11.54 A.M.	39	53	12.25 P.M.	41	47
11.55 A.M.	39	52	12.26 P.M.	41	47
11.56 A.M.	38	51	12.27 P.M.	41	47
11.57 A.M.	38	52	12.28 P.M.	41	48

11.58 A.M.	39	53	12.29 P.M.	41	48
11.59 A.M.	39	52	12.30 P.M.	40	49
12.00 P.M.	38	53	12.31 P.M.	40	49

Based on the Table 1, the average temperature during experiment was 39 degrees Celsius while optimum temperature to grow chicken is between 20 to 24 degrees Celsius. Therefore, the system needs to be designed and improved to ensure that the optimum temperature can be maintained.

5. Conclusion

The proposed system benefits farmer such a way that monitoring temperature and humidity of poultry farm become easy with real-time telegram notification and alarm on site by using IOT system. The proposed system using cooling system is recommended. In future, the integration sensor like ammonia level, light intensity, smoke detector as well as automated responses for these sensors.

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