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Development of Egg Incubator Monitoring System using Thingspeak as Database.

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Abstract: Temperature and humidity detection are a technique that can be used in a variety of applications, including agriculture, monitoring and health. This project focuses on the development of temperature and humidity monitoring systems on egg incubator machines especially those that require continuous monitoring. The methodology chosen to implement this project was to use the Design Thinking model, part of the Internet of Things technology which is the Thingspeak website as a database to the developed system, Arduino UNO microcontroller, sensors used are DHT22 and HC-SR501 to detect temperature, humidity and movement of the egg incubator machine. Programming process using Arduino IDE and at the same time using C language in the programming. The Arduino UNO microcontroller was connected to the output of the WiFi Module ESP8266 as a transmission system to send data to the database and will display the data in the form of graphs on the display of websites and apps on the user's smartphone as a monitoring tool. The result of this project has produced the graph of data reading output on the display on mobile phones and shows the temperature, humidity and 0 is equal to no movement data, 1 is equal to movement. As a result of this developed project, it could achieve the desired output that were able to read the temperature, humidity and movement and then stored in the database. In conclusion, this product as an innovation that can monitor the temperature, humidity, and movement of the egg inside the incubator machine through the graph data display created and applied only through the smartphone display.

Keywords: Arduino UNO, ESP8266, incubator monitoring

1. Introduction

The livestock sector is an important sector. It is a breeding activity of livestock for various purposes such as meat and dairy production. Breeding refers to any growing activity of animal populations that can profit and benefit humans. Breeders produce livestock products such as eggs and meat to eat (Sanjaya, W. S. M. et al., 2018). It also refers to commercial gain to humans. This sector will not only brings economic benefits but also helps in supplying raw materials to the food sector in Malaysia.

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There are various types of livestock that can be identified in the livestock sector in Malaysia. One type of livestock in the livestock sector is poultry farming. Poultry farming is an activity of raising poultry such as chickens or quails to obtain meat and eggs. Poultry that are raised for the purpose of obtaining their meat are called broilers and poultry that are raised to obtain their eggs are called hens. There are also breeders who breed poultry for the purpose of obtaining feathers or feces for commercial purposes. These farms usually acquire poultry from the egg level and will be hatched to acquire poultry offspring such as poultry farming. There are two ways to hatch poultry eggs such as chicken by natural means or using an egg hatching machine (Rusdin, M., & I, A. S., 2014). Natural hatching is hatching that uses a mother hen to incubate the eggs to be hatched. This process is less productive than hatching using a machine because a hen can only incubate 10 eggs at a time while a hatching machine used in industry can incubate thousands of eggs at a time.

An egg hatching machine or incubator is a machine that replaces the hens to help the egg to hatch. This machine uses heat to keep the eggs incubated in a good and proper condition. The temperature of an incubator machine is generated by charcoal, oil, gas or electricity (Okpagu, P. E. & Nwosu, A. W., 2016). The need for this incubator machine is to increase the number of eggs to be hatched and the productivity of chicken production.

1.1 Background of study

The poultry industry in Malaysia is rapidly developing. The high demand for white meat in Malaysia is the main reason for this industry to continue to grow and increase every year (Majid, R. B., & Hassan, S., 2014). The development of technology in the livestock sector also helps in the growth of the poultry industry. Various types of machines or products are emerging throughout the year to help facilitate the work of breeders in the process of raising their livestock. On this basis, more and more young people are interested in getting involved in the broiler sector.

The increase in population in Malaysia every year has further increased the demand for the food sector. Malaysians need almost 1.8 million chickens a day (MStar, 2016). This high volume of demand requires the livestock industry to produce such a large number of chickens in order to meet the market demand. According to the Ministry of Agriculture and Agro-based Industry (2017), Malaysia produces almost 300 million chickens a year and this number is still not able to meet the needs of the market in Malaysia. Various methods must be created so that this request can be met and not depending on external parties.

To meet this demand, chicken entrepreneurs and breeders have used an alternative to hatch eggs in large quantities, namely using a chicken egg hatching machine or incubator. The incubator machine is a machine that replaces the mother hen to produce the heat needed by the egg to hatch. Even temperature control is essential for successful hatching (French, N. A., 2009).

In using an incubator, there are important factors to ensure the success of hatching, namely temperature and humidity. The temperature of the incubator machine should be evenly distributed at 37.40C - 38.20C (Feast, M. et al., 1998). When the exposed temperature is too high or too low, it will reduce the percentage of hatching success. It is very important for the incubator machine to ensure that the temperature is always within the specified range.

Humidity is the level of dryness of an area. It is also an important factor in the process of hatching chicken eggs. Chicken eggs require constant monitoring of moisture levels. Chicken eggs require humidity levels of 50% to 55% RH (Peebles, E. D. et al., 1987). Lack of moisture will cause the egg to dry out and the egg embryo to die while, excess moisture will cause water vapor to seep into the pores of the egg and cause the embryo to drown and die.

Frequency to check temperature and humidity on incubator machines is very important to ensure a percentage increase in success (Agboola, A. K., 2013). Without regular monitoring, the percentage of

hatchery failure would increase and this would result in losses to breeders. In order to monitor the temperature and humidity conditions of the eggs, breeders should always be nearby or hire workers to always be with the incubator machine. This in turn will increase the cost for poultry farmers.

1.2 Problem statement

As a result of research from the background of the problem, the issues that will be highlighted in the development of the prototype of the incubator machine monitoring system is based on the problems faced by poultry farmers. Based on the visit that was conducted to the chicken hatchery in Kota Tinggi found that the failure to hatch chicken eggs will cause losses to breeders. The importance of monitoring the temperature and humidity of the incubator machine at all times is a priority to ensure that the percentage of egg hatching failure is reduced. Due to the busy daily affairs of the breeders could not monitor the condition of the incubator machine at all times. Initiatives to hire workers to constantly monitor the condition of the incubator machine will at the same time increase the costs that must be borne by the breeders. Accordingly, a research to develop a prototype of an incubator machine monitoring system using applications on mobile phones is much needed. With the application of this incubator machine monitor, breeders do not have to worry about the condition of the incubator machine. This is because, with the development of applications on mobile phones, breeders can check the temperature and humidity on the incubator machine remotely. Breeders will also be notified when there is any significant change in temperature and humidity or any movement in the machine. The objectives of the study are as follows:

i. Develop a prototype of the IoT-based Chicken Egg Hatchery Monitoring System.

ii. Analyze the Monitoring System of Chicken Egg Hatchery Machine based on IoT.

iii. Test the functionality of the Chicken Egg Hatchery Monitoring System based on IoT.

2. Methodology

The design thinking model has five main phases that researchers need to focus on, which are empathy, definition, ideas, prototyping and testing.

2.1 Phase 1: Empathy

Empathy is the tendency of a person to feel something that others are doing (Preston, S. D., & De Waal, F. B., 2002). In this phase, an observation is made to identify and understand the problems faced by a particular group that are chicken breeder. From these observations, analysis is made related to the process of hatching chicken eggs performed by the community. From the observations made, most small-scale breeders will let the hens incubate their own eggs while large-scale breeders will buy incubator machines and will have to monitor them constantly. This identified problem could be solved based on the needs of the user.

2.2 Phase 2: Definition

During this phase, the problems that have been identified have been drafted in advance. Where, focus on one problem faced by the user. Researchers have collected preliminary information on the problems that occur by conducting an analysis of the process of incubating chicken eggs. The researcher also expressed his point of view by combining the three elements which are users, needs and objectives. In addition, a statement of problems that could be used to drive the entire design work as soon as possible to achieve the set objectives was made.

2.3 Phase 3: Ideas

This phase is implemented after the definition process is completed. In the idea phase it explains the overall view of the form, structure, theoretical approach, type of media and technology. The

design you want to build must be user-friendly. Aspects of the shape used as well as the size are very important to determine in advance.

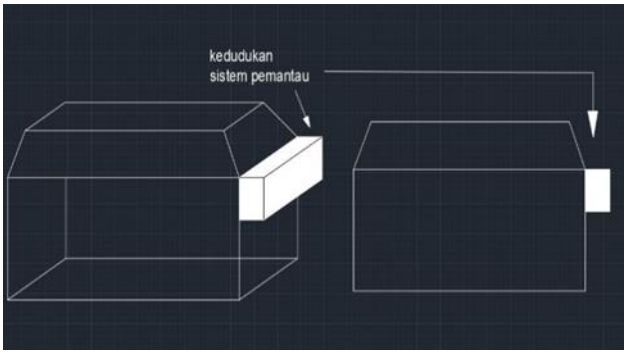

Figure 1: Design idea

In this design development phase is a combination of understanding of problem space and ideas in producing solutions to users. For the initial start of product design, several solutions are provided so that the selection to get the best solution. In this phase, the process of brainstorming ideas and generating creative ideas to develop a product that can solve consumer problems systematically and effectively. Therefore, to illustrate the idea, a final sketch is provided to explain the product developed. Through this sketch, other users can understand the concept of this product. Figure 1 shows an initial sketch of the model design of the incubator machine monitoring system.

2.4 Phase 4: Prototype

In this phase, the researcher needs to list and provide all the equipment and accessories. Researchers also need to plan the layout of equipment to be installed in the correct and precise position so that each of these components can operate properly.

2.5 Phase 5: Testing

In this phase, the researcher conducts tests using two methods, namely the test on the constructed components and the user acceptance test. Each unit involved in the development of this system is combined to form a complete circuit to achieve the objectives and goals of the project. Testing is also carried out to ensure that the system can operate as planned.

2.5.1 Circuit Analysis

Circuit analysis was performed on Arduino circuits and connections to DHT22 sensor, HC-SR501 sensor and ESP8266. The connection of each sensor and module is checked in detail to avoid errors or damage to the connection. Each part of the connection has its own function.

DHT22 is connected to a microcontroller intended to create temperature and humidity readings on the incubator machine. This detector has three connections namely VCC, GND and Data. The VCC terminal is connected to the Arduino UNO 5V terminal as a supply source to the detector. The GND terminal is connected to the GND terminal on the Arduino UNO. The Data Terminal is then connected to pin 2 Arduino UNO as a sensor output. The data from the terminal are temperature and humidity reading data. All connections for DHT22 are connected properly and neatly.

The HC-SR501 sensor is a motion detector that uses infrared to detect any movement. This sensor also has three connections namely VCC, GND and Data. Like the DHT22 sensor, this sensor is also connected to the Arduino UNO. The GND terminal is connected to the GND pin on the Arduino UNO. Connections at all three terminals were checked to ensure no errors occurred.

ESP8622 is a WiFi module connected to the Arduino UNO to enable microcontrollers to connect to the internet. Internet connection is important to send the data that has been taken from the sensor to the database that is Thingspeak. There are eight terminals on the ESP8266. But only five terminals will be used namely Tx, Rx, VCC, GND, and CHPD. As before, the VCC and GND terminals will be connected to the same terminal on the Arduino Uno. Tx and Rx terminals are terminals for transmission and reception. It was connected to the Tx and Rx pins on the Arduino UNO. The CH_PD terminal is the terminal to turn on the transmitter on the ESP8266 and was connected to the VCC on the Arduino UNO.

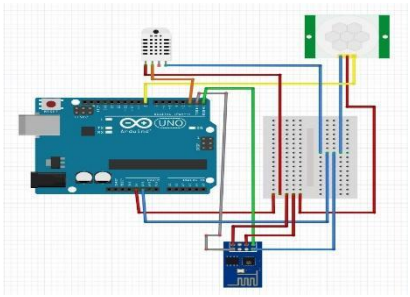

Figure 2: Schematic Circuit

2.5.2 Output Data Analysis

The collected data is sent to the Thingspeak database. The data will be displayed in the form of graphs to make it easier for users to understand the changes in the state of the machine. The resulting graph is divided into three graphs, namely temperature graph, humidity graph and movement graph. Users can see the changes for all three graphs. The applicable change is the change of data received from the product every 30 seconds.

Temperature is one of the most important indicators in this study. An egg needs a temperature of 36 to 40 degrees Celsius. Temperatures that are too high or low over a long period of time will inhibit egg growth (Ali, F., & Amran, N. A., 2016). Therefore temperature monitoring is important in this product. The graph displayed can show changes every 30 seconds of the incubator engine temperature. In the event of any drastic changes to the graph, the user can take appropriate action to improve the situation. Figure 3 shows the results of the incubator machine used. Temperature changes are visible every 30 seconds. The minimum temperature displayed is 38 degrees Celsius and the maximum temperature reaches 41 degrees Celsius. This is a good condition for eggs. The grafh produced is also accurate and equal to the temperature displayed on the incubator machine. This shows that the temperature sensor works well.

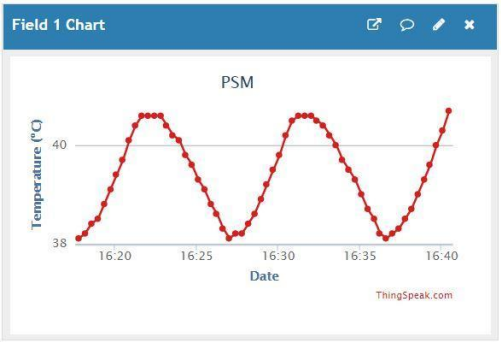

Figure 3: Temperature Graph

The second indicator in this project is humidity. Like temperature, humidity also plays an important role in egg development. Too dry or too wet will cause the egg to fail to hatch. Chicken eggs need humidity at 65% to 70%. Exposure to too dry or too humid conditions over a long period of time will have a negative effect on eggs. On successfully generated graphs, users can see changes in humidity every 30 seconds. In the event of a change that is too large the user can take action to improve the situation. Figure 4 shows the results obtained successfully from the Arduino UNO. The maximum humidity obtained is 71% and the minimum humidity is 65%. This shows that the humidity detector also works well.

Figure 4: Humidity Graph

The last indicator in this study is movement detection. The HC-SR501 detector is used to detect any movement on the incubator machine. This indicator ensures that no external disturbances occur. It can also detect if any eggs have hatched and the operator can move the chicks. The movement graph shows the sum of '0' as there is no movement while '1' for there is movement. In Figure 5,it can be seen that no movement was detected until the researcher tried to wave at the sensor for control purposes. The sensor successfully detects hand movements and displays a '1' number. This shows the sensor is working properly.

Figure 5: Movement Graph

3. Results and Discussion

The development of egg incubator machine monitoring system has been divided into two main phases. The first phase is software development and the second is hardware development. Software development includes operating system installation, configuration and installation of Arduino UNO, ESP8266 and detectors. This project has no storage level because the Thingspeak database provides unlimited storage space. It also receives data as fast as 20 seconds for a single data. The information received will be displayed in the form of a graph on the mobile phone. Operators will be able to save time and cost to monitor this machine. Employers do not need to hire employees to monitor these machines at all times.

This product has been tested by researchers in terms of component connection, programming, and output data. the researcher is satisfied with the results that are produced. This product has also been brought for testing by three experts in the field of electronics. All experts agree that this product can

help save time and reduce costs. All three experts are very positive about the product produced. They also provide views and suggestions for improvement of this product.

All the experts agreed that the design of the product was suitable in terms of components used such as Arduino UNO, DHT 22 and ESP8266. They also agreed that all the components work, and the product achieved its purpose. However, all the experts disagree that the product was able to reduce the inaccurate reading of temperature, humidity and movement.

4. Conclusion

Overall, the Development of the Egg Incubator Machine Monitoring System has achieved its objective where the design of the control operating system is applied by the user remotely and the transmission signal is fast depending on the type of network used by the user. This has been proven by researchers in the technical analysis section where its capabilities have been measured. As such, the discovery of a new technology that is the Internet of Things (IoT) that helps in the whole project. The wireless sensor network system consists of sensors as components for inputs, UNO Arduino microcontrollers as processing units and signal transmitters. Using the Thingspeak website as a Thingview database and application was very helpful and user-friendly. This product can also assist users in monitoring remote chicken egg incubator machines for safety monitoring. This system plays an important role in the poultry industry because with this system, it is easier for consumers to know the temperature changes and egg moisture as well as the safety of chicks. As a result of this project, the product can help and facilitate the business of entrepreneurs by saving time and cost to hire employees. Advances in wireless networks bring many benefits in various applications. The goal of Internet of Things (IoT) technology is to maintain simple features and focus on the standards needed to achieve a satisfactory level.

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