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Temperature and Humidity Monitoring System Environmental Cat Incubator Based on the Internet of Things (IoT) †

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Abstract: Kittens in their first four weeks are in their most critical period because they do not yet have the ability to thermoregulate their bodies, and it is still difficult for them to adapt to environmental temperatures. Due to this condition, veterinary clinics and cat-lover communities need facilities that can maintain a kitten's body temperature within the normal range. One way to help in the care of these kittens is to use a special incubator for animals. Incubators are useful in situations where animals cannot control their body temperature conditions. The expected method to monitor the work system of the incubator is internet-based monitoring, as part of IoT (internet of things). Monitoring is very important for animal health workers and cat lovers in monitoring the temperature and humidity in the incubator using the internet, which allows monitoring to be carried out anytime and anywhere from a smartphone through the Blynk application. The purpose of this research is to create an IoT-based kitten incubator monitoring system through the blynk application so that the owner or nurse of the kitten can monitor in real time via a smartphone so that time efficiency can be improved, by using NodeMCU ESP8266 microcontroller with fuzzy logic method. The incubator can work automatically to regulate the temperature through lighting and air settings in it, with the applied temperature ranging from 26 degrees to 30 degrees Celsius.

Keywords: Blynk IoT; incubator; humidity; kitten; temperature

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1. Introduction

Kittens in their first four weeks are in their most critical period because they do not yet have the ability to thermoregulate their bodies, and it is still difficult for them to adapt to environmental temperatures. The mortality rate for kittens under 9 weeks of age ranges from 6 to 20% [1]. Newborn animals are generally less capable of thermoregulation than older individuals, their body size is smaller, they have less hair, and their physiological response or regulation is not well developed [2]. Thermoregulation is the ability of an animal to regulate or maintain its body temperature. Thermoregulation plays a very vital role in maintaining body homeostasis so that enzymes, hormones, and others work properly so that the physiology runs normally. The kitten's lack of ability to thermoregulate is the main cause of being susceptible to hypothermia. Hypothermia is a condition when the cat's body temperature is below normal temperature or below 37 °C. The normal temperature of a cat is 38.6 °C, heart rate is 140–210 times per minute, and respiratory rate is 20–24 times per minute [3]. Hypothermia is a very dangerous condition because it can cause an increase in heart rate and breathing, which can lead to cardiovascular system failure. Hypothermia is what also causes cats to be unable to process food so they do not have enough nutritional intake. When a kitten's body temperature drops, the kitten's blood sugar level drops below normal (hypoglycemia). The kitten's internal organs automatically begin to decline. The colder the temperature, the faster the kitten will go into hypothermia, coma, and then die.

Due to this condition, veterinary clinics and cat-loving communities must be able to create an environment that can maintain a kitten's body temperature within the normal range, especially for kittens without a mother. One way to help in the care of these kittens is to use a special incubator for animals. Incubators are useful in situations where animals cannot control their body temperature conditions, such as for kittens of the first four weeks of age and when animals are injured or sick. While it is very important to warm the kitten, care must be taken to avoid heating too quickly. Dehydration, shock, and death can result from heating too fast.

In some cases, an incubator can also be used to control the humidity (moisture content) of the animal's environment, and to keep the kitten's body temperature stable. The incubator will help in caring for kittens at a critical age under 4 weeks. Through the incubator, food intake, nutrition, and a stable temperature are regulated in such a way that the ambient temperature is maintained at 28–30 °C. Its main function is as a tool in helping the care of newborn cats. A good incubator should be accurate and have an adjustable temperature control system. Incubator construction should be solid and easy to clean, so as not to harbor infectious agents. It should be easy to observe the patient; ideally the patient is clearly visible without opening the door.

Monitoring and monitoring of the incubator has been carried out manually, namely by turning off and turning on the lights based on the temperature listed on the thermometer in the incubator. The expected method to monitor the work system of the incubator is internet-based monitoring, as part of the IoT (internet of things). Monitoring is very important for animal health workers and cat lovers in monitoring the temperature and humidity in the incubator using the internet, which allows monitoring to be carried out anytime and anywhere from a smartphone through the Blynk application, because this application can control and monitor anything remotely, wherever and whenever. Note that it needs to be connected to the internet with a stable connection, and this is what is called the Internet of Things (IoT) system [4]. In addition, this application is also very easy to use, available on the Playstore and Appstore for free, and many microcontrollers can be controlled through this application platform.

Newborn kittens have physiological characteristics that are very vulnerable compared to adult cats, but this can be overcome with good care, which will provide many benefits [5]. The percentage of deaths in puppies and cats due to hypothermia ranges from 5 to 35% [6]. Neonatal survival is closely related to thermogenesis, especially when there is a decrease in body temperature at birth when kittens move from a warm environment in the womb to a cold extrauterine environment [7]. The first 24–72 h after birth is a period when body temperature is easy to drop [8].

Temperatures below 36 °C are strongly associated with the incidence of hypothermia and the incidence of death in kittens [9]. The normal temperature range of a newborn kitten is between 35 and 37 °C, increasing from 36.1 °C to 37.8 °C on the first day and reaching an adaptation period on day 28 after birth [10]. Therefore, it is very important to maintain a controlled ambient temperature for the newborn kitten and provide an adequate temperature during the first week to prevent hypothermia. In addition, avoid overheating, which can trigger the dehydration process with respiratory failure due to reduced ventilator response to carbon dioxide [11]. The thermoneutral zone for domestic cats is 30–38 °C.

Internet of Things is a term that is currently being discussed among millennials; the Internet of Things, also known by the abbreviation IoT, is a concept that aims to expand the benefits of continuous Internet connectivity that allows us to connect machines, equipment, and other physical objects with networked sensors and actuators to acquire data and manage their own performance, enabling machines to collaborate and even act on newly acquired information independently. Basically, IoT devices consist of sensors as data collection media, Internet connections as communication media, and servers as collectors of information received by sensors and for analysis [12]. Currently, there are many platforms that provide features for IoT in the form of a website or application on smartphones, one of which is Blynk. Blynk is an IoT platform on smartphones (Android or IOS) that can be used

to control various kinds of microcontrollers such as Arduino, NodeMCU ESP8266, ESP32, Raspberry Pi, and many more.

2. Method

This study examines the development of an incubator that is integrated with the application of technology based on the Internet of Things (IoT). The several stages that will be carried out in this research consist of designing and manufacturing the incubator plate, testing and application, with the final stage being testing. The design and manufacture of the incubator plate is the initial stage where the incubator is made without any additional features provided. After the incubator is made, the Internet of Things (IoT) is applied to the incubator, which consists of the application of sensor and electronic components to support the implementation of the IoT system. The application of these components coincides with the development of application software, which will later be integrated with hardware components that are applied to the incubator until the systems are connected and can work online. With the application of online Internet-based application software, monitoring of temperature and humidity, which is a critical point in the use of incubators in treating kittens, can be carried out remotely via mobile phones. After this IoT application works, the next stage is to conduct testing to ensure that the developed tool can work very well before it is finally used by partners and marketed.

3. Result

The incubator made in this study is an incubator that is intended for newborn kittens, where kittens born less than one month prior have a period of vulnerability to death. Therefore, this incubator was created as a solution to this problem. The incubator is designed in such a way as to be large enough to accommodate both kittens and mother cats. The design of the incubator can be seen in Figure 1 as follows.

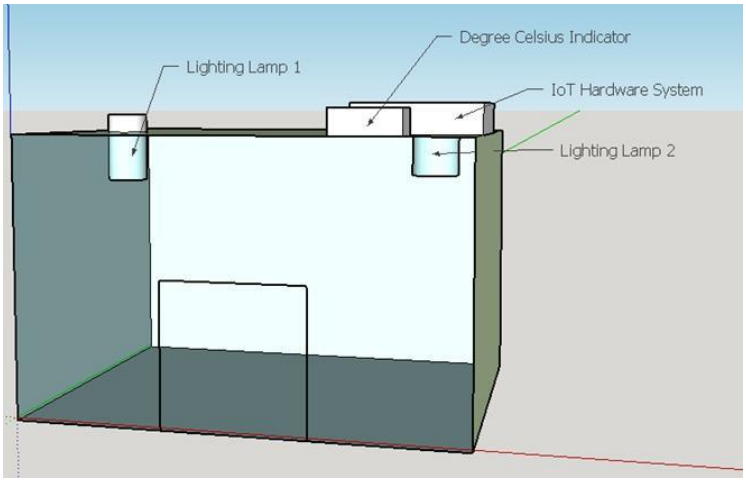

Figure 1. the kitten incubator design.

The image above is a basic design as a guide for making a kitten incubator. The incubator is made from acrylic fiber, which is then shaped into a square equipped with IoT supporting hardware equipment which can be controlled using a smartphone. The incubator result can be seen as follows in Figure 2.

Figure 2. the kitten incubator.

Temperature Parameter

The temperature parameter is the main thing that is of concern in the manufacture of this incubator. The temperature is made stable by adjusting the hot light produced by the lamp when the temperature needs to be increased, while when the temperature needs to be lowered, the air circulation produced from the blower will be faster so that the intensity of air circulation in the room is higher. The temperature applied to the kitten incubator ranged from 26 °C to 30 °C. the temperature in this range needs to be maintained to suit the needs of the kitten's body.

From the observations that have been made, the average air temperature that can be obtained is 28 °C. With this temperature, if there is a change in temperature that is influenced by external factors, the sensor will adapt to increase or decrease the temperature according to the temperature set in the system. In this case, temperature control is performed digitally using the Internet of Things (IoT) system. The IoT system works by using the blynk IoT application installed on a smartphone; with the application the desired temperature is set and can be monitored remotely. If there is a change in temperature that is influenced by external factors in the incubator, the lighting or air circulation system will work to adjust the temperature to match that set in the application. Figure 3 is as follows.

Figure 3 above is the interface display of the Blynk IoT application; from that view, monitoring can be carried out by looking at the information listed on the application. From the display above it is known that there are two indicators that measure the temperature in the room; at temperature 1 it is measured that the room temperature is 25.70 °C, while at temperature 2 it is measured that the room temperature is 25.90 °C, and from the two indicators it is obtained that the average room temperature is 25.80 °C. In addition to room temperature, humidity can also be monitored in this application; it can be seen that indicator 1 shows that the humidity of the room is 52%, while indicator 2 shows that the humidity of the room is 39%, and from the two indicators the average humidity of the room is 46%. By using the NodeMCU ESP8266 microcontroller that is connected to the Blynk IoT application above, temperature and humidity can be continuously monitored and controlled in real time remotely.

Figure 3. Blynk IoT application.

4. Conclusions

This study examines the development of an incubator that is integrated with the application of technology based on the Internet of Things (IoT). The temperature parameter is the main thing that is of concern in the manufacture of this incubator. The temperature is made stable by adjusting the hot light produced by the lamp when the temperature needs to be increased, while when the temperature needs to be lowered, the air circulation produced from the blower will be faster so that the intensity of air circulation in the room is higher. By using the NodeMCU ESP8266 microcontroller which is connected to the Blynk IoT application, temperature and humidity can be monitored and controlled in real time remotely using the Internet.

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