Design and Development of Control and Monitoring Systems in Internet of Things (IoT) Based Cat Cage (Case Study: Violet Pet Shop & Clinic)

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***Abstract*— Violet Pet Clinic & Shop is a place to day care and care for pets such as cats which is located at Jalan Borobudur No.11, Mojolangu, Kec. Lowokwaru, Malang City, East Java Province. At Violet Pet Clinic & Shop, it provides various facilities including grooming, day care, doctor consultation, and ultrasound. The type of research carried out includes the type of development research, which functions to produce certain products and test product effectiveness. Equipment testing results show good performance. The tools developed can be a solution to problems at Violet Pet Shop & Clinic. The temperature sensor has an average reading error of 0.88 percent with an accuracy percentage of 99.12 percent, the ESP32 camera can capture images properly. In one of the control systems, feeding in large quantities with a feed dose weighing 150g can only provide 4 times of feed with a delay of 10 seconds.**

Keywords: **Cats, Petshop, Servo Motor, DHT22, ESP32-Cam, ESP32, Feed Control.**

I. INTRODUCTION

In modern cities, with the development of office and business areas, many individuals do not have the convenience to be close to nature. This causes the desire to fulfill emotional needs by looking after pets, one of which is a cat [1]. Cats are one of the most common carnivorous mammals kept by humans [2]. According to a survey conducted by Rakuten Insight on the Asian continent, Indonesia is ranked first as the most cat keeper with a percentage of 47%. Then followed by the Philippines with 42%, Thailand with 42%, Vietnam with 34%, Malaysia with 34%, and South Korea with 9% [3].

The interaction between humans and animals has various benefits for human welfare [4]. Various studies have shown that caring for animals can improve the quality of life of individuals in psychological and physical aspects [5]. On the psychological aspect, individuals who raise animals can also improve their welfare. Individuals will not be prone to experiencing loneliness, depression, and other symptoms of physical or psychological illness [6]. Allen et al (1991) stated that women who have pets will have lower levels of stress because they often regard pets as their best friends. While on the physical aspect, it was found that pets can reduce their owner's heart rate and blood pressure in all age groups through sensory stimulation [7]. Pets have also shown cardiovascular healing benefits in humans [1].

Cats are animals that are free from uncleanness but require a lot of effort and attention in maintaining them [8]. Cats as pets are considered as valuable family members. Therefore, maintaining health and diet is the main task of every pet owner. Most nutritional diseases in cats are caused by problems with irregular feeding patterns [9].

Individuals who keep cats are not always at home and can leave cats at home for a long time so they cannot prepare food, cannot pay attention to their health, or their pets get sick [10]. Therefore, many cat keepers entrust their pets to pet shops and pet clinics. One of them is at Violet Pet Clinic & Shop. Violet Pet Clinic & Shop is a place to day care and care for pets such as cats which is located at Jalan Borobudur No.11, Mojolangu, Kec. Lowokwaru, Malang City, East Java Province. At Violet Pet Clinic & Shop, it provides various facilities including grooming, day care, doctor consultation, and ultrasound.

Based on an interview with one of the doctors on duty at Violet Pet Shop & Clinic, it is known that there are several problems and obstacles faced, namely pressure from consumers or owners to always provide information about the condition of their pets. The IoT system has the benefit of being able to provide convenient services through smart technology for pet owners.

The rapid development of technology and information has made the Internet of Things widely used [11]-[14]. The meaning of things in IoT is not only limited to "connecting together", but can also be realized in various functions such as localization, recognition, management, search, and so on. The Internet of Things allows physical monitoring to be carried out with just one click on the application interface. IoT can connect gadgets to the internet based on the protocols needed to produce information exchange and communication. This makes the automation system provide convenience for consumers so they can save the energy used.

In this research, an IoT-based clinic pet care system will be developed to be able to control feeding and monitor pets that can be accessed by owners when their pets are at Violet Pet shop.

II. METHOD

This research is development research that functions to produce certain products and test product effectiveness. The author takes several steps to design a control system and monitoring system.

A. *Hardware System Block Diagram*

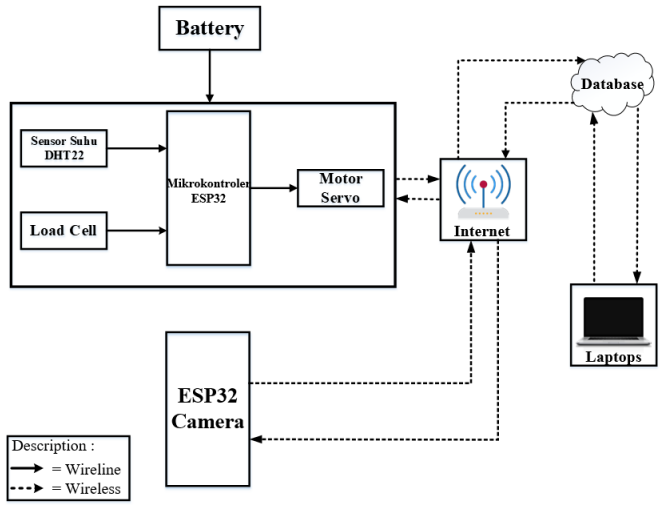


Figure 1. System Block Diagram

Fig. 1 shows a block diagram for designing a control and monitoring system for cat cages based on the internet of things. In Fig. 1 there are several parts such as the DHT22 sensor, load cell, and servo motor which are connected to the ESP32 microcontroller which is connected to the battery as a power source and also the ESP32-Cam which is connected to the battery. Using the internet network helps sending data to the database so that it can be accessed on the website.

B. *Customer Block Diagram*

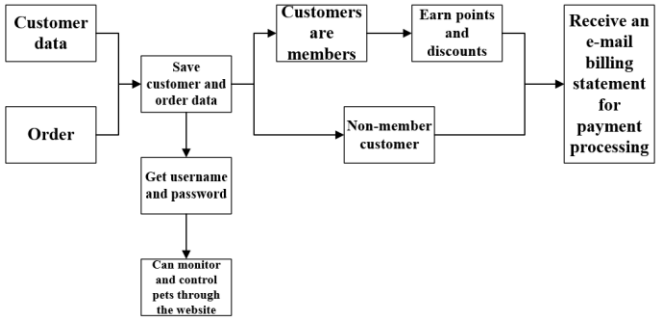


Figure 2. Customer Block Diagram

Fig. 2 The customer block diagram above illustrates the flow and facilities that customers get after registering. Customer data and orders that have been selected by the customer will be stored in the database, for customers divided into 2, namely Customer Members and Customer Non-members. The facilities for Customer Members and Non-members will be different where members will get several benefits, namely getting points on each transaction and getting discounted prices on several services. Non-member customers will not get the same facilities, for all the normal prices will still apply.

C. *System Flow Chart*

Fig. 3 shows that the two flow charts above are a sequence for operating the tool and using the website for the admin where first the admin ensures that the tool is on. Then the sensors and WebCam will send data to the database, then the admin logs in and on the dashboard, the admin can choose whether to monitor first or control first. If you select monitor (A) first then select the monitoring menu then select it again to monitor the conditions in the cage or temperature and humidity. If the admin chooses to do controlling (B) then the admin can feed the pets and can find out the remaining feed available. Feeding can be done in two ways, namely manually and automatically.

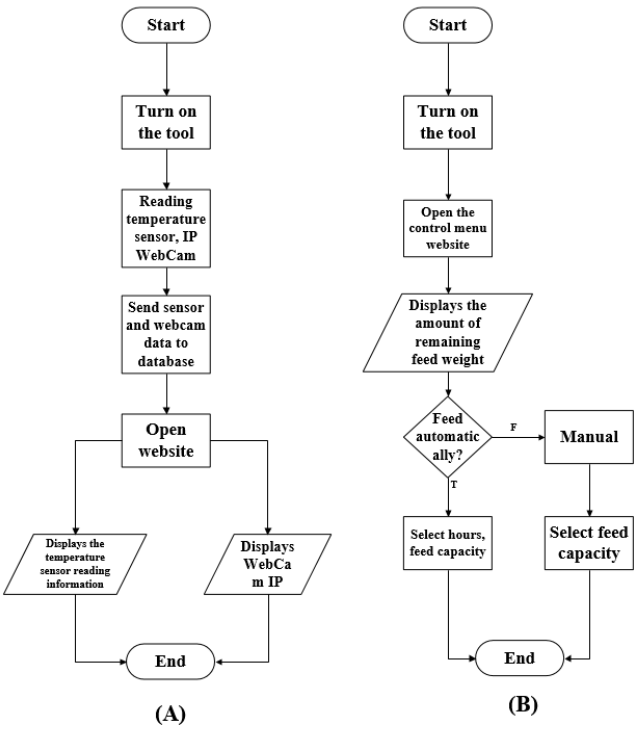


Figure 3. (A) Monitor System Flowchart, (B) Control System Flowchart

D. *Customer Flow Chart*

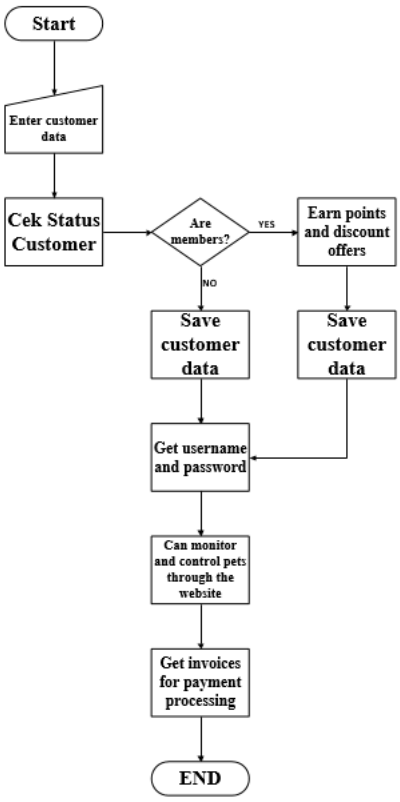


Figure 4. Customer Flowchart

Fig. 4 shows the customer registration process. First, the customer must visit the pet clinic & shop to register offline. After registering, the data will be entered into the database. Then check whether the customer is a member or non-member. If the customer is a member, it will benefit from getting points and getting a discount on every purchase transaction. After checking the customer's status, the customer gets a username and password that is used to log in to the website so that the customer can monitor and control the pets that have been deposited at the Violet Pet Clinic & Shop.

E. Hardware Planning

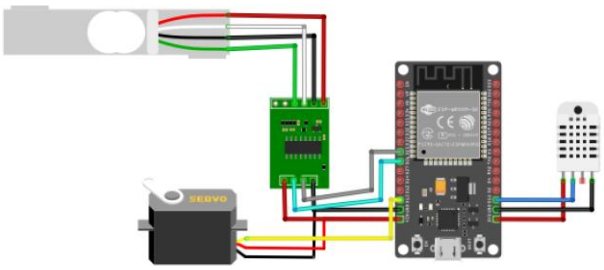


Figure 2. 5 Hardware Plan 1

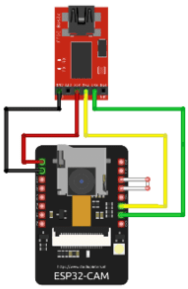


Figure 5. Hardware Plan 2

Fig. 5 is a series of ESP32 microcontroller devices connected to the DHT22 Sensor, Load Cell Sensor, and SG90 Servo Motor. In Fig. 5 is a series of ESP32-Cam devices connected to the FTDI Programmer which is used to send programs from the Arduino IDE to the ESP32-Cam.

III. RESULT AND DISCUSSION

This chapter will discuss the overall results of all that has been planned from the results of the design and design of software and hardware. This chapter contains the results of sensor testing that will be used.

A. Cage Circuit Results

Figure 6. Installation in Enclosure

Fig. 6 is a series of cages that have been assembled with IoT installations and the feeding system has been used manually or automatically.

B. System Circuit Results

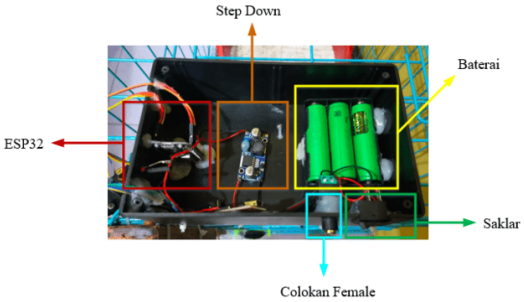


Figure 7. System Design 1

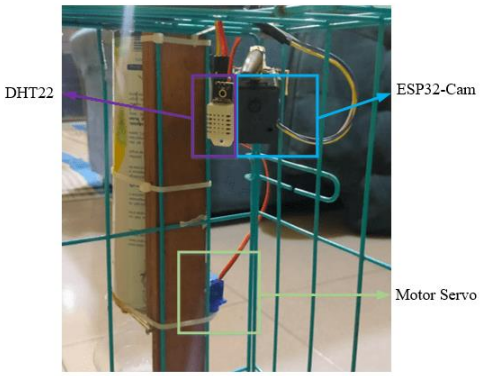


Figure 8. System Design 2

Fig. 7 is a circuit that contains an ESP32 Microcontroller, Step Down, Battery, Switch and female plug. In Fig. 8 is a series of ESP32-Cam, Servo Motor, and DHT22 Sensor. The next step is to assemble the input and output components.

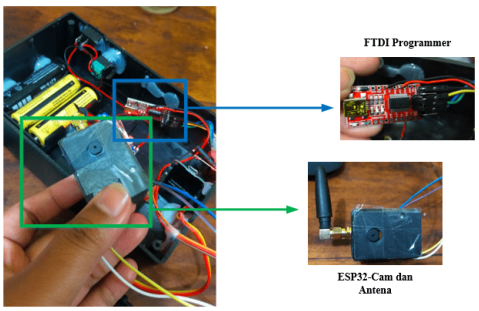


Figure 9. Webcam System

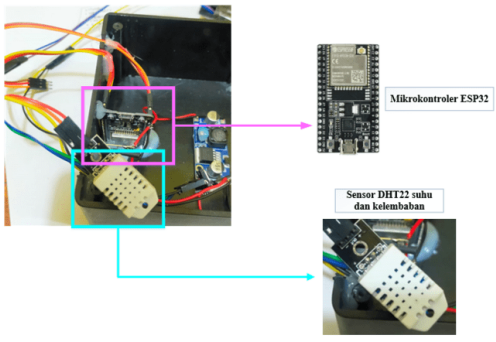


Figure 10. Temperature Sensor System

Figure 11. Feed Container System

C. *Customer Software Result*

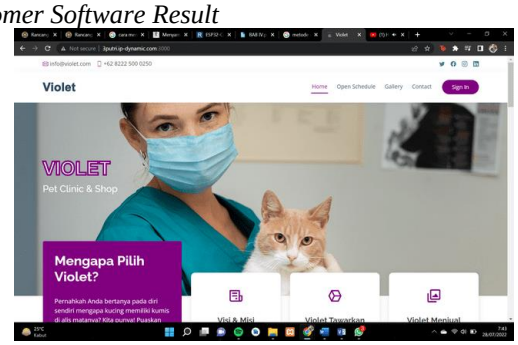


Figure 12. Customer Website Page

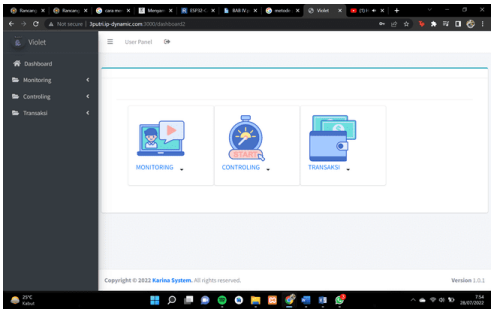


Figure 13. Customer Dashboard Page

Fig. 12 and Fig. 13 are web views used by customers to search for information, monitor and remotely control their pets.

D. *Admin Software Results*

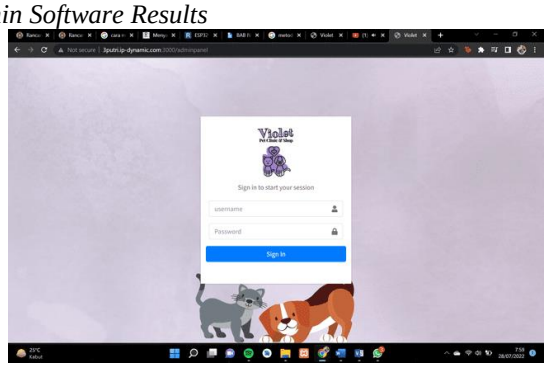


Figure 14. Admin Sign-In Page

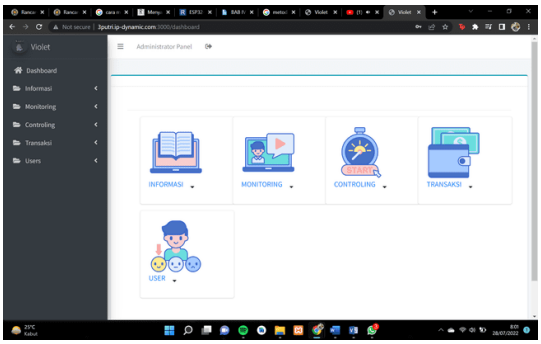


Figure 15. Admin Dashboard Page

Fig. 14 and Fig. 15 are web views used by the admin which have several functions such as being able to upgrade such as the feed menu and operational hours, as a customer registration medium, and other information.

E. *Web-Cam Website Results*

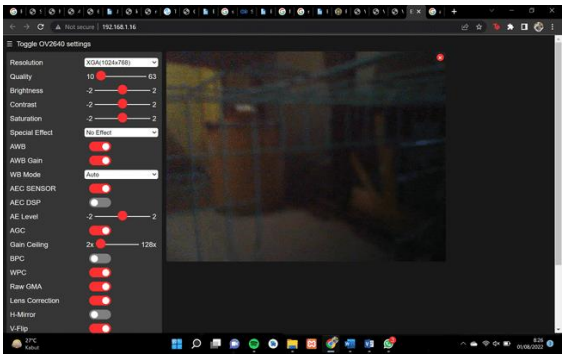


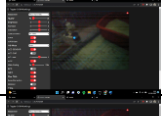
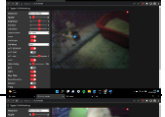
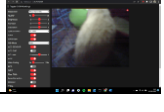
Figure 16. Website to Display Webcam Results

In Fig. 16 is a website display that displays webcam results, which can display live video in the cage.

F. *Overall Test Results*

TABLE I
SYSTEM TEST RESULTS

No.	Time	DHT22 Sensor		Food (gram)	WebCam
		Temperature (℃)	Humidity (%RH)		
1.	08.00	27,7	78,6	23	
2.	09.00	27,4	79,1	48	
3.	10.00	27,3	79,4	75	
4.	11.00	26,3	79,1	103	
5.	12.00	26,4	79,2	128	
6.	13.00	26,4	79,3	149	

No.	Time	DHT22 Sensor		Food (gram)	WebCam
		Temperature (°C)	Humidity (%RH)		
7.	14.00	26,4	79,4	176	
8.	15.00	26,4	79,1	206	
9.	16.00	26,4	79,2	223	
10.	17.00	26,4	79,1	241	
11.	18.00	26,4	78,9	266	
12.	19.00	26,5	79,2	294	
13.	20.00	26,5	79,1	314	
14.	21.00	26,6	79	340	
15.	22.00	26,6	78,9	373	

From the Table I, it can be seen that the average DHT22 sensor is at a temperature of 26.64℃ and at a humidity of 79.1% RH. The feed control system column shows the number of grams of feed that has been given. In the webcam column it can be shown that the webcam can display the state of the cage.

G. Questionnaire Results

The results of this questionnaire were divided into 3 participants, where these 3 results consisted of Clinic Doctors, Clinic Employees, and Customers. Following are the results of the questionnaire:

- *Clinical Doctor Questionnaire Results*

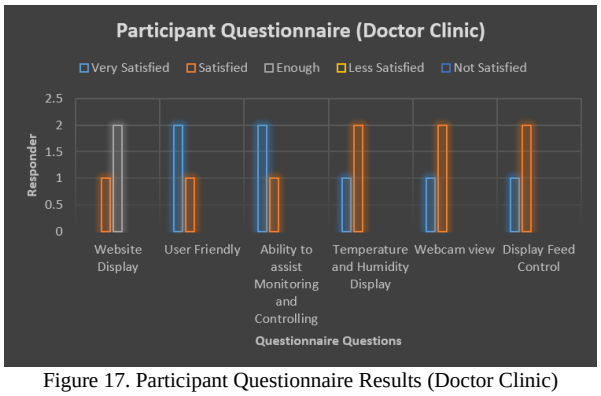


Figure 17. Participant Questionnaire Results (Doctor Clinic)

In the diagram above, a total of 3 doctor respondents were obtained. Questions about the appearance on the website get 1 person satisfied and 2 people are enough. The question of ease of use of the application (user friendly) found 2 people very satisfied and 1 person satisfied. Questions about the application's ability to help monitor and control pets found that 2 people were very satisfied and 1 person was satisfied. Questions on the display of temperature and humidity monitoring found that 1 person was very satisfied and 2 people were satisfied. The webcam monitoring display question found that 1 person was very satisfied and 2 people were satisfied. The question of displaying the remaining weight of the feed and the feed control system found that 1 person was very satisfied and 2 people were satisfied.

- *Clinical Staff Questionnaire Results*

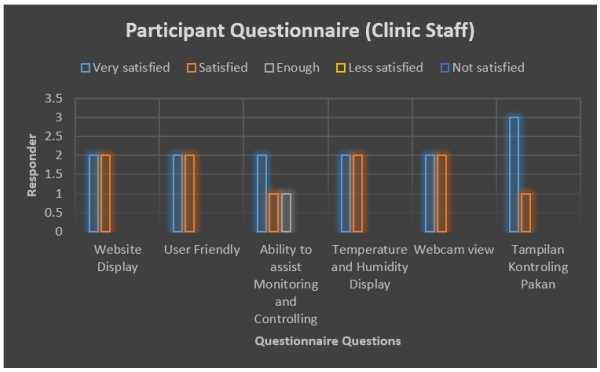


Figure 18. Participant Questionnaire Results (Clinic Staff)

In the diagram above, it is obtained from a total of 4 employee respondents. Questions about the appearance on the website get 2 people satisfied and 2 people are enough. The question of ease of use of the application (user friendly) found 2 people were very satisfied and 2 people were satisfied. Questions about the application's ability to help monitor and control pets found that 2 people were very satisfied, 1 person was satisfied and 1 person was sufficient. Questions on the display of temperature and humidity monitoring found that 2 people were very satisfied and 2 people were satisfied. The webcam monitoring display question found that 2 people were very satisfied and 2 people were satisfied. The question of displaying the weight of the remaining feed and the feed control system found that 3 people were very satisfied and 1 person was satisfied.

- *Customer Questionnaire Results*

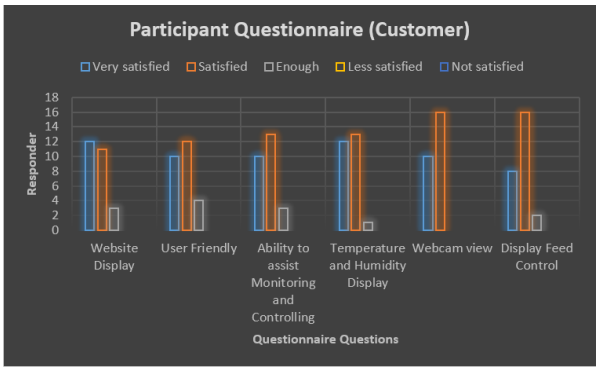


Figure 19. Participant Questionnaire Results (Customer)

From the data from the questionnaire results above from 26 customer responders it is known that from questions regarding the appearance of the website menu, it was found that 12 people

chose very satisfied, 11 people chose satisfied and 3 people chose enough. Questions regarding the ease of use of the application (user friendly) found 10 people were very satisfied, 12 people were satisfied, and 4 people were sufficient. Questions about the application's ability to help monitor and control pets found that 10 people were very satisfied, 13 people were satisfied, and 3 people were sufficient. Questions on the display of temperature and humidity monitoring found that 12 people were very satisfied, 13 people were satisfied, and 1 person was sufficient. Monitoring display questions (webcams) found 10 people were very satisfied and 16 people were satisfied. The last question regarding the appearance of the remaining feed weight and feed control was obtained 8 people were very satisfied, 16 people were satisfied, and 2 people were sufficient.

IV. CONCLUSION

The results of an interview with Doctor Andini AS at the Violet Pet Clinic & Shop found problems, namely regarding feeding cats, how to respond to customers who always ask news about their cats all the time and how to reduce cat owners' worries about feeding them. meal times and portions for their cats.

The development of monitoring and control tools in this study aims to make it easier for Violet Pet Clinic & Shop customers to be able to continue to monitor their cats when they are placed in their care without worrying about them.

Based on the tests that have been carried out, it can be seen that the average of the DHT22 sensor at temperature is 26.64 ℃ and humidity is 79.1% RH. In the feed control system column, it shows the number of grams of feed that has been given. In the webcam column it can be shown that the webcam can display the state of the cage.

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