Dogs Feed Smart System With Food Scales Indicator IoT Based

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***Abstract*—An IoT-based system of feeding and drinking forpet dogs will be described in this paper. Regular feeding and drinking become a problem when pet owners are not at home or near their pets. Feeding and drinking equipment combined with IoT technology can answer this problem. In this research, the IoT system created an IoT-based system with remote control and monitoring to make it easier for animal owners to providepet food and drink via smartphone devices. The pets referred to in this research are dogs. This system consists of two main functions, namely feeding and drinking. Each of these functions can operate manually and automatically. In addition to these two functions, there is an extension function, namely weighing food. Automatic feeding and drinking can operate according to a schedule designed using the RTC sensor DS2321 and manually via the Blynk Android app. Load cell sensor to measure theweight of food in the food container and ultrasonic sensor to measure food residue and drinking water in the container. The results of weighing food and measuring food and drinking waste are monitored through a smartphone application. Based on the test results, the results show that the tool can work according to the design function. The measurement results using the load cell sensor have an accuracy of 98% in weighing food weight compared to the reference results from the reference scales. The overall test results show that the system works well by providing manual input by the animal owner and automatically based on the RTC sensor. With this result, pet owners can leave their animals without worrying because they can monitor the animal's feeding and drinking schedule via their smartphones.**

***Keywords*—Animal Feeding, Internet of Things (IoT), Pet Dogs; Load Cell, Real-time Scheduling.**

I. Introduction

Pets are animals that are tamed and kept by humans to become animals with pleasant personalities or can be a source of happiness. The history of the practice of raising animals is related to the domestication of animals that has been going on since prehistoric times. The most common pets kept by humans are dogs and cats. According to archaeological research, it is most likely that the first domesticated animals were dogs about 12,000 years ago [1].

Involving pets in people's daily life routines can provide several benefits. These benefits include social interaction, exercise, emotional support, and social connectedness [2]. Currently, dogs are pets for human life, not just guard animals. However, several studies have shown that keeping a dog can reduce stress levels for a retired employee [3] and assist therapy in children with autism developmental disorders [4]. In practice, keeping a dog is not easy because dogs need a variety of care to stay healthy and happy. One example of treatment is the provision of highly nutritious feed with a scheduled feeding schedule. The problem that is often faced is forgetting to give food. Dogs who eat irregularly, such as late eating, can cause health problems such as vomiting. Another problem is overfeeding because the owner leaves the dog at home for a long time, whether working or doing activities all day outside the house. The consequences are that it can cause dogs to consume excess food so that the dog weight increases to become obese [2]. In addition, feeding that is not correctly scheduled due to being left by the owner out of town or during the Covid-19 pandemic, the animal owner is in hospital health care, can cause a change in the dog's reaction to the owner [2] and in some cases, some dogs die of starvation. Internet of Things (IoT) technology is a solution. It can overcome these problems by monitoring and controlling internet media-based equipment in real-time.

The purpose of this research is to monitor and control the eating and drinking of pet dogs based on IoT technology. In this research, we propose an IoT-based system with a feeding device consisting of food and drink for pet dogs that can be monitored and controlled via a smartphone. Monitoring is carried out to determine the feeding schedule and control to regulate the amount of feed given based on the weight ofthe remaining food in the container and drinking water in the container so that it is not excessive and as needed.

II. Related Work And Motivation

IoT technology is a network consisting of devices connected to the internet network. The IoT ecosystem consists of devices such as sensors, microcontrollers, applications, and others. Devices on an IoT network can communicate using MQTT as the standard communication protocol [5]. The IoT system must at least have sensors so that the essential devices in the IoT system are sensors that collect data and share it with connected devices in real-time [6]. Feeding and drinking equipment for animals, especially dogs, generally consists of a food feeder with a container and a drinking water dispenser. Currently, these devices replace manual devices [7]and have been equipped with functions as intelligent devices, where monitoring and control are automatic with real-time information [8]. The schedule for feeding animals can be done using atime sensor, Real Time Clock (RTC). The RTC sensor, while measuring the portion of animal feeding, can use a Load Cell (LC) sensor so that the portion of food is not excessive and regulate the amount of food that comes out using ultrasonic and PIR sensors [8], [9].

The application of IoT as an automatic pet feeding system monitored via smartphone devices has been carried out in several related and previous research. Research has focused on how to make a well-scheduled meal and serve a portion of food according to the pet's needs. So the sensor devices that play a role are RTC and LC sensors. In several related research conducting tests and measurements were to get the maximum possible accuracy, which is above 90% and the minimum error rate is below 10%. Several related research includes research that developed a cat feeding system for eating and drinking with an accuracy rate of 68% and 85% and errors of 32% and 15% respectively [10]. From this research, it is still considered low for the accuracy level of success in feeding and high for errors due to delays in the process.

In research on animal feeding with an android application, an error rate of 1% for feeding and 17% for drinking was generated due to poor water circulation, causing the remaining water in the water hose to flow still [11]. Feeding dogs with an accuracy of 78% was performed in one research [9] Another research with an accuracy of up to 99.3% success in feeding and drinking cats [8].

The research above shows that the feeding device focuses on two subsystem functions: feeding and drinking. In addition, these research measure the accuracy of feeding and drinking and the error rate. In research [9]–[11] the accuracy obtained is still below 90%, and the error rate is still above 10%. However, only the research [8] with 99.3% accuracy for feeding and drinking did not include the error rate. Therefore, this research aims to create an IoT system for monitoring and controlling pet dog feeding and drinking. Besides, this research also targets an accuracy value above 90% and an error rate below 10%.

III. Proposed Architecture

To realize this IoT-based pet dog feeding and drinking system, the research method was carried out in several stages, including First designing the IoT system architecture presented in block diagrams, second designing system workflows presented in system and tool workflow diagrams, and third designing and making hardware and programming, fourth designing and making software interfaces for use on smartphones and fifth doing subsystem testing, namely tools and the wholesystem. The stages of the research can be seen in Figure 1.

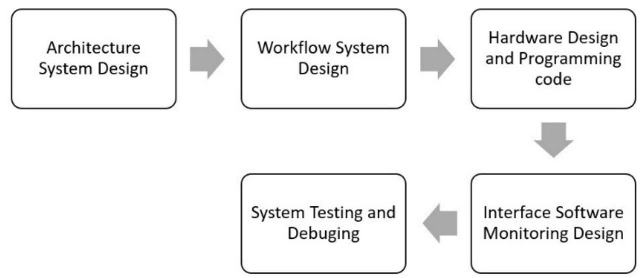


Fig. 1. Stages of research IoT systems for pet dog feeding and drinking

A. System Architecture Design

In this pet dog feeding and drinking system, each sub-system, namely Sensors (RTC, Ultrasonic, Loadcell), Motors, relays, and application interfaces, are connected to a controller, Arduino UNO R3. The subsystem of the WiFi module is ESP8266-01 which functions to integrate via the TCP/IP protocol between the device and the application interface on the smartphone so that Arduino can communicate via WiFi access with the internet network. As an interface between the user and the tool, Blynk is used. Blynk is one of the IoT monitoring application platforms on smartphones based on Android and iOS.

The primary sensors use Real-time clock (RTC), ultrasonic, and load cells. The RTC sensor is useful for displaying the time consisting of day, date, month, year, hour, minute, and second so that users can know when to feed and drink pet dogs. Ultrasonic sensors help measure the amount of food in the container. The Load cell sensor helps measure the weight of the remaining food in the container. The output component consists of a servo motor as a regulator of food release from the container to the container. A relay is helpful as a smartphone switch activates the mini water pump. The architecture proposed in this research can be seen in Figure 2 as a block diagram of an IoT-based system for feeding and drinking pet dogs.

B. Workflow System Design

The workings of the IoT system are presented in a flow diagram in Figure 3. The system is divided into two subsystems: tools that deal directly with dogs and IoT software with users or dog keepers. Start with the initialization process of ESP8266-01 or the WiFi module to connect to the internet network by checking WiFi access points set up and available around the dog owner's house. Furthermore, a signal is sent tocheck the connection with the Blynk IoT server if the internet connection has been connected. The initialization process is repeated if the Blynk server has not been connected. If the Blynk server is successfully connected, the RTC sensor will be active and directly provide data in the form of time and date.

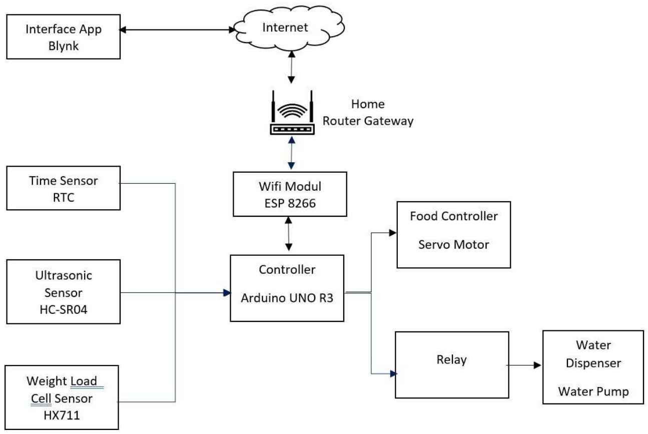


Fig. 2. Block diagram of pet dog feeding and drinking IoT system

Ultrasonic sensors are used to measure food and beverage residue in storage containers. Then if the time from the RTC sensor has shown the feeding schedule, the servo motor will rotate to remove the food from the container, and the water pump is activated to remove the drinking water. But if it's not time to eat, the ultrasonic sensor and load cell sensor are active. Meanwhile, the load cell sensor measures the food's weight in the container. The measurement results by the two sensors will be displayed on the Blynk Android smartphone interface application.

Then there is a condition to check the input from the application, which consists of the "feed" and "give drink" buttons. This condition is if the owner wants to control the tool directly. If the "feed" button is pressed, the servo motor rotates to issue food, and the "feed" button is pressed, the mini water pump is active to release water. However, the tool will finish working if there is no application input.

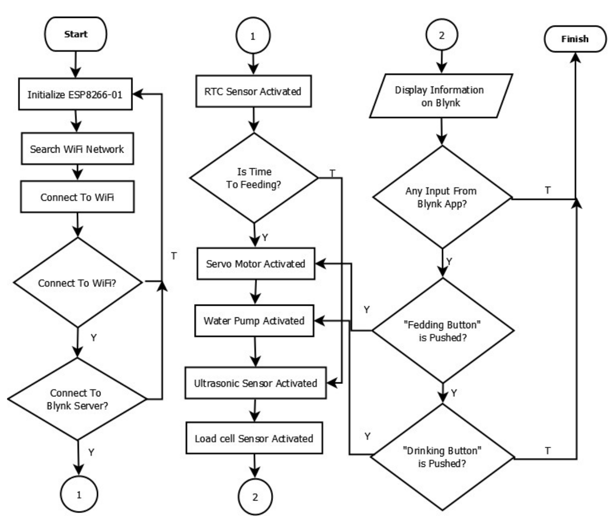


Fig. 3. Flowchart of pet dog feeding and drinking IoT system

C. Hardware Design and Programming

Based on the block diagram of the architecture and workflow of the IoT system for feeding and drinking pet dogs, at this stage, a tool is made in the form of implementation by assembling the hardware into one and implementing programming into the tool. The electronic components used are Arduino Uno R3 as a control center and ESP8266-01 as a wifi module to connect the device to internet communication. Communication between controller and Wifi module is done serially with cross configuration between Transceiver (TX) and Receiver (RX) on each component.

All settings are applied identically to each feeding and drinking device. Then the components used as input are sensors consisting of the real-time clock (RTC), ultrasonic, and load cell sensors, then servo motor components, relays, and mini water pumps are used as outputs. In addition, the Blynk Android application is used for input and output. The schematic of the breadboard system can be seen in Figure .

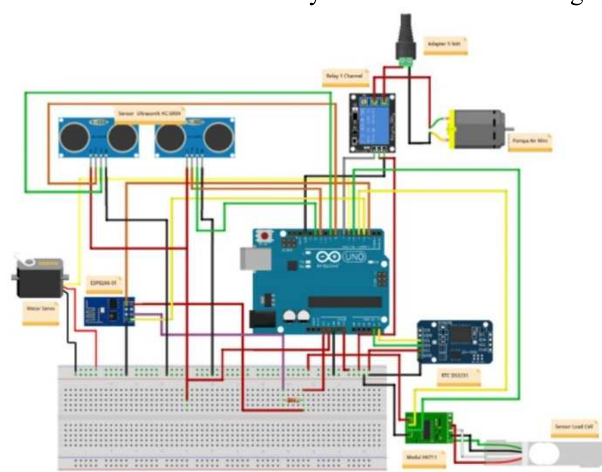


Fig. 4. Schematic Breadboard Pet dog feeding and drinking IoT system

A schematic of a series of devices with three main functions is shown in Figure 4. The first significant function is feeding. The components that work on this function are servo motors and RTC sensors. The RTC sensor acts as an input that provides the real-time date and time data; Arduino UNO R3 then processes the input. The output of the first function is the servo motor rotates according to the scheduled clock. The second function is to provide drinking water through a mini water pump which acts as the output of this function. The input to this function is the time and date data that comes from the RTC sensor and is processed on the Arduino UNO R3. The mini water pump activates according to the set hour. The last primary function is to weigh food; in this function, the load cell sensor serves as an input. The input is uploaded to the Arduino UNO R3 and processed into output in the Blynk Android application.

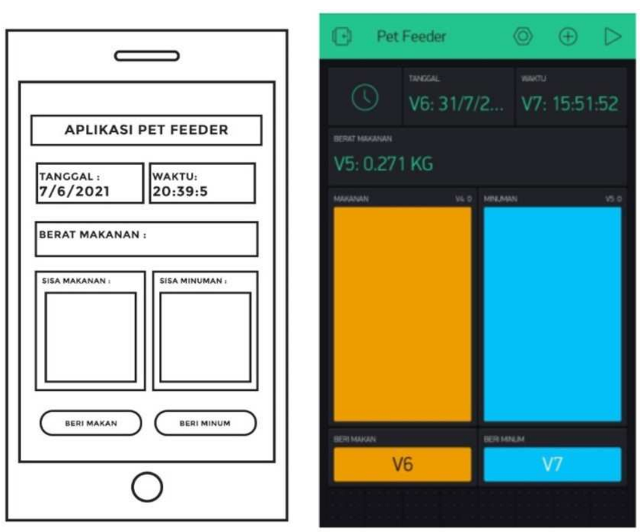
The design of the program code on the Arduino UNO R3 microcontroller is written through the Arduino IDE software and uses the C++ programming language. The program code that has been written is then uploaded or embedded into the Arduino UNO R3. The feeding and beverage program is automatically designed using time data from the RTC sensor.

Then, the schedule for feeding and drinking is set in the program so that the servo motor rotates and the mini water pump is active according to the predetermined hours. Feeding and drinking are done via a button on the Blynk Android app. The button on the application is declared as a virtual pin, and then the program conditions are designed if the button is pressed. The servo motor rotates, or the mini water pump is active, and if it is pressed again, then the servo motor stops rotating, or the mini water pump turns off and stops actively.

The food weighing program is designed by declaring the pins of the HX711 module, which is connected to the load cell sensor first. Then the load cell sensor is calibrated to a value of 0 in the program. After the calibration, the load cell sensor can weigh the food and display its value on the serial monitor in the Arduino UNO R3 software and application.

D. Interface Software Design

The software design was carried out using the Android Blynk software. The layout of the application design is shown in Figure 5. In this application, five boxes display the date, time, and weight of food, leftovers, and leftovers. The values on the five boxes come from sensors and are uploaded via Arduino UNO R3 to the Blynk cloud server. Then there are two buttons to provide food and drink.



(A) (B)

Fig. 5. (A) Application Design Layout, (B) Display on Blynk

E. System Testing and Debugging

System testing includes testing the three main functions and testing the entire system. Testing of three main functions consists of testing the function of feeding and drinking manually as well as testing the function of feeding and drinking automatically/manually (Figure 6) and weighing the weight of food (Figure 7). Testing the feeding and drinking function manually was carried out 15 times by pressing the feed or drinking button alternately and seeing the suitability of the condition of the servo motor and mini water pump with the input given.

Testing the feeding and drinking function is automatically carried out by setting the schedule for eating and drinking at five different times at five-minute intervals to determine the suitability of the output to the input from the RTC sensor. The food weighing function is tested by comparing the results of the weight of the food measured by the load cell sensor and digital scales, the data from the two weighings is analyzed, and the accuracy and difference values are sought. Testing the entire system of the tool was carried out 15 times to determine the success of the functions designed on the tool. In this test, two inputs come from the application and the RTC sensor, and monitoring is carried out on the condition of the servo motor, mini water pump, the weight of the food measured by the load cell sensor, the distance of the remaining food, and the distance of the remaining drink.

Fig. 6. Feeding and Drinking Function Test

Fig. 7. Food Weighing Function Test

IV. Result And Discussion

This tool has a container for storing food and beverages (Figure 8). The tool is designed using wood and is in the form of a box with a size of 28 cm× 28 cm × 21 cm and has four legs under it. The food storage container can hold 135 grams of dog food, and the drink storage container can hold drinking water with fewer than 500 ml volumes.


Fig. 8. Feeding and Drinking Equipment Packaging

A. Function Test

Testing the feeding and drinking function manually based on input from the application shows a one-time discrepancy between the input given and the designed output. This discrepancy is caused by the disconnection of the device from the WiFi connection. The results of this test are shown intable I and table II.

TABLE I. FEEDING FUNCTION TEST

No.	Feed Button on Blynk (0/1)	Motor Servo Rotation (degree)	Result
1	On	180	C
2	Off	0	C
3	On	0	×
4	Off	0	C
5	On	180	C
6	Off	0	C
7	On	180	C
8	Off	0	C
9	On	180	C
10	Off	0	C
11	On	180	C
12	Off	0	C
13	On	180	C
14	Off	0	C
15	On	180	C

C=Success
×=Unsuccess

Testing the automatic feeding and drinking function based on a defined schedule shows success in each test. The results of this test are presented in Table III.

Testing the weighing function of food shows that the load cell sensor has an accuracy of 98%. These results indicate that the accuracy of this tool is very good because it is still above the reference accuracy from studies [9]–[11]. This result is obtained through calculations using Equation 1. This sensor also has a difference of 1 gram compared to the results of weighing by digital scales. The results of this test are shown in Table V and presented in the chart in Figure 9.

$$Accuracy = \frac{\Sigma R}{\Sigma L}\ x\ 100\% \quad (1)$$

TABLE II. DRINKING FUNCTION TEST

No.	Drink Button on Blynk (0/1)	Motor Servo Rotation (degree)	Result
1	On	On	C
2	Off	Off	C
3	On	On	×
4	Off	Off	C
5	On	On	C
6	Off	Off	C
7	On	On	C
8	Off	Off	C
9	On	Off	×
10	Off	Off	C
11	On	On	C
12	Off	Off	C
13	On	On	C
14	Off	Off	C
15	On	On	C

C=Success
×=Unsuccess

TABLE III. FEEDING AND DRINKING FUNCTION TEST

No.	Time RTC (AM/PM)	Motor Servo Rotation (Degree)	Water Pum	Result
1	14.10	0	OFF	C
2	14.11	0	OFF	C
3	14.12	0	OFF	C
4	14.13	0	OFF	C
5	14.14	0	OFF	C
6	14.15	180	ON	C
7	14.16	180	ON	C
8	14.17	0	OFF	C
9	14.18	0	OFF	C
10	14.19	0	OFF	C
11	14.20	180	ON	C
12	14.21	180	ON	C
13	14.22	0	OFF	C
14	14.23	0	OFF	C
15	14.24	0	OFF	C
16	14.25	180	ON	C
17	14.26	180	ON	C
18	14.27	0	OFF	C
19	14.28	0	OFF	C
20	14.29	0	OFF	C
21	14.30	180	ON	C
22	14.31	180	ON	C
23	14.32	0	OFF	C
24	14.33	0	OFF	C
25	14.34	0	OFF	C
26	14.35	180	ON	C
27	14.36	180	ON	C

C=Success
×=Unsuccess

TABLE IV. OVERALL SYSTEM TEST

Frequency Test	Input	Time RTC	Servo Motor	Water Pump	Feed Out (gr)	Remaining Feed(cm)	Remaining Drink (cm)	Result
1	F1	13.50	ON	OFF	57	6	1	Success
2	F2	13.51	OFF	OFF	57	6	5	Success
3	F3	13.52	OFF	ON	57	6	5	Success
4	F4	13.53	OFF	OFF	57	6	5	Success
5	F5	13.55	ON	ON	46	8	12	Unsuccess
6	F1	13.57	OFF	OFF	46	8	12	Success
7	F2	13.58	OFF	OFF	46	8	12	Success
8	F3	13.59	OFF	ON	46	8	12	Success
9	F4	13.40	OFF	OFF	46	8	12	Success
10	F5	14.00	ON	ON	35	12	12	Success
11	F1	14.03	ON	OFF	0	12	12	Success
12	F2	14.04	OFF	ON	0	12	12	Success
13	F3	14.05	OFF	ON	0	12	12	Success
14	F4	14.06	OFF	OFF	0	12	12	Success
15	F5	14.10	ON	ON	0	12	12	Success

F1 =App Feed On
F2=App Feed Off
F3=App Drink On
F4=App Drink Off
F5=RTC Feed and Drink

TABLE V. FOOD WEIGHING FUNCTION TEST

Frequency Test	Digital Scale Reference (gr)	Load Cell Sensor (gr)	Deviation (gr)
1	5	6	1
2	10	11	1
3	15	16	1
4	20	21	1
5	25	26	1
6	30	31	1
7	35	36	1
8	40	41	1
9	45	46	1
10	50	51	1
11	55	56	1
12	60	61	1
13	65	66	1
14	70	71	1
15	75	76	1
Accuracy Load Cell (%)		98%	

ΣR =Digital Scale Reference
ΣL =Load Cell Sensor

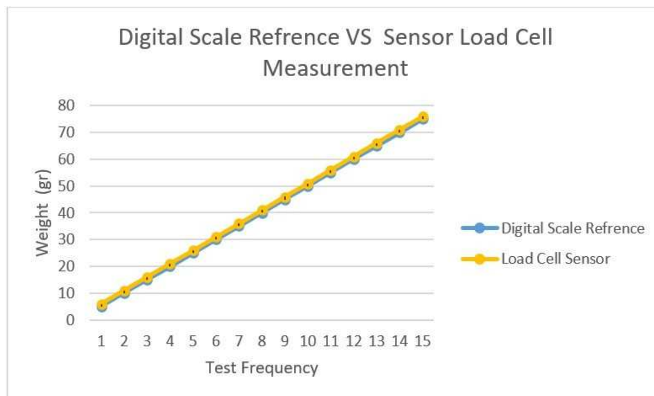


Fig. 9. Chart of measurement difference between Digital Manual Scale and Load cell Sensor

Testing the tool system's overall function based on the input type, namely from the application and the RTC sensor. Parameters measured were the weight of the food taken out and the distance between the remaining food and drinks. The results show a one-time discrepancy in the designed output, and this is because the device has a connection interruption from the wireless network, causing the connection to be disconnected. This problem does not last long because the device will reconnect with WiFi.

V. CONCLUSIONS

Feeding and drinking IoT dog systems have been designed, built, and tested. Based on the test results, the system can work well, marked by monitoring the weight of the food removed from the container and controlling the opening and closing of the container via a smartphone device. The same thing is also obtained in the drinking function can be monitored and controlled. The tool can also weigh food and measure food and beverage residue in containers. Weighing food on the tool has an accuracy of 98% and a difference of 1 gram compared to a digital scale as a reference for the results. This result shows that the reference accuracy generated by reference studies based on the literature review is 90%. Although from each test on the function of feeding and drinking, there is one error; however, it is still tolerable. Based on these results, this tool can overcome the problems conveyed and utilized by dog owners. In the future, this result can develop into a complete system by adding a camera to monitor pets' conditions.

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REFERENCES

[1] B. P. Smith, "The domestic dog: Its evolution, behavior and interactions with people.: Edited by james serpell. cambridge: Cambridge university press, 2017. 416 pages. isbn: 978-1-107-02414-4 (hardback)," 2019.

[2] A. Vincent, H. Mamzer, Z. Ng, and K. J. Farkas, "People and their pets in the times of the covid-19 pandemic," *Society Register*, vol. 4, no. 3, pp. 111–128, 2020.

[3] R. Juliadilla *et al.*, "Peran pet (hewan peliharaan) pada tingkat stres pegawai purnatugas," *Jurnal Psikologi Integratif*, vol. 6, no. 2, pp. 153–175, 2018.

[4] S. S. Hall, H. F. Wright, A. Hames, D. S. Mills, P. Team *et al.*, “The long-term benefits of dog ownership in families with children with autism,” *Journal of Veterinary Behavior*, vol. 13, pp. 46–54, 2016.
[5] E. P. Wibowo, A. Wibisono, S. Nawangsari, and A. Suritalita, “Prototype of feeding devices, temperatures and humidity monitoring at broiler chickens breeders with the internet of things concept,” in *2018 Third International Conference on Informatics and Computing (ICIC)*. IEEE, 2018, pp. 1–5.
[6] A. A. Laghari, K. Wu, R. A. Laghari, M. Ali, and A. A. Khan, “A review and state of art of internet of things (iot),” *Archives of Computational Methods in Engineering*, pp. 1–19, 2021.
[7] S. Koley, S. Srimani, D. Nandy, P. Pal, S. Biswas, and I. Sarkar, “Smart pet feeder,” in *Journal of Physics: Conference Series*, vol. 1797, no. 1. IOP Publishing, 2021, p. 012018.
[8] Y. Chen and M. Elshakankiri, “Implementation of an iot based pet care system,” in *2020 Fifth International Conference on Fog and Mobile Edge Computing (FMEC)*. IEEE, 2020, pp. 256–262.
[9] K. Karyono, I. H. T. Nugroho *et al.*, “Smart dog feeder design using wireless communication, mqtt and android client,” in *2016 International Conference on Computer, Control, Informatics and its Applications (IC3INA)*. IEEE, 2016, pp. 191–196.
[10] N. W. Nugraha and B. Rahmat, “Sistem pemberian makanan dan minuman kucing menggunakan arduino,” *SCAN-Jurnal Teknologi Informasi dan Komunikasi*, vol. 13, no. 3, pp. 41–48, 2018.
[11] K. Y. Triastuti, I. Istiadi, and S. A. Putra, “Rancang bangun sistem pemberian makanan dan monitoring kondisi kesehatan pada hewan berbasis aplikasi android,” in *Conference on Innovation and Application of Science and Technology (CIASTECH)*, vol. 2, no. 1, 2019, pp. 293–300.