Evolution in Electrical and Electronic Engineering Vol. 2 No. 2 (2021) 93-101

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Cat's Monitoring and Feeding Systems via Internet of Things (IoT)

Nasrin Hannani Mohd Rasyidi[1], Rosnah Mohd Zin[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2021.02.02.012
Received 04 July 2021; Accepted 27 July 2021; Available online 30 October 2021

Abstract: A cat (Felis cats) is a small carnivorous mammal domestic animal and more like a household child. Thus, to keep a good emotional bond between the cat and its owner, the cat keeper needs to monitor and feed the cat regularly even he or she has difficulty go to outstation. To assist the cat keeper, a monitoring and feeding system for the cat should be created to aid in delivering the cat's food automatically or manually via the Internet of Things (IoT) in a unitary portable cat feeder with two removable storage containers that include feeding food and drinking part. The method of the project uses the concept of IoT. From the controller devices like NodeMCU ESP 32 and ESP 32 camera module, application by using Blynk Application, and last to the collecting sensor data via MATLAB ThingSpeak, used the concept of IoT because they connect with a wide range of Wi-Fi network. The contribution from the IoT system will make this technology reliable and easy for the user to use. These proposed systems are believed to monitor and feed the cat efficiently without presented by its owner, and finally helping the cat keeper keep a good emotional bond with the cat once completed.

Keywords: Cat Monitoring, Feeding System, Internet of Things (IoT)

1. Introduction

A cat feeding system is an automatic machine that delivers out cat's food or kibble independently along setting time or control its affairs by replacing the human operator to deliver the food. As the cats became part of certain family, their feeding on time was an important job [1]. Thus, the feeding system is automatically delivering the food during cat's mealtimes like at 6:00 a.m., 12:00 p.m. and 6:00 p.m. However, humans can control the system to release the food at any time based on the quantity in a food storage. Therefore, this system includes a device to monitor the quantity of the cat's food left in the storage box. Besides, a cat monitoring system is a system with a device to help the human to supervise the activities and ambient conditions of the cat. Users for this system will be able to know and learn the characters and conditions of the cats without apprehension whenever they need parting from their cats for several times.

*Corresponding author: rosnah@uthm.edu.my

The main idea for this project is about a system based on Internet of Things (IoT) that able to monitor the activities of the cats, measure the quantity of cat's food and feed the cats on time by using Blynk application on a smart phone. However, some researches have been done to get the ideas from several cat feeder systems that have different features implemented from previous development. The first cat system has been developed by implemented a feature inside the system where the cat food would be served to the cats automatically up to a certain quantity only when the cat comes near to the box when they feel hungry and at the same time can be monitored by using mobile app [2]. Meanwhile, another cat feeder implemented a weight sensor to dispense the kibbles within the right amount of food based on the weight of the cat to maintain the health of the cats [3]. Besides, a cat feeder from third journal has been created a monitoring system for an automatic cat feeder using a webcam and a stepper motor that is connected to a Raspberry Pi as the main controller as an advance feature [4].

Correspondingly, from the studies there are few related major and even minor problems have been identified based on all the previous existing pet feeder systems. A big issue with the existing pet feeder system is that most of the system feed the food to the pet but some of them do not include monitoring system to surveillance their pets and most of them also do not have devices to control the quantity of the food livestock in the box. Hence, this report presents the development of the pet feeding system that focuses especially on the cat for being able to feed several cats, monitor the remaining livestock and observing the cats when needed.

1.1 Aim

Cat's Monitoring and Feeding Systems Via IoT is planning to ensure the safety, health and necessity for the cats have been taken care of in absence of its cat keepers so that the cat keepers can do their other tasks without worrying about feeding and monitoring the cats.

1.2 Objectives

This research work embarks on the several objectives. The first objective can design a feeding system that can deliver the cat's food automatically or manually to the cats by using Internet of Things (IoT). Thus, this work needs to develop a system with capability to measure the quantity of the cat food and monitor activities and ambient conditions of the cats during absence of cat keepers. Finally, the last objective for this project is to evaluate the performance of cat feeding system by collecting data from other devices.

2. Methodology

The methods for developing the suggested cat's monitoring and feeding systems via IoT will be presented in this section. The overall block diagram of the system is provided in the first subsection, followed by the flow chart of the process mechanism, and details of each function.

2.1 Block Diagram

A complete block diagram in a Figure 1 that consists of four parts can be developed for the entire project. The first part is the input; it has one sensor and one module controller. The sensor is an Ultrasonic sensor (HC-SR04) and NodeMCU ESP32 Wi-Fi module act as a controller module to receive data collected of quantities of drinking water and kibbles from the sensor. Then the data will be transferred to the cloud server and smartphone with Blynk Application via Wi-Fi. Furthermore, this controller module can help the Blynk Application to transmit instruction of releasing kibbles manually to the servo motor (SG90). However, another part is the feeding system can feed the cat automatically by using time setting from the RTC module (DS3231). Therefore, in this part will be released the kibbles base on the fix times that have been set in the programming which is feed for everyday and at 6:00 o'clock, 12:00 o'clock and 18:00 o'clock. Consequently, the last part consists of ESP 32 Camera module which allows the development of IP addresses for streaming live videos through web server with the help of FTDI Programmer (FT232RL) in providing USB compatibility for camera module.

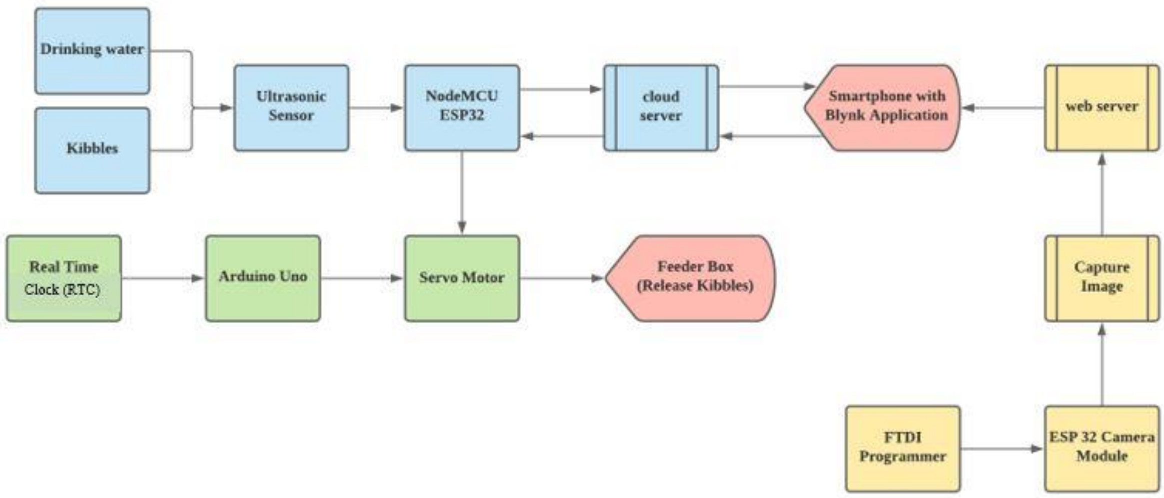


Figure 1: Block diagram of operational project

2.2 Project Flowchart

The flowchart from Figure 2 shows the overall system's function that should be display in Blynk application system. It includes two main parts of the system which is to monitor and feed the cats automatically.

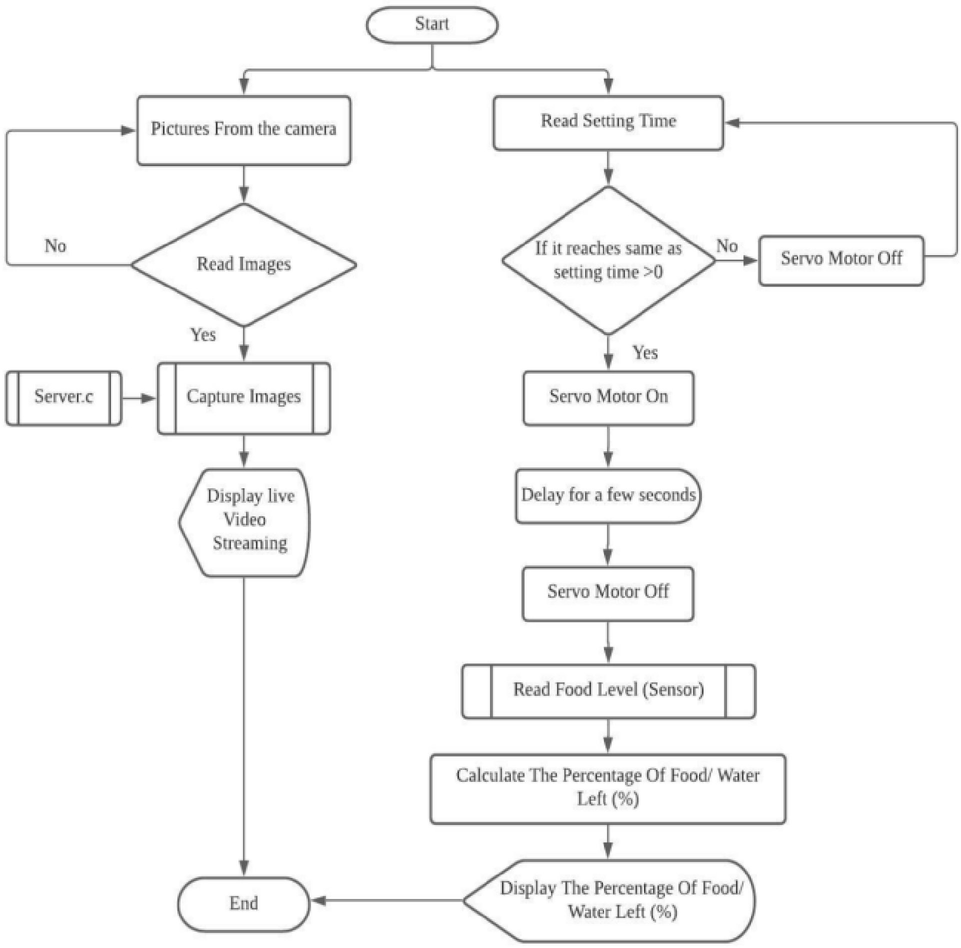


Figure 2: Flowchart of monitoring and feeding systems

2.3 Equations

In this project has been discussed about connectivity between NodeMCU ESP-32 Wi-Fi module and Ultrasonic sensor HCSR04 which are two vital devices to monitor and measure the quantity of cat's food or also call as kibbles and water in the containers by using Blynk application via Wi-Fi. An ultrasonic sensor is an electronic system that uses ultrasonic sound waves to determine the distance between a target object and transforms the reflected sound into an electrical signal. Calculation of the distance (S) is based on the obtained time. It is because this sensor does not count anything by its own, but only has impulses of certain duration. Thus, the controller board must be made all the calculations. The calculation is using the following relationship as stated as Equation 1.

$$S = vt\,;\ t = \frac{T}{2} \Rightarrow S = v\left(\frac{T}{2}\right) \qquad \text{Eq.1}$$

Here, S is a distance while v is the sound velocity about 340 m/s; while t is the wave's movement time from the sensor to the target; T is the wave's movement time from the sensor to the object and back. It is important to divide by two since the signal passes the distance to the object and back, then when it takes just the distance to the object. However, to calculate the percentage (%) of remaining cat's food (kibbles), the ultrasonic sensor module which is located at the top of the inner side of container is used to measure the distance from the sensor to the kibbles level in the container. The measured distance in the unit of centimeter (cm) is used to calculate the remaining kibbles in the container in the unit of percentage, %. The formula used to calculate the percentage of remaining kibbles as mentioned as Equation 2.

$$\%\text{ of remaining kibbles} = \frac{\text{Bottom level} - \text{Measured level}}{\text{Bottom level} - \text{Top level}} \times 100\% \qquad \text{Eq.2}$$

Where % remaining kibbles = The percentage of remaining kibbles in container. Top level = The distance from the ultrasonic sensor to the maximum level of the kibbles can be contained in the container. Bottom level = The distance from the ultrasonic sensor to the base of container. Measured level= The distance from the ultrasonic sensor to the level of the kibbles contained in container. Besides, the formula used to calculate volume of kibbles as follows:

$$\text{volume of kibbles } (\text{cm}^3) = \frac{\%\text{ of remaining kibbles}}{100}\left(\pi r^2\left(\text{Bottom level} - \text{Top level}\right)\right) \qquad \text{Eq.3}$$

3. Results and Discussion

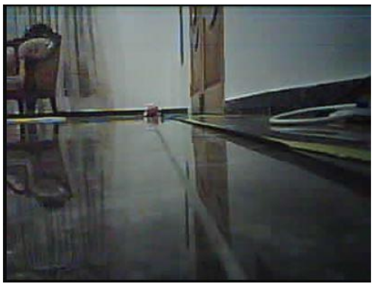
This part explains the outcome and discussion of constructing the Cat's Monitoring and Feeding Systems Via IoT (CMFSVI) from beginning to end. The technique for obtaining the project's results was a combination of Autonomous and Platform design testing. The entire testing technique is designed to generate the result specified in the objective.

3.1 Autonomous Testing

3.1.1 ESP32 Camera Module

In live video streaming, an ESP 32 camera is utilized to watch and monitor the cat's activity. The ESP-32 CAM does not have any on board USB connector, so this device needs an FTDI programmer to upload code through the U0R and U0T pins (serial pins). Therefore, testing of performance is required to determine how far and capability of the camera can capture clear image of a sample subject by using programming. The testing of the image has been measured every 50 cm interval and the results were shown in Figure 3.

(a)



(b)

Figure 3: Result testing of images camera at, (a) 50cm and (b) 300 cm

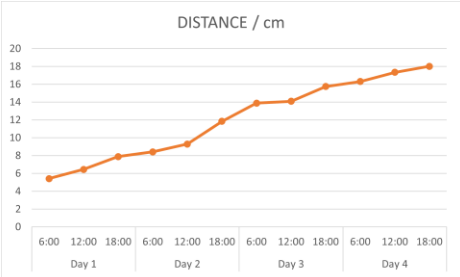
The images of the sample subject from different lengths, 50 cm, 100 cm, 150 cm, 200 cm, 250 cm, and 300 cm. The images of a toy cat can be seen clearly at the length of 50 cm until 200 cm. Meanwhile, the length from 200 cm until 300 cm, the images of the toy are not clear enough to be seen. Therefore, from this testing, maximum length that suitable for the live streaming to get clear image of the subject is 150 cm length.

3.1.2 Ultrasonic Sensor

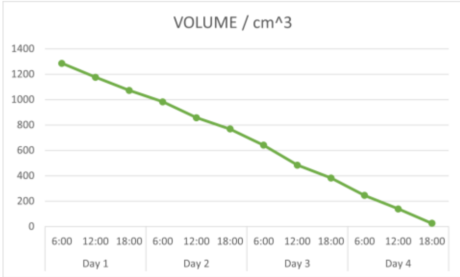
Cat's Monitoring and Feeding Systems Via IoT (CMFSVI) has been testing at a house in Tangkak, Johor. The data such as distance, percentage and volume of kibbles were tabulated and plotted during cat mealtime at 6.00 a.m., 12.00 p.m., and 6.00 p.m. for four days. The ThingSpeak cloud server was collected and stored the data to be analyzed later. For this project, the bottom level is 22 cm, the top level is 5 cm, and the radius of the food container is 12 cm. The feeder system, which comprised the servo motor was programmed by using real time clock (RTC) to drop kibbles each hour for data collection for distances from the ultrasonic sensor to the kibbles level, percentage of kibbles left, and volume of kibbles. Besides, the percentage and volume of kibbles in the food container will fluctuate as the distance value varies. Therefore, in terms of relationship, when the distance between the ultrasonic sensor and the kibbles level increases, the percentage and volume of the kibbles in the food container decreases or vice versa. Table 1 shows the data of the distance, volume, and percentage of leftover kibbles collected over time, while Figure 4 shows the graphs created to show the trend of the result values.

Table 1: Results of the distance, volume and percentage of the kibbles by time interval

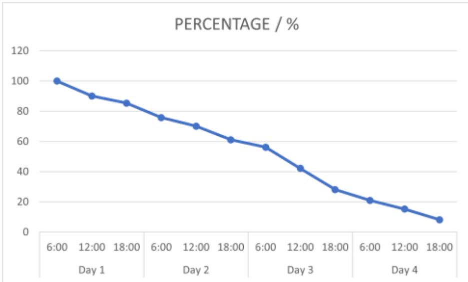
Days	Times	Distance / cm	Volume / cm^3	Percentage/ %
	6:00	5.43	1285.23	100
Day 1	12:00	6.45	1175.82	90.1
	18:00	7.89	1072.02	85.4
	6:00	8.43	982.32	75.81
Day 2	12:00	9.3	857.02	70.12
	18:00	11.84	767.45	61.1
	6:00	13.89	640.6	56.24
Day 3	12:00	14.09	483.12	42.15
	18:00	16.32	381.9	28.12
	6:00	18.02	245.06	20.98
Day 4	12:00	20.5	138.82	15.25
	18:00	21.7	25.72	8.2



(a)



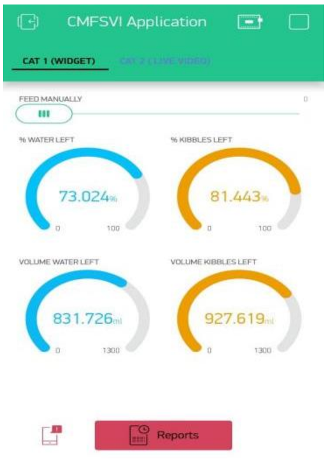
(b)



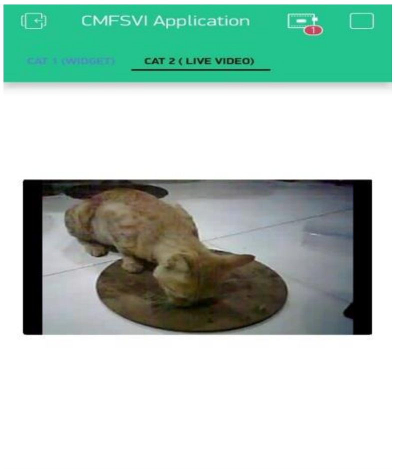
(c)

Figure 4: Data storing in Thingspeak cloud server for releasing kibbles (a)distance, (b) volume and (c) percentage

Since the NodeMCU ESP32 module and ESP 32 Camera module provide Wi-Fi connectivity, they are used for IoT implementation with the Blynk application. The data were uploaded to a server and can be viewed through the Blynk application. The data gathered by the Blynk application is shown in Figure 5. Percentage of kibbles and water remaining, volume of kibbles and water, and live streaming data acquired from the ultrasonic sensor and camera module can be readily monitored and presented in the form of a display gauge, notification, and video streaming using smartphones and the Blynk application.



(a)



(b)

Figure 5: CMFSVI application system (a) cat 1 (widget) includes slide mode to feed cat manually, and four gauges to monitor percentage and volume of kibbles and water, and (b) cat 2 (live video) includes live video streaming with cat

3.2 Platform Design Testing

Figure 6 shows the model of feeder box that has been designed by using Solidwork. This storage divides by two parts of container and tray which is one part is storage food and another part is for drink. The image is illustrated with the actual size of the feeder box and some information regarding the purpose of drawing parts.

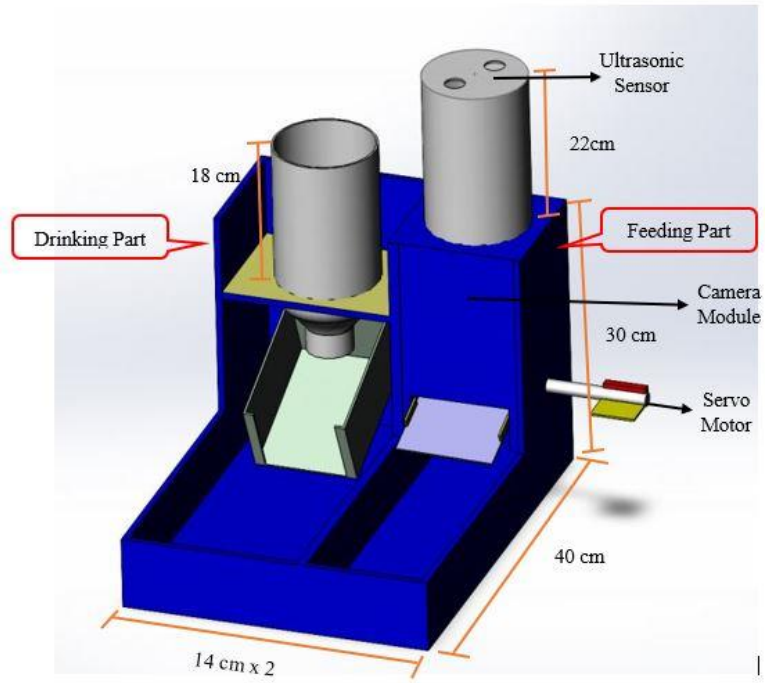


Figure 6: 3D model of CMFSVI feeder box

The body structure in the development of the feeding box is fabricated by using corrugated plastic board. This board is made from polypropylene and polyethylene, are two thermoplastics that are commonly used and flexible. The rigidity, lightweight, and insulating properties of clear polycarbonate corrugated sheet make it suitable for roofing food and drink inside the storage box, where low impact resistance is less of a problem.

3.3 Discussions

Further explanation from observations of the results and analysis of the data are placed in this part.

3.3.1 Feeder Box

Stability testing is carried out as part of the platform testing method to ensure that the platform remains stable as the cat’s approach. This is due to the light weight of the plastic corrugated boards. If the platform is not built properly, the box can fall vertically if the weight inside is not perpendicular to the height of the box.

Therefore, this testing focused on the weight or volume of the cat food and drinking water that suitable to be filled up in the feeder box. The design of the box includes a plastic container to ensure the food is save in an airtight area as well as to keep a good quality of the food. However, the capacity of the container only can be filled up until 1.3 liter or 1.3 kg of the cat food. From the observation, this quantity of the cat food is appropriate for four days of meal with three times feed per day. Besides, this maximum capacity is also suitable for the corrugated boards to accommodate the weight without collapsed in a vertical condition due to the gravitational force from the height of the feeder box.

From the observation, the result shows the platform is implemented with the cats are in a stable condition. That meets the requirement of the project to make the platform of the feeder box suitable to use even cannot meet with large quantity of the cat food. As a conclusion, the result of the stability testing of this CMFSVI platform is a success and make it more reliable to measure the parameter of quantity of the cat food or water.

3.3.2 Data Analysis of Ultrasonic Sensor

In this part, the analysis was conducted with 36 data points consisting of distance, volume and percentage of remaining cat food or kibbles over a 12-time interval start from 6:00 o'clock for day one until day four at 18:00 o'clock due to the first 36 points are considered relevant. This is because of the problem with autonomous testing that was previously mentioned, and it reached the minimum quantity of the cat food in the container. Therefore, this data analysis was carried out using the information from the remaining kibbles in the feeder box. The response towards releasing cat food at every 12-time interval is based on the observation of distance, volume, and percentage. The data analysis is based on the Figure 1 and Table 2. Hence, according to the data collected, the average difference in volume, percentage and distance for kibbles dropped, was calculated, and tabulated as follows:

Average difference in volume, cm^3:

$$= \frac{109.41 + 103.8 + 89.7 + 125.3 + 89.57 + 126.85 + 157.48 + 101.22 + 136.84 + 106.24 + 113.1}{11}$$

$$= 116.49cm^3$$

Average difference in percentage (%):

$$= \frac{10.62 + 7.28 + 6.29 + 5.59 + (-3.67) + 17.65 + 14.09 + 1.36 + 6.88 + 4.69}{11}$$

$$= 6.435\%$$

Average difference in distance, cm:

$$= \frac{1.02 + 1.44 + 0.54 + 0.87 + 2.54 + 2.05 + 0.20 + 2.23 + 1.7 + 2.48 + 1.2}{11}$$

$$= 1.48\text{cm}$$

Table 2: The total average difference for each volume, percentage, and distance

Difference average in distance/cm	**Difference average in volume/cm^3**	**Difference average in percentage/%**
1.48cm	$116.49cm^3$	7.53%

Calculation of the distance is based on the obtained time. It is because ultrasonic sensor does not count anything by its own, but only has impulses of certain duration. Thus, the controller board must be made all the calculations. However, to calculate the percentage (%) and volume of remaining cat's food (kibbles), the ultrasonic sensor module which is located at the top of the inner side of container is used to measure the distance from the sensor to the kibbles level in the container.

The total average difference for each volume, percentage and distance are tabulated in Table 2. From the results, the averages of difference in volume, percentage and distance have been calculated to know the relationship between the distance, the volume and percentage of cat food or kibbles released out from the feeder box every one-hour interval. The results showed that every 1.48cm difference in distance between the top and bottom of the kibbles inside the feeder box, the kibbles will be dropped from the feeder box around average of $116.49cm^3$ and 7.53% from the total kibbles for every cat mealtime, starting from 6:00 o'clock in day one until 18:00 o'clock in day four. Therefore, this system was known to release the kibbles by the servo motor as much as $116.499cm^3$ of volume and 7.53% each time it delivered. However, the reading values have been taken 12 times until the final reading have reached $25.72cm^3$ or 8.2 % of remaining kibbles to make the kibbles enough and suitable to apply within four days' supply for three times mealtime per day while the drinking water could reach until seven days before the bottle empty from the observation.

4. Conclusion

Subsequently, the development of the Cat's Monitoring and Feeding Systems Via IoT (CMFSVI) for user observations has gone through several procedures like design, material selection, and several tests ranging from various perspectives such as programming testing, autonomous testing, stability testing, and finally, the installation of the entire platform tested with cats. Several objectives have been met effectively throughout the project's progress in accordance with the project's initial idea. The CMFSVI successfully measures kibbles and water remaining inside the feeding box, including distance, volume, and percentage after automatically released by time interval, which is the objectives of this project. Furthermore, the user can monitor the activities of the cats from their smartphone. Nevertheless, this project's overall was successful in terms of programming, design, and function of the system and devices. This system can supply cat food or kibbles to the cats for the four days and three times mealtime per day with the maximum of two cats per time because of the limit size of the feeder box. Therefore, the size of the design can be amended, and several ideas can be made to enhance and improve the project in the future.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] D. C. Turner. and P. Bateson, The Biology of Its Behavior, Book of The Domestic Cat., 2000

[2] H. A. Rani, "Design of Automatic Cat Feeder with Cat's Weight Detection," *Universiti Teknikal Malaysia Melaka,* 2018

[3] S. M. H., N. N. M., A. R. B. M. B. Mritunjay Subhashchandra Tiwari, "Automatic Pet Feeder Using Arduino," *International Journal of Innovative Research in Science, Engineering and Technology,* vol. 7, no. 3, March 2018

[4] N. D. F. L. K. N. Anggraini, "Mobile-based monitoring system for an automatic cat feeder using Raspberry Pi," *Telkomnika (Telecommunication Computing Electronics and Control),* vol. 18, no. 2, pp. 1038-1046, 2020