Automatic Cat Feeding Monitoring System with The Arduino Mega 2560-Using Hc-Sr04 Sensor Based Internet of Thing (IoT)

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Abstract*— There is no doubt that pet owners will be very helpful in making pet care very easy and efficient. There is a sense of satisfaction for pet owners. With busy lives, some people are looking for the latest innovations to make it easier for them to take care of their pets at home. From this difficulty, we can see that building a remote control feeding machine is crucial to making it easier for owners to feed their pets and keep cats' development organic. This study uses a systems development life cycle approach. SDLC is a logical process used by systems analysts when developing information systems. This includes requirements gathering, validation, training, and system ownership. This SDLC concept supports numerous software development models and serves as a framework for planning and guiding the development of information systems to complement pet feeding systems. It can make it simpler for the owner to feed the cat at home, even when they are busy or away from home, so that inappropriate feeding management will never happen again to pets.

Keywords — automatic cat feeding, arduino mega 2560, hc-sr04 sensor-based, internet of things (iot)

I. INTRODUCTION

Many Indonesians choose dogs as friends to relax and unwind when they are tired. This behavior is fairly typical in busy environments where people are bored and need something to entertain them. Cats and dogs are the most popular pets because their cute behavior and soft fur make people believe that a cat or a dog is the best choice for pets.

Taking care of animals is a difficult task. Of course, as an adopter, you have to take the time to care for your pet, especially because of its high cost. The most basic but most important is regular and divided feedings. Pets can gain weight if their portion sizes and feeding schedule are excessive [1]. If a cat lacks it, it will be malnourished and prone to illness. However, as adopters, we also need to perform other activities in the home, which makes handling pets in the home more difficult, especially if the adopter leaves the home within a few days, it is even more difficult for the adopter to control the pet in the home.

Due to the high activity levels, it can be difficult for adopters to schedule animal feeding based on portion sizes and schedules. Feeding and serving schedules for different animals based on [1]. Feed the cat four times a day, starting in the morning and every few hours for cats 0 to 4 months old. Feed cats 4 to 6 months old up to 3 times a day. They can now maintain their nutrient levels for a longer period of time. Then, for cats 6 months and older, divide their daily calories into 1-2 or more meals based on owner and pet preference.

Due to the lack of understanding of the appropriate ratio of animal feed by animal owners, the cases of animal obesity are increasing, so that overfeeding often occurs and leads to obesity. Of course, this is no longer a trivial issue when it comes to animal health. Pet obesity is one of the frequent problems for pets who neglect their food intake. Based on data from Banfield Veterinary Hospital [1].

Thus, with this tool, adopters no longer need to worry and confuse how to arrange food well, even if they have activities outside the home, as this tool is designed to adjust food portion weights and fill pet food. Lunchboxes with a fixed schedule set by the adopter so that pets can continue to eat on portion sizes and feeding schedules without having to worry about bad things like obesity or malnutrition in pets at home.

The real time clock acts as a pet food control clock based on the clock set by the pet owner. The servo motor acts as a valve opener, allowing the food from the hopper to drop onto the pet's food pan. According to research [3], using a servo motor for rotary motion is better than using other methods because it avoids food getting stuck in the container door. Using the Arduino UNO in this tool also serves as the main tool to control the tool worker. The tool also comes with a rechargeable battery, so adopters never have to worry about power outages when the adopter leaves the house. The tool is designed to use feeder accumulators that are no longer dependent on PLN resources.

This tool uses a rechargeable battery and is intended to bridge a power outage, the feeder will continue to operate according to its function, and this feeder is still reasonable to use if you want to leave the house during a power outage to avoid the risk of fire.

II. THEORITICAL REVIEW

A. Internet of Things

The Internet of Things (IoT) is a relatively new communication paradigm that envisions a near future in which everyday objects will be equipped with microcontrollers, digital communication transceivers, and associated protocol stacks, enabling them to communicate with each other and with users. Therefore, it is an integral part of the Internet [4].

Furthermore, by enabling easy access and interaction with various devices such as home appliances, surveillance cameras, surveillance sensors, actuators, displays, and vehicles, IoT will encourage the development of massive exploitation of such objects to provide citizens, businesses and

government agencies The potential volume and variety of data generated by the provision of new services. [5].

B. Pet Feeder

A feeder is a specially designed device that feeds pets on a schedule set by the pet owner [8]. The feeder can be automatically controlled via software on the website or on a mobile device.

C. Cat

Cats are smart, cute and funny creatures. When people are lonely, these animals can serve as companions and playmates [22]. His lovely patterns and mannerisms attract his devotees to indulge in him and spend time with him. Many breeds of cats have recently invaded Indonesia. On the other hand, a house cat or house cat is just as amazing. Each type of cat has different benefits.

D. Hardware

Hardware is any device that makes up systems and other devices that enable a computer to perform its tasks in a physical manner that can be clearly seen and distinguished from the data it contains or operates on. The main part of the hardware includes input (input), CPU (central processing unit), memory (secondary memory) and output (output) [9]. The hardware used in the feeder study is as follows:

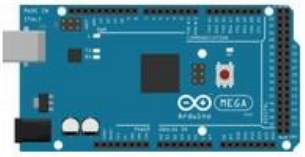

Figure 1 Arduino Mega 2560

The Arduino Mega2560 is a board based on the ATmega2560 microprocessor [10]. The Arduino Mega2560 has 54 digital input/output pins, 15 of which can be used as PWM outputs, 16 analog inputs and 4 UART (serial port hardware) connectors, a 16MHz crystal oscillator, a USB connector, Jack Power, ICSP connectors and a reset button [10]. That's all you need to facilitate the operation of your microcontroller. Just connect it to a computer or AC-DC converter or battery via USB to start activation. The Arduino Mega 2560 is compatible with most shields made for Duemilanove or Diecimila boards. Arduino Mega 2560 is the latest version after Arduino Mega. Arduino Mega 2560 form factor.

Figure 2 ESP8266

ESP8266 is Thinker AI's WLAN module. The ESP8266 can operate in one of three modes. The first mode is called basic mode. ESP8266 base mode is a mode that allows the author to check and confirm the state of the ESP8266, whether it is in a good or incomplete state. The second WiFi mode is layered mode. When we use WiFi in ESP8266 state, we use layered mode. The TCP layer is the third mode. The TCP layer mode is the default mode of the ESP8266, which the author uses when connecting to the Internet. Additionally, the ESP8266 includes two firmware modules that can be used to run user-supplied commands. The AT-Command firmware was the first to ship. During development of MCU node firmware, both firmware types have their own advantages and limitations.

Figure 3 Buzzer

A buzzer is an electronic component designed to convert electrical energy into sound vibrations. A buzzer consists of a coil that is excited by an electric current, making it electromagnetic. The coil is pulled in or pulled out depending on the current flow and the direction of the magnetic poles. Any reciprocating motion of the coil attached to the diaphragm causes the air to vibrate, which produces sound [12]. In this paper, the buzzer is used as a reminder component when the stored food is insufficient.

What we know is that the buzzer only makes one sound. By programming on Arduino or other microcontrollers, we can use a buzzer with various kinds of mono sounds. You can make Do Re Mi Fa S d so on [13].

F igure 4 Motor Servo

Servo motors are divided into two types, namely standard servo motors and continuous rotation servo motors. The difference between the two servo motors is not very big. The output shaft can only rotate 90o and 90o clockwise, which means that the shaft can only rotate in a semicircle. Servo motors usually only move to a certain angle, not continuously like DC motors and stepper motors. However, for specific purposes, the servo motors can be modified to carry continuous loads. In robotics, these motors are often used for legs, arms, or other parts that have limited motion and require high torque. [15].

Figure 5 Liquid Crystal Display (LCD) 16 x 2.

A liquid crystal display (LCD), an electronic display fabricated using CMOS logic technology, was used in this study to display system information. LCD is a display medium that uses liquid crystals to create visible images [16]. LCDs have been used in various fields such as electronic devices such as televisions, calculators or computer screens. The LCD is important because it acts as a tool to display information working on the feeder. LEDs provide many functions, such as a display consisting of 16 characters and two lines, can store 192 characters, has a character generation

program, can be addressed in 4-bit and 8-bit modes, and is equipped with a backlight [17].

Figure 6 Real Time Clock (RTC)

RTC (Real Time Clock) is an electronic device in the form of a chip that can calculate time (seconds to years) and store time data with real-time precision [18].

As for the characteristics of the RTC type DS3231, that is, the RTC correctly counts the second, minute, hour, date, month, week, and year of the week, I2C Serial has fixed the minimum communication flow of the RTC, 2.0-5.5 full voltage operation, 16 pins SOIC package, simple wire interface (I2C and SQW/Out), programmable square wave output, temperature sensor accurate to 3o degrees Celsius [19].

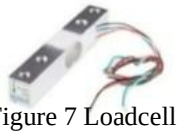

Figure 7 Loadcell

A weight sensor (load cell) is a sensor used to determine the pressure or weight of a load. Load cells are often used as the main component of digital weighing systems and can also be used to bypass scales that employ the compression weighing concept [20].

Figure 8 The HX711 Module

HX711 Load Cell Module Type Component is used as an amplifier for the output signal of the load cell, the HX711 module converts the analog data to digital data or more commonly known as an analog-to-digital converter (ADC) and connects the load cell pins to the module of the Arduino MEGA 2560 , used as a microprocessor.

Figure 9 Sensor Ultrasonic

An ultrasonic sensor is a device used to determine the distance between two objects. Measuring distance is about 2-450 cm. This gadget communicates the reading distance via two digital pins. This ultrasonic sensor works by transmitting reflections of sound waves that can be used to determine the presence or distance of objects at a specific frequency and calculate the time required in microseconds. It is called an ultrasonic sensor because it uses ultrasonic waves (ultrasonic waves) to detect the distance of objects [21].

III. METHOD

A. Research Methods

This study employs the System Development Life Cycle (SDLC) methodology. SDLC is a process for developing a system. SDLC is a logical process that systems analysts follow while creating an information system. It includes requirements gathering, validation, training, and system ownership. The SDLC is divided into various stages, planning, analysis, design, implementation, and system maintenance. This SDLC idea underpins several software development models and serves as a framework for planning and regulating information systems manufacturing.

B. Block Diagram

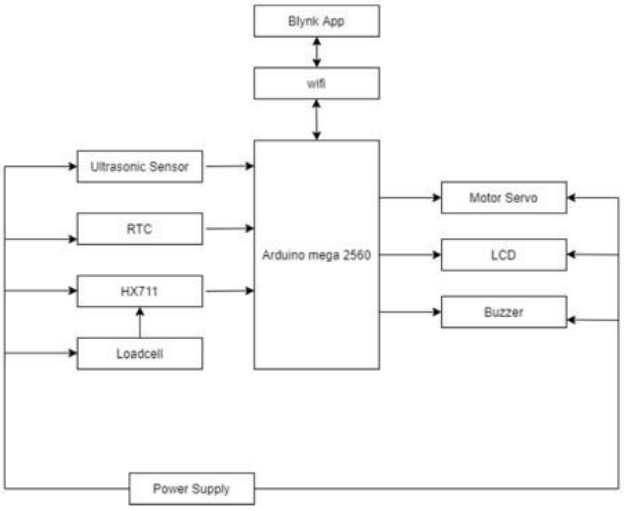

Figure 10 Block Diagram

The Pet Feeder block diagram is shown in Figure 12 The Pet Feeder is controlled by an Arduino Mega 2560 microcontroller. Essentially, the Arduino Mega 2560 is in charge of the main program's flow and the control of all sensors and actuators employed. Additionally, the Microcontroller is responsible for all data transmission between the Pet Feeder and the User Smartphone through the ESP8266 Wi-Fi Module. ESP8266 Wi-Fi module written in Lua using NodeMCU firmware.

C. Flowchart Pet Feeder

Flowcharts are extensively used in a variety of areas to record, examine, plan, and improve complicated processes via the use of simple and easy-to-understand di- agrams. Flowcharts, also referred to as flowcharts, use rectangles, ovals, diamonds, and maybe a variety of other forms to denote the kind of step, as well as linking arrows to denote flow and sequence. Flowcharts may vary in complexity from ba- sic hand-drawn diagrams to complex computer-generated layouts depicting several phases and paths. The following is the flow chart for this research

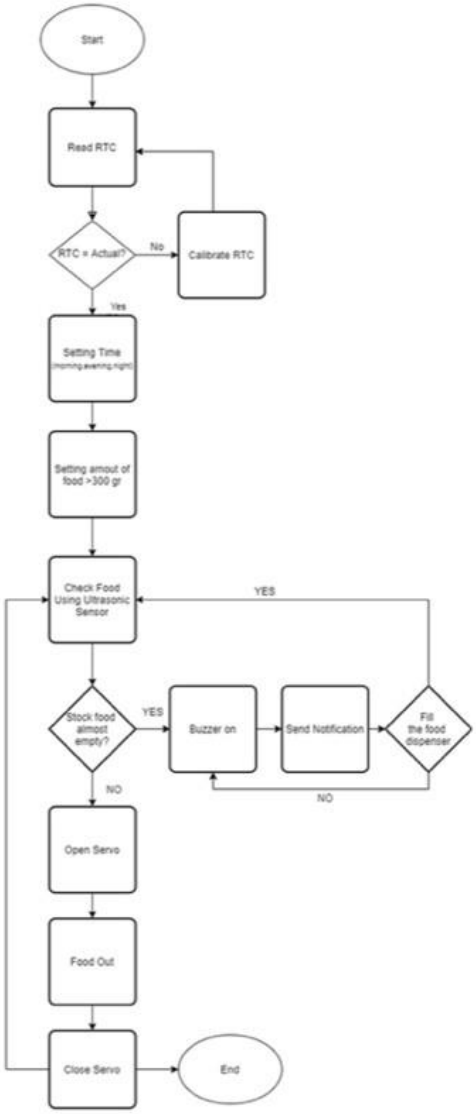

Figure 11 Flowchart Pet Feeder

The explanation of the flow diagram of the automatic pet feeder system is de- signed: the first condition, the system will read the Real-Time Clock. If not, the program will calibrate the RTC, return to the initial state, and reread the RTC. If it follows the schedule determined by the animal owner, the system will display the time setting (morning, afternoon, and night). The owner fills the food storage 1kg, then the ultrasonic sensor will check whether the food in the dispenser is whole or not if not, the buzzer will make a sound, and the system will send a notification to the blynk application, and the owner fills the food storage, if yes the ultrasonic sensor will detect if the food storage is whole, the system will stop notifications sent to the buzzer and the Blynk application on the animal owner's smartphone.

In the second condition, the system will if the food stock is not running low. The servo will open, and the food will fall into the bowl that has been provided. The servo will be closed again, and the condition will return to the ultrasonic sensor, which will detect the food supply in storage.

D. Pet Feeder System Circuit Schematic

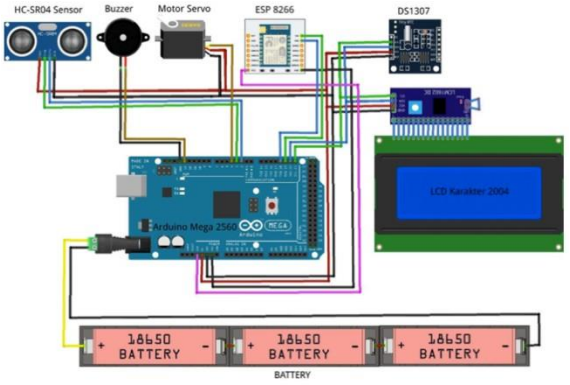

Figure 12 Pet Feeder System Circuit Schematic

To run this tool all components need to be assembled so that the tool can work as expected. The author compiles each component so that it can be understood even more.

E. Testing Scenarios

To find out that the tool is working properly, it is necessary to test the tool which includes hardware testing and software testing. Tests carried out on the equipment to determine the suitability of the theory with the design results, namely by knowing the measurement results on each device that has been made.

1. Testing on Pet Feeder Equipment Tool testing is carried out to find out whether the tools that have been designed can function as previously planned. The goal is to find out that the designed circuit has worked as expected. The RTC test is conducted to test whether the RTC can provide the right time data for the microcontroller. The test is carried out by displaying the time reading on the LCD Display and comparing it with the time on the computer. Servo motor testing is done by providing a degree value for servo motion. The warning device will work when the LDR detects light then the Arduino program will control activating the buzzer. This device will alert pond owners to fish feed supplies. The test results of the whole machine can be integrated with each other well with the primary control on the Arduino Uno as the brain of the system created.
2. Testing on the Web or Application This test is used to monitor system activities as well as calculate feed requirements. The web or application is directly connected to the Arduino Mega 2560 microcontroller, so the data obtained by the Arduino Mega 2560 microcontroller is sent to the web server and later processed and displayed to a web page or application on Blynk.

IV. RESULT AND DISCUSSIONS

A. RTC DS1307 Module Testing

RTC testing is carried out to test whether RTC can provide the right time data for the microcontroller to be tested by displaying the time reading on the LCD Display and comparing it with the time on the computer. RTC to set meal

schedule automatically. This tool will display 3 time differences, namely morning, afternoon and evening so that it can provide food to cats according to cat needs.

Figure 13 RTC Testing

After carrying out the testing process, it can be concluded that Arduino can display data from RTC. The data displayed on the series of monitors is the data of hours, minutes and seconds. So that the RTC can later be used to adjust the cat's feeding schedule automatically. There are 3 time settings, namely morning, afternoon and evening, which are taken from the time the cat eats regularly. In this RTC data retrieval there is still an average delay of 40 seconds from the time it should be.

B. Loadcell Module Testing

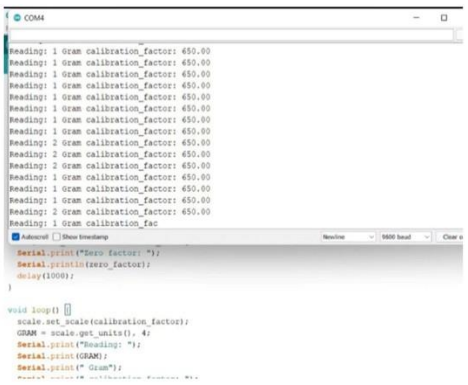

Figure 14 Loadcell Calibaration Process

To calibrate the load cell sensor, we can do it by placing a known load weight on the load cell. To get value load cell sensor calibration is by adding or reduce the calibration factor value to the weight value. After obtaining the calibration value, the next step is to enter the calibration value into the load cell sensor reading program.

```
#include "HX711.h"
#define DOUT  9
#define CLK  8
HX711 scale(DOUT, CLK);
float calibration_factor = 750.20; //1360.00 380.40
int GRAM;

int lcdColumns = 20;
int lcdRows = 4;

char namaHari[7][12] = {"Min", "Sen", "Sel", "Rab", "Kam", "Jum", "Sab"};
int Trig_Pin = 3;
int echo_Pin = 2;
```

Figure 15 Load Cell Weight Reading Sensor

After performing and getting the calibration value, step then enter the calibration value into the program read the load cell sensor and check whether the load cell is functioning properly.

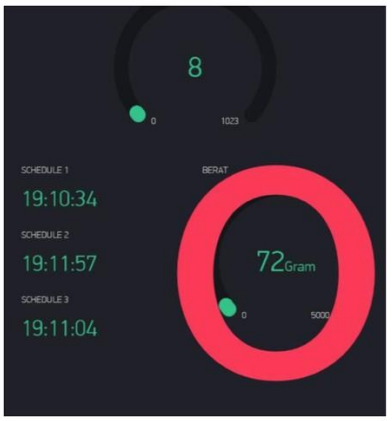

Figure 16 Load Cell Testing Methode

From the test results of the Load cell sensor, it can be concluded that when there is no load placed above the load cell eats a value of 0, and if placed the load above the load cell, the value will change as much as the weight on the load.

Table 1 Testing Result Load Cell Sensor.

Trial	Weight		Difference (gr)	Error (%)
	Load Cell (gr)	Scales (gr)		
1	77	75	2	2,67
2	63	63	0	0
3	51	50	1	2
4	40	39	1	2,56
5	34	31	3	9,68
6	19	19	0	0
7	15	15	0	0
Average				2.41

C. ESP8266 Testing

ESP8266 as a wifi module so that the device can be connected to the internet network and can be controlled via the Blynk App and the web. The data retrieval process on the ESP8266, by ensuring the wifi ID and password are the same as those in the coding. after that, we can turn on the pet feeder. After there is a "bib" sound, it means that the wifi has been connected to the device.

Testing methode the results of testing the ESP8266 method went well although sometimes you have to wait a few minutes to be able to connect between tools and applications

Figure 17 ESP8266 Testing Methode

As shown on the table 2 the average result of the delay between esp connected to wifi

Table 2 Testing Result ESP8266

Time	Average Delay
Morning	98.75
Evening	70.17
Night	86.27

The application is directly connected to the Arduino Mega 2560 microcontroller, so the data obtained by the Arduino Mega 2560 microcontroller is sent to the web server and later processed and displayed to the web page or application on the blynk. The ESP8266 delay test to the Blynk application was carried out 2 times with 10 trials for each test and the testing time was in the morning and afternoon. Result of delay 188.288 ms. According to the TIPHON standardization based on the results obtained, the data transmission time from ESP8266 to the Blynk Application is in the good category with index 3. The results can be observed in the figure below:

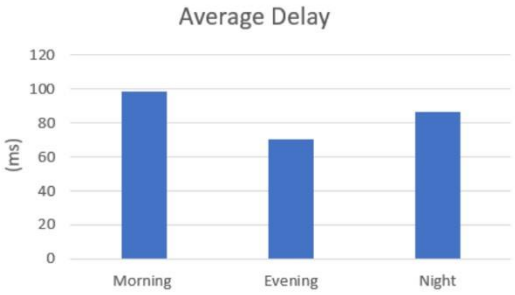

Figure 18 Testing Result of ESP8266

D. Motor Servo Testing

In testing the servo motor is used as an actuator to sort between the existing feeds measured by weight by the load cell. Also to know if the servo motor is working according to Arduino commands as the door opens and closes the food so that the food will fall into the bowl.

In the data in Table 3 is an experiment on the first day on the delay that exists in the servo motor every time it open and closes .It can be concluded that the average delay value when Android controls the Servo Motor when the angle of 0°-45° has a value of 0.70 in the day one.

Table 3 Testing Result Servo Motor 1

Sliding Time	Open Time	Delay
08:30:08:92	08:30:10:12	1.2
14:30:15:42	13:30:15:82	0.40
20:30:20:00	20:30:20:51	0.51
Average		0.70

Shown in table 4.4 is an experiment on the second day on the delay that exists in the servo motor every time it open and closes 0.62 in the day 2 which means it only takes less than 1 second to control the Servo Motor so that the feed valve is fully closed.

Table 4 Testing Result Servo Motor 2

Sliding Time	Open Time	Delay
08:30:08:92	08:30:10:12	1.2
14:30:15:50	13:30:15:82	0.32
20:30:20:00	20:30:20:34	0.34
Average		0.62

E. Ultrasonic Sensor Testing

An ultrasonic sensor is a device used to determine the distance between two objects. Ultrasonic sensors are needed to accurately measure cat food. The data was taken by conducting three experiments, and the authors were able to compare the results of measuring the height of the ultrasonic sensor food which will be displayed on the blynk and the results of measurements using a ruler.

After uploading the code, display the data with Serial Monitor. Now try to give an object in front of the sensor and see the measurement. After uploading the code, display the data with Serial Monitor. Now try to give an object in front of the sensor and see the measurement. And the system will send a notification to the blynk application, and the owner fills the food storage, if yes the ultrasonic sensor will detect if the food storage is whole, the system will stop notifications sent to the buzzer and the Blynk application on the animal owner's smartphone. In table 3 is the result of ultrasonic sensor test data. From the results of the comparison of temperature readings between the ultrasonic sensor and the ruler, an average error of 13,07

Table 5 Testing Result Ultrasonic Sensor.

No.	Ultrasonic Sensors (CM)	Ruler (CM)
1	2	2
2	5	7
3	7	6.5
4	8	9
5	6	10
6	8	8
7	5	7
	Average Errors (%)	7.071428571

F. Liquid Crystal Display (LCD) Testing

On 16x2 LCD testing with the aim of finding out if the LCD can display char- acters that correspond to the given program. LCD 16×2 (Liquid Crystal Display) is a data viewer module, as a compound to display data in the form of writing and images. 16x2 LCD means that lcd has 2 rows and 16 columns.

Figure 19 LCD Testing

In figure 21, the LCD display indicates that the module can display characters according to programs made using arduino IDE. The value will be displayed on the screen when the servo motor has finished rotating. The LCD can show the characters in this final project by using a library called Liquid Crystal. The LCD will display a box indicating the level of the container and the feed plate. As the name indicates, this print() command prints, or shows on the LCD, a text message. The syntax for writing print() is as follows. LCD. Print (data) where LCD is the variable name and data denotes the message to show.

G. Buzzer Sensor Testing

Buzzer is an electronic component that belongs to the transducer family, which can convert electrical signals into sound vibrations. Another name for this compo- nent is called a beeper. In making the tool, this time the buzzer serves as a reminder when the food in storage is almost empty. The buzzer test was performed by connecting one of its legs to the digital pin and the other leg to the ground.

No	Buzzer Status	Storage Condition
1	Rings	Empty
2	Not Ring	Empty
3	Rings	Not Empty
4	Rings	Empty

Figure 20 Testing Result of Buzzer

V. CONCLUSION

Based on this final project, an automatic cat feeding monitoring system with the arduino mega 2560 -using hc-sr04 sensor based internet of thing (iot) has been created. After carried out several stages of testing on the tool, it can be concluded that:

1. This automatic feeder can unload dry feed, set the time and give an alarm if the feed is running low, according to commands given via the Blynk platform.
2. Sending data to the application is real time but it takes a few seconds for the data to appear to the application
3. In the load cell sensor test, there are sensor reading error average value as big as 10,63%.

Based on the results of the final project, it still has limitations from This final project is due to ability, and time, while the limitations are as follows:

1. The servo is replaced with a stepper motor so that when opening the door there is no choking of feed so that the feed container results in accordance with the data entered into the load cell.
2. This tool can be developed with other microcontrollers such as Raspberry Pi4 and others.

Based on the limitations described in this final project, this tool still has short- comings; Therefore, it is hoped that in the future it can be improved. This Final Project can be continued by anyone. Will be better if the system in this tool can be redeveloped and improved, the tool will be superior.

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