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A Smart Pet Monitoring and Feeding Based on Feedback Control System

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Abstract *– Automatic pet feeders can set the time and amount of food in advance with precise scales, according to, who are lost, forgotten, or are out of a need to feed their pets. It can also be recording and monitoring via the Internet of Things (IoT). It also needs to strong and durable. At first, the principle of operation of the machine, the food is contained in a silo and has a screw conveyor inside to feed the dog food. The machine consists of an ultrasonic sensor, a camera to detect the movement of the dog, and a loadcell for feedback control. Every feeding is scheduled for each mash and is weighted in order to get the right amount for the dog each meal. Second, the action is controlled via the IoT system by operated through mobile phone and can be monitoring the system all time. Overall, this fully automatic dog food machine is developed to produce the effect of continuous operation of the work in automation. It is a method of the operating system that is controlled from the driver design and control principle technology through the microcontroller system in operation results in the precise timing of the food release, the scheduled work time.*

Keywords — *Internet of Things, Automatic System, Vision System, Pet Food Feeding, Feedback Control System.*

I. INTRODUCTION

Nowadays, for people who love animals, especially pets like dogs and cats. So they could not find food to eat by themselves. When we are not at home for many days, and some people have to seek immediate solutions such as asking a neighbor to help feed their pets for you or take your dog and cat to the hotel [14]. But no matter what method they do, they causing trouble for both themselves and others, even in the case of pet deposit hotels that the more merciless the money in our bags anyway. Some people even cancel the trip because they are worried about their beloved pets. Therefore, the invention of the automatic pellet feeder was designed to facilitate the feeding of animals [1] in order to reduce the working time by the machine. This automatic pellet feed can be programmed to can set the daily feeding schedule, which the time can be set in minutes per time. Within a day, more than one feeding can be taken. The working model of this machine is divided into three systems [4]. The user can select the mode of operation as needed, including the onetime feeding operation mode is programmed to have a onetime operation; for example, the user-programmed the machine to work at six o'clock, and when the time comes, the machine will feed the animals and just finish the work, and another mode is working mode with setting schedule, for example, there is a program of animal feeding every Monday, Tuesday, Wednesday at six o'clock. The machine will feed the animals at six o'clock on Monday, Tuesday, Wednesday every week. The last one, The operation system of the pet feeder, is via the Internet. Allows pet owners to order feeding programs through the website whenever and wherever they want. By the time the machine completes the feeding program, there will be a notification on the web page that the feeding has been completed. So making the ownerless worried about their pets not eating also in the event that the food is out of stock, there will be a notification on the web page as well. And also to increase convenience by sending E-mail to pet owners to notify them as well.

This paper is presented as follows. In section II, the research method of smart pet monitoring and feeding is presented. Microcontroller, IoT, and control system are presented in section III, and In section IV, presents experimental result and conclusion are presented.

II. RESEARCH METHOD

A. Hardware Design

The structural design of the automatic dog feeder controlled by the microcontroller is a silo tank with dimensions of 368 * 254 mm. The bottom of the silo is equipped with a screw conveyor that dispenses the dog food through the outside dispenser. For calculating the silo, you can find it as follows.

Section I. diameter = 0.368 m ; radius = 0.127 m ;
hight = 0.368 m

There fore, volume = $\pi r^2 h$
= 3.14*0.03*0.03*0.368
= 0.0010399 Cubic Meter

Section II. Top diameter = 0.254 m ; radius 0.127 m

Bottom diameter = 0.125 m ; radius = 0.0625 m
hight = 0.3 m

There fore, volume = $\frac{\pi h}{3}(R^2 + Rr + r^2)$

$= \frac{3.14*0.3}{3}((0.127)^2 + (0.127*0.0625) + (0.0625)^2)$

= 0.000878 Cubic

Section III. Diameter = 125 mm = 0.125 m ;
radius = 0.0625 m
hight = 10 mm = 0.01 m

There fore, volume = $\pi r^2 h$

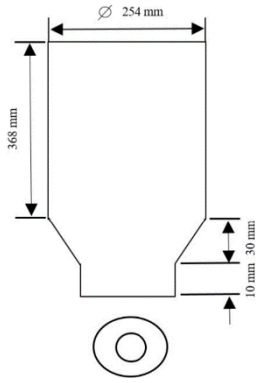

Fig. 1 The volume of hopper for feeder

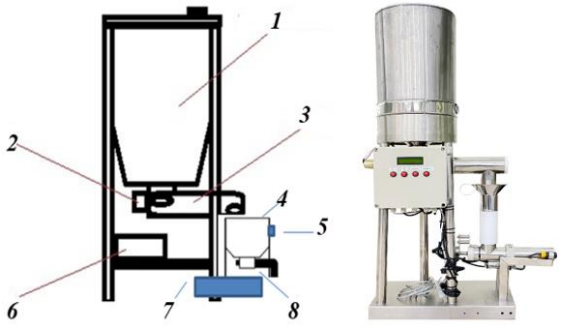

Fig. 2 Structure of the feeder

The picture above it consists of the following

1. Hopper
2. DC Motor No.1
3. Screw Conveyor
4. Volumetric Trank
5. Sensor
6. Control Unit
7. Loadcell
8. DC Motor No.2

At the same time, a screw conveyor for conveying food to the dog. The working power and size of the motor to drive the screw conveyor can be calculated as follows.

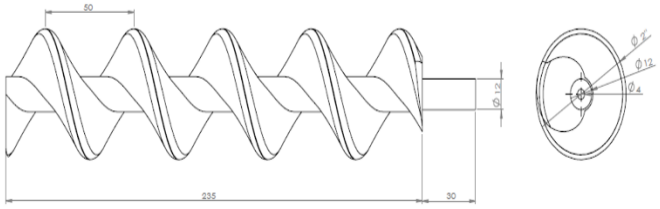

Fig. 3 Screw Conveyor

Screw blade diameter = 50 mm
Drive shaft diameter = 12 mm
Pitch = 50 mm
Screw blade thickness = 2 mm

So that, Ccpacity(Q) = $\frac{\pi(D-d)^2 * s * n * sg * i * 60}{4}$

Where D = screw diameter
d = drive shaft diameter
s = pitch
n = revolutions per minute
sg = specific weight of the material (540 g)
i = degree of via filling (0.1)
λ = coefficient (6.0)

Thus $= \frac{\pi(0.5-0.12)^2 * 0.5 * 60 * 540 * 0.1 * 60}{4}$

$= 11,018 kgh^{-1}$

The total of the load screw conveyor is obtaining as

$$P = Pv + Pn + Pst \quad (1)$$

Where Pv = the power of the material
Pn = the power of the unloaded screw
Pst = the power of the horizontal screw

The power of the material (Pv)

$$= \frac{lm * L * \lambda * g}{3600} \quad (2)$$

$$= \frac{11,018 * 0.235 * 6.0}{3600 * 102}$$

= 0.042 kW

The power of the unloaded screw (Pn)

$$= \frac{D * L}{20} \quad (3)$$

$$= \frac{50 * 0.235}{1000 * 20}$$

=0.000587 kW

The power of the horizontal screw (Pst)

$$= \frac{lm * H * g}{3600} \quad (4)$$

$$= \frac{11,018 * (0.235 + 0.03)}{3600 * 102}$$

$$= 0.00795 \text{ kW}$$

Total the screw conveyor power

$$= Pv + Pn + Pst \quad (5)$$

$$= 0.042 + 0.000587 + 0.00795$$

$$= 0.0505 \text{ kW}$$

program, C is written to control and set the timer function to control the flow rate of the dog food as 2 times a day, and loadcell will monitor the weight coming out of the silo to get the right amount of food per meal and let the dog eat on time.

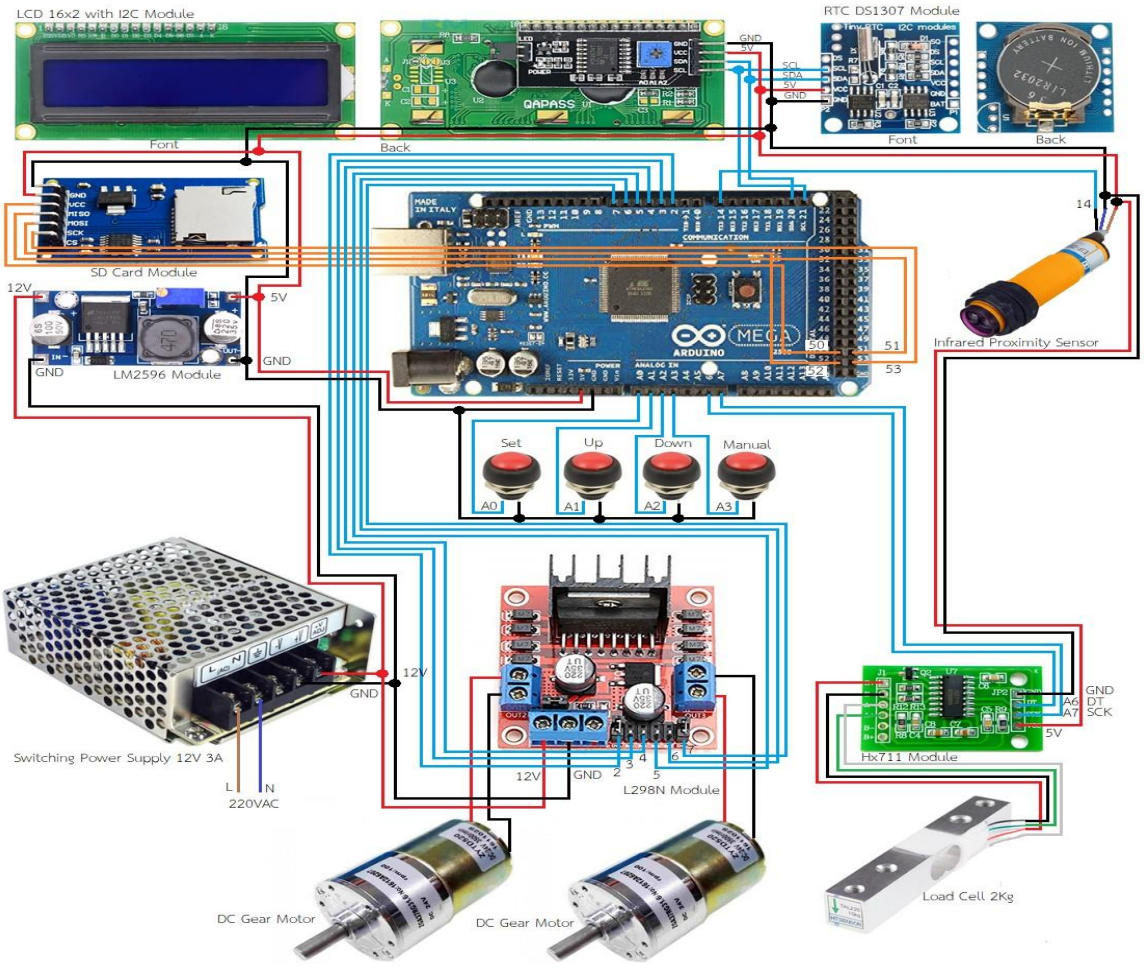

Fig. 4 Control system of a smart pet

B. Control System

The control system will control all the tasks, feeding the dog at the specified time. This control system is controlled through a microcontroller [3]. The Arduino MEGA receives various input signals such as a switch, a loadcell, a sensor and sends the signal through its output, for example, via a display. It will use C language to program the control. In the The process of automatic dog feeders. There will be procedures and check the machine operator with a working plan as a flow chart in the picture below.

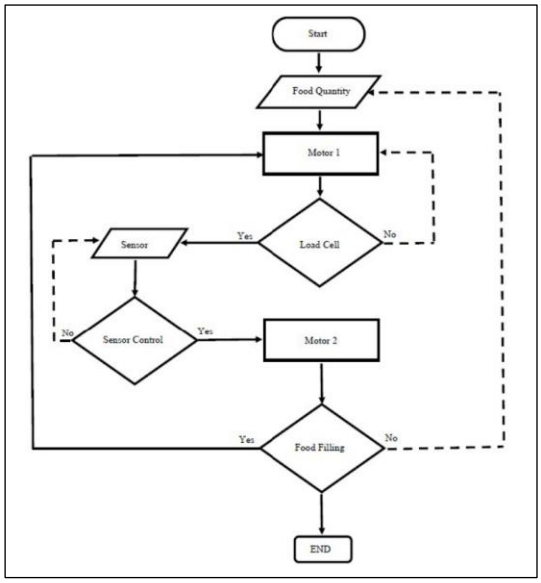

Fig. 5 Flow Chart of a smart pet

The equipment and components of the automatic control system by the microcontroller system are as follows. 1) use equipment to control the automation by controlled a microcontroller system [10]. In order to operate the system and control all functions via the Arduino board and control unit. 2) The motor rotates to remove food from the silo. 3) Load cells are used as equipment for measuring the volumetric weight of food to make the system work according to the specified conditions. 4) Use the sensor as a device to detect animals or dogs to activate the system to operate the specified conditions. 5) Use an SD card as a device to record sensor operation data.

C. Feedback Control System

A smart pet feeder approach in automatic control theory is one where the instantaneously measured state is feedback and compared to the desired state [16]. The difference between the two of them is then used to guide further adjustment in the screw conveyor. When the difference is 0, that is, when the actual state is the same as the desired state, no further adjustments are made; as a particular smart pet feeder, we consider a velocity servo control problem. A DC servo motor is to rotate the screw conveyor. It is required that the angular velocity of the arm as a function of the time be maintained at $\omega_0(t)$. Use velocity feedback of the motor load output angular velocity $\omega(t)$ and the velocity error.

$$e(t) = \omega_0(t) - \omega(t) \tag{6}$$

To provide the needed corrections in maintaining the required angular velocity.

for motor and load

$$k_T = J\frac{d\omega}{dt} + b\omega \tag{7}$$

$$G_m(s) = \frac{\Omega(s)}{I(s)} = \frac{k\tau}{Js+b} \tag{8}$$

for the current amplifier

$$Au = \tau\frac{di}{dt} + i \tag{9}$$

$$G_a(s) = \frac{I(s)}{V(s)} = \frac{S}{\tau s+1} \tag{10}$$

for the loadcell and input transducer

$$u = k\omega \tag{11}$$

$$G_t(s) = \frac{V(s)}{\Omega(s)} = k \tag{12}$$

Where $k\tau$ = torque constant for the motor
J = mass moment of inertia
b = viscous damping coefficient
A = DC gain of the amplifier
τ = amplifier time constant
k = sensor constant

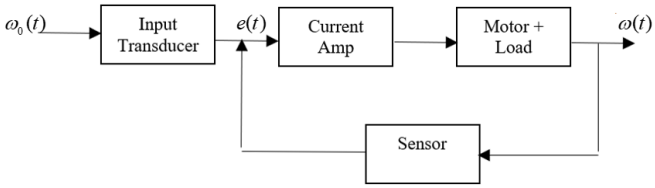

Fig. 6 Block diagram for velocity feedback control system

D. Internet of Things

Nowadays, the Internet of Things (IOT) has a very active role in the life of humanity. Thus making the development bring and design a large number of applications to connect and direct through. Device IoT thus, as it became popular and spread rapidly today, it is necessary to purchase applications that have efficiency in use and operation [2],[4]. The best job To achieve the objectives and needs of the next user. Dog feeding control system through the application on an android operating system, wireless light switch prototype with an android application by this research work has developed a prototype. Control through the use of equipment with Node ESP8266 or NodeMCU. It is connected via a control unit, motor, screw, load cell and can be displayed via the LCD screen, which can be operated via an application on compatible devices. Operating system android can also record the dog's food consumption through the webcam.

It is a computer language used to develop web pages in conjunction with HTML, CSS, and JavaScript to make web pages move. It may be used to verify the correctness of the information that users enter. Or use it to bring about changes on the web page And add features for the web to be able to interact with the user. It will connect to Anto.io as a medium for communication. Anto set the server for you to use for free. As an intermediary in communication between various things on the internet. A platform that includes tools for backend or server-side management that can build mobile applications efficiently. And also reduce the time and cost of doing Server-side or data analysis as well.

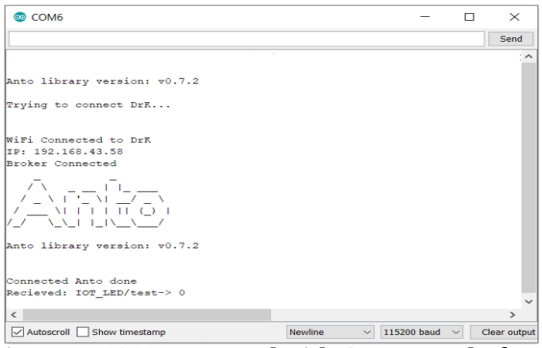

Fig. 7 Esp8266 connected with Anto IoT Platform

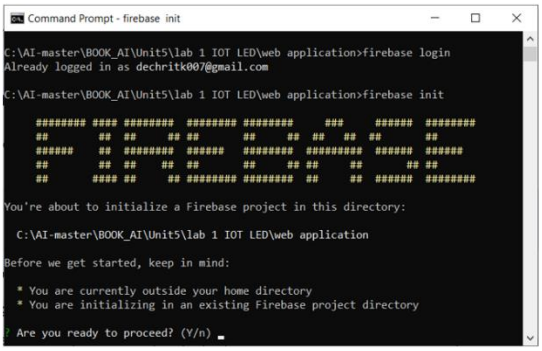

Fig. 8 Firebase Platform

III. EXPERIMENTAL AND RESULTS

In this experiment, the researcher designed to control the food delivery system over time. By setting a pattern for the food delivery system 1-2 times a day at the appropriate time for the dog to eat at the right time. Therefore, the morning period is set at 6:00 AM to 8:00 AM and in the evening at 6:00 PM until 8:00 PM for a period of 21 days for each meal. The three types of food are divided into three types: Brand Smart heart, Brand Roral Canin and Brand Pedigree. All three feeding tests provided a predetermined amount of food at each meal of 40 g, 50 g and 60 g to test and collect the dog's dietary data. To be compared with the weight of each dog as well. At the average rate, there was the least amount of leftovers, 2 grams, and the greatest number of leftovers were 6 grams of the 21-day test.

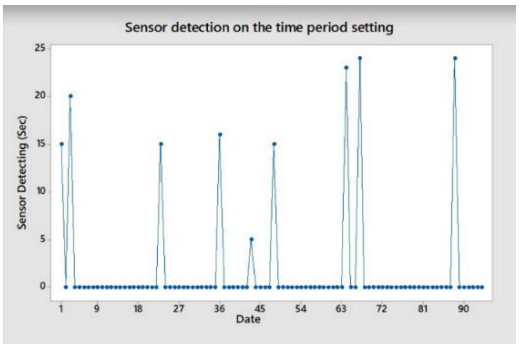

Fig. 9 Detection of dog and dispensing food in time between 6 - 8 am and 6 - 8 pm

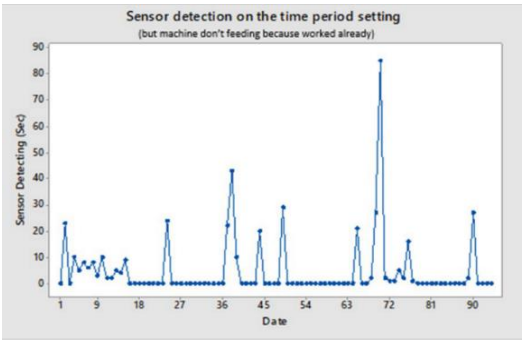

Fig. 10 Detection of dog but not dispensing food in time between 6 - 8 am and 6 - 8 pm

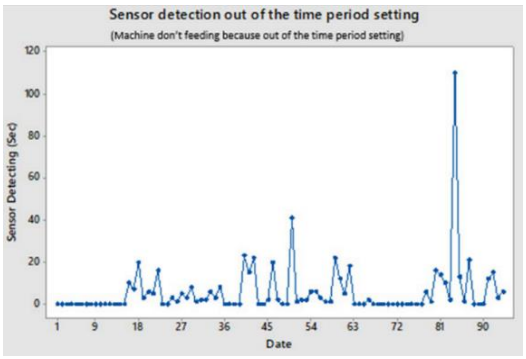

Fig. 11 Detection of dog but not dispensing food in time ดfrom 8 am to 6 pm

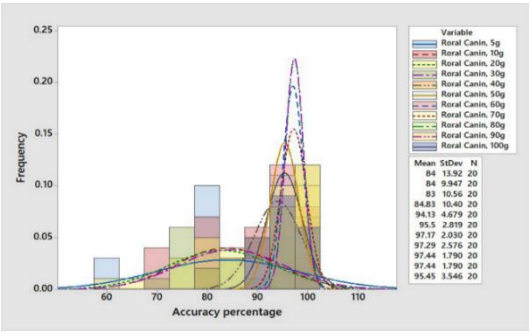

Fig. 12 Check the quantity and accuracy of the food delivery type A

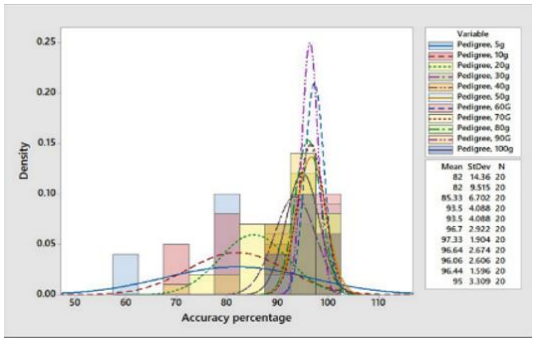

Fig. 13 Check the quantity and accuracy of the food delivery type B

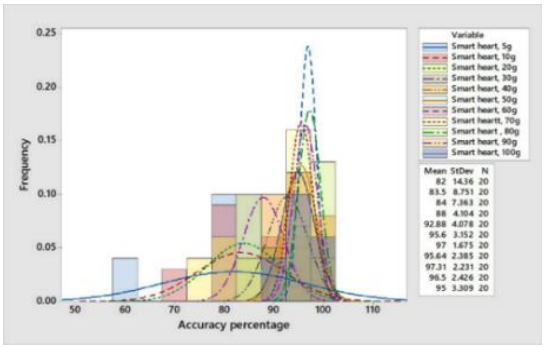

Fig. 14 Check the quantity and accuracy of the food delivery type C

IV. CONCLUSIONS

This IoT controlled dog food dispenser by feedback control. It is constantly detecting dogs to dispense the dog food and not pay the dog food with a set time period then can control the work well. For food, it can be divided into three types as follows: Type A, Type B, and Type C, which are commercially available. The result of the release of all three types of food according to the dog's body mass index. The dog feeder can detect the amount and feeding accuracy of dogs as follows: Type A food, mean the average feeding rate of 50 g to 100 g is 94.13% to 95.45 %. Type B food means the average feeding rate of 50 g to 100 g is 92.88 % to 95.00%. Type C food means the average feeding rate of 50 g to 100 g is 93.50 % to 95.00 %. The test shows that the machine can feed the dog on time, and the dog can eat all 3 types of food more than 90 %.

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