Available *online* at : http://jnte.ft.unand.ac.id/

Jurnal Nasional Teknik Elektro

| ISSN (Print) 2302-2949 | ISSN (Online) 2407-7267 |

Automatic Feeder for Laying Hens Based on Noise Amplitude

Rian Ferdian [1], Zaki Minango Dasman [1], Yan Heriyandi[2], Mohammad Hafiz Hersyah[3]

[1] *Faculty of Information Technology, Universitas Andalas, Padang, Sumatera Barat 25163 INDONESIA*
[2] *Faculty of Animal Science, Universitas Andalas, Padang, Sumatera Barat 25163 Indonesia*
[3] *Graduate School of Science and Technology, Nara Institute of Science and Tehcnology, Nara 630-0192 Japan*

ARTICLE INFORMATION

Received: September 15, 2021
Revised: February 28, 2022
Available online: March 29, 2022

KEYWORDS

Automatic feeder, microcontroller design, Cultivating of Laying Hens, feeding management, temperature, chicken behavior, sound of chicken

CORRESPONDENCE

E-mail: rian.ferdian@it.unand.ac.id

A B S T R A C T

Food is an essential aspect of the laying hens' cultivation process. The delay of the feeding time and the short amount of food can cause stress to the hens. Furthermore, an excessive amount of food can cause overweight and reduce hens' productivity. This paper provides a method to automate the feeder for laying hens using a device based on microcontroller technology. A tool that can detect chicken behavior when hungry and the temperature of the cage can provide an excellent feeding management system for the breeder. The automatic feeder can see chicken behavior, also the environmental condition around the cage. A specific noise amplitude caused by the hungry hens can trigger the feeder. This feeder also design aims to provide the food in the right amount at the right time. Thus, the breeder can minimize the stress of laying hens, reduce food waste, and keep the hens ideal. Here the system can save the chicken's food around 13.76% more efficient.

INTRODUCTION

Feeding management is one of the fundamental elements in laying hens' cultivation. The food's cost is the primary outcome in applying hens' farm. Thus, food efficiency is also the key to laying hens' cultivation success. Moreover, feeding also affects the hens' development. Delay in feeding time can cause stress to the hens that can affect their fertility. The feeding amount also influences hens' weight condition. Too much food can cause hens to be overweight and also lower their fertility. For laying hens, once it drops its productivity, it is almost irreversible.

Laying hens can be found in various regions in Indonesia. The laying hens business, no matter how small the scale of business, must be managed professionally [1]. Cultivating laying hens is generally carried out in rural areas due to the large amount of available land. In addition, the environment in rural areas is more favorable for cultivation because it is far from residential areas to avoid noise. A stable temperature is also vital in laying hens because laying hens are sensitive to temperature changes. Laying hens cannot live well in extreme weather conditions [2].

The cultivation of laying hens is usually done on a large scale by cultivating thousands of laying hens at once. The feeding method that has been widely used so far in feeding laying hens is manual. Farmers provide feed directly at certain times. Manual feeding is less effective because farmers do not know how many servings of feeding needs for laying hens. The manual method can lead to uncontrolled feeding. In addition, one of the highest costs of laying hens comes from the cost of purchasing rations. Therefore, good management in feeding is needed [3].

Laying hens are animals that are easily stressed. One of the most common stresses in chickens is heat stress. Heat stress is a stress disease caused by the ambient air temperature exceeding the average temperature so that the chicken cannot balance the production and dissipation of body heat. Stress in chickens can cause a decrease in production. When heat stress occurs in chickens, it will cause drinking water consumption to increase, while feed consumption will decrease. In addition, the dry season also causes heat stress to occur more frequently in chickens, especially during the day [4]. High ambient temperatures can reduce egg production. More energy is needed to regulate body temperature at high ambient temperatures, thereby reducing the energy supply for egg production. At high environmental temperatures, feed consumption decreases, reducing nutrients in the body and ultimately decreasing egg production [5].

The feeding process by manual method still has problems knowing the correct amount and time of feeding. Furthermore,

https://doi.org/10.25077/jnte.v11n1.944.2022

each hen may have a different characteristic of its feeding behavior. Thus, it is very challenging to customize the feeding process for each hen. It is necessary to design a tool that can detect the behavior of chickens when hungry and the temperature of the cage to get good feed management so that the system can feed chickens automatically. This paper considers the hungry chicken voice will have a different amplitude compared to their normal voice [6]. The starving will usually make a fuss as a sign that the chicken needs to eat. According to North, the noise caused by laying hens when hungry is a behavior (habit) when chickens communicate their needs to farmers. At the same time, the cage's temperature is detected to determine the portion of feed given. Giving the right amount of feed will increase the savings in feed use [7].

METHOD

This paper used an experimental research methodology. The process starts from designing a system form and deciding the location of each component. Next, the functions inside each element are defined as a flowchart. Later, the measurement to assess the whole system already meet all the given specifications.

Hardware Design

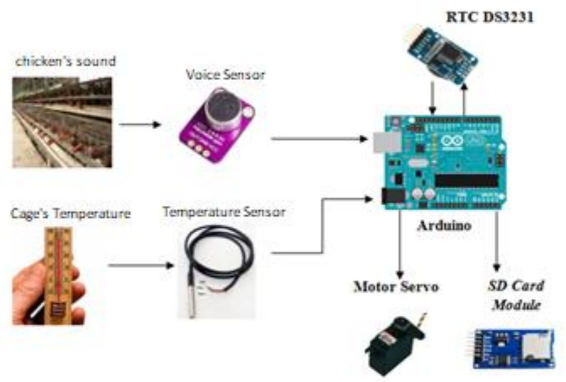

Figure 1. Feeder Block Diagram

We can consider two conditions for the automatic feeder: the voice amplitude and the cage's temperature. The system uses the MAX 4466 to capture and digitize the hen's voice. MAX 4466 is an electret microphone amplifier that has been optimized as a voice amplifier to read the noise produced by laying hens when hungry. In this paper, we use a DS18B20 temperature sensor to detect the environment's temperature condition. The results of the temperature sensor readings will determine the amount of food that comes out. A servo motor is used in this automatic feeder as the actuator for the container opener. Arduino UNO microprocessor is the center of the automatic feeder. Arduino UNO is the system's central controller, processing the data sent from the sound and temperature sensors. Arduino UNO is already widely used in many application [8,9]. The feeder also used an SD card daughter module to store its data. The delay between each feeding is controlled using an real time clock. The system block diagram is shown in Figure 1.

Process Design

This design is done by specifying the functionality of the system. Systematically, the flow of system functions, in general, can be seen in the flowchart below.The process can be categorized into three parts: 1. System Initialization and Noise Amplitude Detection, 2. Food Amount Calculation 3. Post Process.

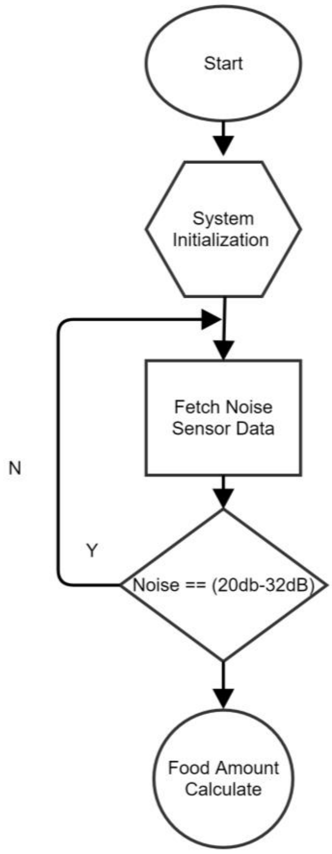

Figure 2. Noise Amplitude Detection Process

The first process in the automatic feeder is system initialization and noise amplitude detection. In this step, the Arduino will establish the communication between each component in the system. Then the microcontroller will check the noise amplitude from the MAX 4466. In this feeder, the noise amplitude from the hens will trigger the opening mechanism in the food container. The Arduino will check the noise to be 20 - 32 dB to start the further operation. The flowchart of this first process can be seen in the Figure 2 above.

Several researchers reported that environmental temperature affects feed consumption [10-12]. Room temperature above thermoneutral causes a decrease in feed consumption. The US National Research Council estimates a reduction in feed consumption of 1.58% for a one-degree Celcius increase in ambient temperature above 24.5°C. The decline in feed consumption when the chickens are 51-90 weeks old can be seen in table 1.

https://doi.org/10.25077/jnte.v11n1.944.2022

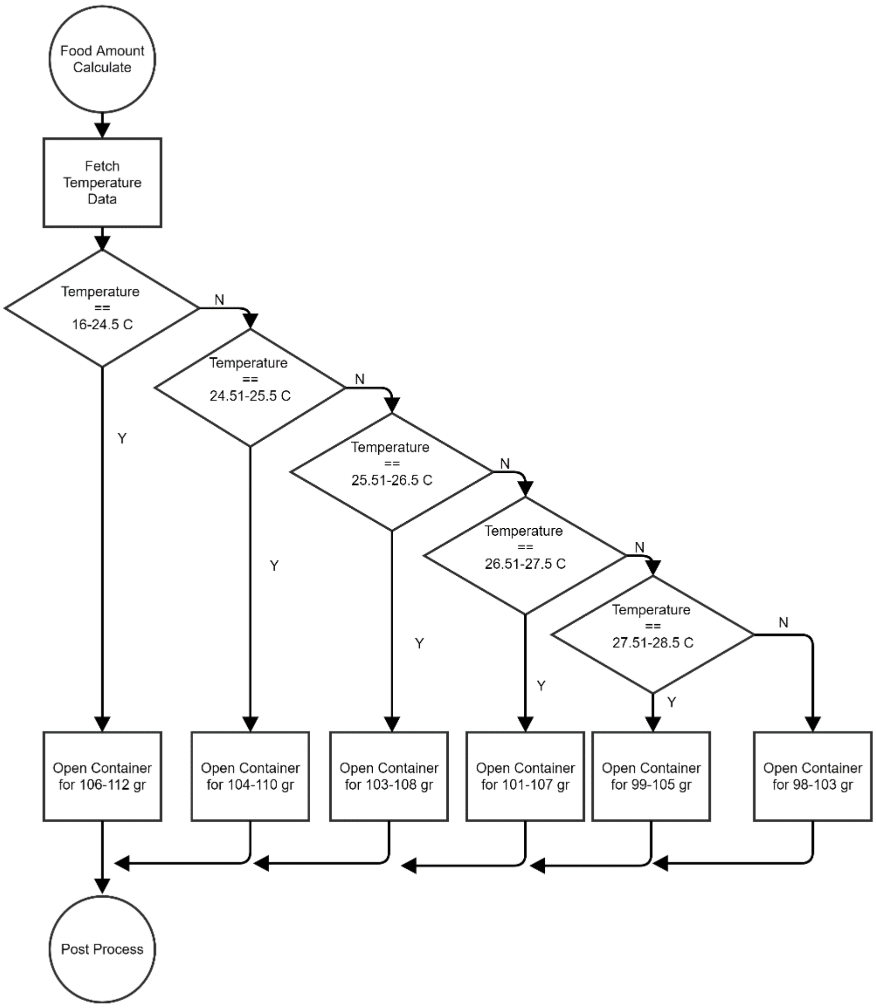

Figure 3. Food Amount calculation

Table 1. Consumption of Laying Chicken Feed Based on Environmental Temperature [9]

Temperature	16°C-24.5°C	24.51°C-25.5°C	25.51°C-26.5°C	26.51°C-27.5°C	27.51°C-28.5°C	28.51°C-29.5°C
Weight (gr)	106-112	104-110	103-108	101-107	99-105	98-103

The second process is translating the information from Table 1 to detect the amount of food for the hens. In this part, the Arduino will fetch the data from the temperature sensor. Then, from the temperature information, Arduino will decide the time length for the servo motor to open the container. If the temperature is normal (16-24.5 C) the container will open for 106-112 gr of chicken food. For every degree Celcius increment, the feeder will reduce the fare by 1.58% [13,14]. The flowchart of the second process can be seen in Figure 3.

The last process for the automatic feeder is the post process. In this part, The Arduino will store the feeding time information to the SD card memory. Furthermore, the feeder also needs to stop giving the food for at least 3 hours. Here the feeder needs to keep the hens from becoming obese [15,16]. At this part, the Arduino will start the RTC module to start the 3 hours counting. The flowchart of the post process part can be seen in the Figure 4.

The feeder implementation is realized by supporting laying containers measuring 40cm x 10cm x 30cm, which serves as a shelter for laying hens. Figure 5 shows the hardware implementation results from the back, side, and component boxes. The feeder is connected directly to the hens' cage. The noise sensor MX 4466 is located inside the enclosure to obtain a clear hens' noise signal. To evaluate the feeder quality, here the sensor quality, actuator quality and overall system quality are assessed

Figure 4. Post Process

(a)

(b)

Figure 5. Hardware layout (a) Front Section (b) Side Section

RESULTS AND DISCUSSION

Sensor Quality

There are two sensor assessments that performed in this part, the sound sensor and the temperature sensor. The sound sensor assessment is performed by comparing the sensor data with the data from the decibel meter that has been installed on the previous smartphone. The assessment data can be seen in the Table 2.

Table 2. Noise Sensor Assessment

Iteration Number	Sensor MAX4466 (dB)	DesibellMeter (dB)	Different (dB)	Error (%)
1	11	13	2	15.39
2	13	16	3	18.75
3	11	14	3	21.43
4	8	10	2	20
5	7	8	1	12.5
6	14	17	3	17.65
7	12	13	1	7.7
8	9	11	2	18.19
9	10	13	3	23.08
10	13	15	2	13.34
Average Different			**2.2**	
Average *Error*			**16.80%**	

Temperature sensor assessment is carried out to see the sensor's response to temperature during the feeding process. The test is done by connecting the sensor to the Arduino Uno microcontroller. The DS18B20 sensor will read the temperature value in the laying hens' enclosure. Here, the Digital thermometer with 0.1 accuracy and resolution is used.

Table 3. Temperature Sensor Assessment

Iteration Number	Sensor DS18B20 (°C)	Digital Termometer (°C)	Difference (°C)	Error (%)
1	30.37	32.3	1.93	5.98
2	30.44	31.7	1.26	3.97
3	30.75	31.9	1.15	3.61
4	30.81	31.2	0.39	1.25
5	30.25	31	0.75	2.42
6	29.37	29.6	0.23	0.78
7	28.37	28.9	0.53	1.83
8	28.1	29	0.9	3.1
9	30	30.8	0.8	2.6
10	29.69	30.2	0.51	1.69
Average Difference			0.845	
Average *Error*			2.72%	

https://doi.org/10.25077/jnte.v11n1.944.2022

Actuator Quality

In the actuator test, the servo motor is assessed. The evaluation is done by giving input in the form of readings from the sound sensor with an average sensor reading of 20dB-32dB every 30 seconds. Then when the sound sensor reading has reached that value, the system will read the temperature sensor value to determine the length of time the feed valve opens. Here the corresponding opening length of time to the specified food amount is measured. After conducting the experiment, some data were obtained. The obtained data is shown in the Table 4.

Table 4. Servo Motor Assessment

Temperature	16°C-24.5°C	24.51°C-25.5°C	25.51°C-26.5°C	26.51°C-27.5°C
Target Weight (gr)	53-56	52-55	51-54	50-53
Duration (s)	0.233s	0.233s	0.225s	0.225s
Received Weight				
1	53.6	53.6	50	50
2	55.5	55.5	56.3	56.3
3	59.2	59.2	45.3	45.3
4	55.4	55.4	55.2	55.2
5	49.8	49.8	53.1	53.1
6	52.3	52.3	56	56
7	51.7	51.7	56.8	56.8
8	59	59	51	51
9	52.4	52.4	45.6	45.6
10	52	52	52.1	52.1
Average	**54.09**	**54.09**	**52.14**	**52.14**

It can be seen in the table, the amount of feed released is sometimes different. The height of the feed influences the difference in the container. If the container is loaded, the downward pressure of the feed is greater, causing more feed to come out.

System Quality

Overall system testing aims to ensure whether the system can work according to its function. The comprehensive system test plan with the formulation of the query and the purpose of the system. The data generated during the ten days of the experiment is as shown in the table 5 below:

Table 5. Overall System Assessment

Date	Hour	Noise Level(dB)	Temp(°C)	Weight food(gr)
13.07.2019	6:41:33	26	22.94	108.18
13.07.2019	10:05:07	28	29.31	98.28
14.07.2019	7:10:45	22	23.35	108.18
14.07.2019	14:12:37	27	29.06	98.28
15.07.2019	7:15:47	30	24.52	108.18
15.07.2019	11:23:50	22	29.62	98.28
16.07.2019	6:45:16	24	23.12	108.18
16.07.2019	10:22:31	27	28.50	103.32
17.07.2019	7:42:18	28	25.81	104.28
17.07.2019	10:55:16	31	29.31	98.28
18.07.2019	6:47:16	25	24.44	108.18
18.07.2019	13:49:22	21	30.12	98.28
19.07.2019	6:55:40	24	24.44	108.18
19.07.2019	12:57:47	20	29.81	98.28
20.07.2019	7:04:04	23	23.60	108.18
20.07.2019	14:47:30	25	29.19	98.28
21.07.2019	6:40:54	24	22.72	108.18
21.07.2019	14:05:24	26	29.87	98.28
22.07.2019	6:51:20	21	23.85	108.18
22.07.2019	10:53:50	27	28.37	103.32

Here the number of foods that the proposed approach can save also is assessed. The paper compares the proposed automatic feeder with the manual feeding process. The result can be seen in Table 6 below.

Table 6. Food Saving Assessment

Iteration -	**Food Amont**		**Saving**	
	Manual	**Auto Feeder**	**Difference**	**(%)**
1	240 gram	206.46 gram	33.54 gram	14
2	240 gram	206.46 gram	33.54 gram	14
3	240 gram	206.46 gram	33.54 gram	14
4	240 gram	211.5 gram	28.5 gram	12
5	240 gram	202.56 gram	37.44 gram	15.6
6	240 gram	206.46 gram	33.54 gram	14
7	240 gram	206.46 gram	33.54 gram	14
8	240 gram	206.46 gram	33.54 gram	14
9	240 gram	206.46 gram	33.54 gram	14
10	240 gram	211.5 gram	28.5 gram	12
Average	**240 gram**	**207.07 gram**	**32.9 gram**	**13.76**

The testing results for several days in laying hens show that the average amount of food is 205.14 grams. In the manual method, the amount of food given is 240 grams for two laying hens. The amount of feed that the proposed system saved was 14.54%, or an average of 34.86 grams per day. The system obtained the food savings because the amount of feed was based on the cage temperature reading. The amount of feed that comes out can be reduced when the temperature is hot. In contrast, manual feeding is always a fixed amount of 120 grams per head. The manual method is a waste of food because it is not necessarily the feed needed for laying hens.

CONCLUSIONS

The design of automatic feeders for laying hens can maximally provide feed automatically. The temperature sensor and servo motor can work properly when getting the input noise level of 20dB-32dB. Information of the feeding time also can be stored correctly on the SD card. The noise sensor can have an average error of 1 dB. Furthermore, the temperature sensor is having a 2% error compared to the digital thermometer. The average chicken feed issued by the system in a day is 205.14 grams. This amount is a saving of 13.76% in the use of feed. The average amount of feed saved is 32.9 grams per day for two chickens. Moreover, for real implementation It can be concluded that the proposed automatic feeder system is more efficient than manual feeding. By keeping the feed efficiently for the laying hens, the breeder can also minimize the cost of raising chickens.

ACKNOWLEDGMENT

The research published in this paper is supported by Faculty of Information Technology, Universitas Andalas, Indonesia.

REFERENCES

[1] Nurmanaf, A. Rozany. 2003. *Tingkat Konsumsi Telur Dan Variasi Keseimbangan Produksi-Konsumsi Antar Provinsi Di Indonesia*. Puslitbang Sosial Ekonomi Pertanian: Bogor.

[2] Yupi. 2011. *Analisis Usaha Tani Ayam Ras Petelur*. Universitas Islam Negeri Syarif Hidayatullah: Jakarta

[3] Zulfikar.2014. *Manajemen Pemeliharaan Ayam Petelur Ras*. Universitas Syiah Kuala: Banda Aceh

[4] Bird, N.A., P. HuNToN, W.D . Morrison dan L.J. Weber. 2003. *Heat Stress in Caged Layers*. Ontario-Ministry -if Agriculture and Food.

[5] Gunawan, D.T.H. Sihombing. 2004. *Pengaruh Suhu Lingkungan Tinggi Terhadap Kondisi Fisiologis Dan Produktivitas Ayam Buras*. Institut Pertanian Bogor: Bogor

[6] N. Li, Z. Ren, D. Li, and L. Zeng, "Review: Automated techniques for monitoring the behaviour and welfare of broilers and laying hens: towards the goal of precision livestock farming," animal, vol. 14, no. 3, pp. 617–625, 2020.

[7] North, M. O., 1980. *Stress: What It is and How to Recognize It*. Poultry Digest 39:80-86.

[8] Andesta, D., & Ferdian, R. (2018, September 29). *Sistem Keamanan Sepeda Motor Berbasis Mikrokontroler dan Modul GSM*. JITCE (Journal of Information Technology and Computer Engineering), 2(02), 51-63. https://doi.org/https://doi.org/10.25077/jitce.2.02.51-63.2018

[9] F. El Khair and R. Ferdian, "*Rancang Bangun Sistem Kontrol Pertumbuhan Sayuran di Dalam Ruangan Dengan Sistem Tanam Aeroponik*", chipset, vol. 1, no. 01, pp. 5-9, Apr. 2020.

[10] Krogh, T.H. 2000. *Wrong Climate may result in loss of production*. Skov A/S Opslag-Artikler. 71.

[11] NRC. 1981 . *Effect of Environmental on Nutrient Requirements of Domestic Animals*. NationalAcademy Press:Washington, D C.

[12] Hy-Line International. 2018. *Panduan Manajemen Ayam Petelur Komersial Brown.*

[13] Cherian G. S., Effect of Feeding Full Fat Flax and Canola Seeds to Laying Hens on the Fatty Acid Composition of Eggs, Embryos, and Newly Hatched Chicks, Poultry Science, Volume 70, Issue 4,1991,Pages 917-922,

[14] P. Luiting, "Genetic variation of energy partitioning in laying hens: causes of variation in residual feed consumption," World's Poultry Science Journal, vol. 46, no. 2, pp. 133–152, 1990.

[15] M. M. Van Krimpen, R. P. Kwakkel, B. F. J. Reuvekamp, C. M. C. Van Der Peet-Schwering, L. A. Den Hartog, and M. W. A. Verstegen, "Impact of feeding management on feather pecking in laying hens," World's Poultry Science Journal, vol. 61, no. 4, pp. 663–686, 2005.

[16] M.C. Meunier-Salaün, J.M. Faure,"*On the feeding and social behaviour of the laying hen*",Applied Animal Behaviour Science,Volume 13, Issues 1–2,1984,Pages 129-141

https://doi.org/10.25077/jnte.v11n1.944.2022