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IoT-based Automated System for Monitoring and Controlling Maggot Feed Provision in Broiler.

Rivaldi Eka Putra[1], Musayyanah[2], Harianto[3], Pauladie Susanto[4]

Computer Engineering, Faculty of Technology and Informatics, Unievrsitas Dinamika[1234]

Corresponding Author: Musayyanah (musayyanah@dinamika.ac.id)

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Abstract

The application of the Internet of Things (IoT) in the agricultural sector brings a revolution in more efficient and sustainable crop management and monitoring. By integrating sensor devices and data connectivity via the internet, IoT enables monitoring of feed for Boiler chickens with Maggots. The main sensor devices are load cell and servo sensors. The load cell sensor is used to weigh the weight of the feed given. The Servo sensor is used to open the feed container. The sensor device used is a weight sensor that is capable of weighing Maggots 99.99% accurately. The servo device is capable of opening the Magot container. Integration with the Blynk IoT platform can be done remotely, by monitoring the weight of the feed and controlling the feeding time of the Boiler Chicken.

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INTRODUCTION

In today's digital era, the application of technology in various sectors of life has become a necessity to increase efficiency and productivity, including in the livestock sector (Madushanki et al., 2020). Chicken farming, as one of the important components in the food industry, requires continuous innovation to be able to meet the growing market needs. One of the critical aspects in chicken farming is efficient feed management, which not only affects the health and growth of chickens but also cost and labor efficiency.

The poultry industry, particularly broiler farming, has witnessed significant advancements in technology to enhance productivity and reduce operational costs. One such innovation is the integration of the Internet of Things (IoT) in farming practices (Javaid et al., 2022). IoT-based systems have the potential to revolutionize the monitoring and control of various aspects of poultry management, including feed provision systems, which are crucial for ensuring proper nutrition and feed efficiency in broiler farming (Farooq et al., 2020).

Maggot feed provision, an increasingly popular and sustainable alternative to traditional animal feed offers a unique opportunity for optimization. Maggots, rich in protein and fat,

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serve as a nutritious and eco-friendly feed for broilers (Dörper et al., 2024). Black Soldier Fly (BSF) is the larva, commonly known as maggot. The maggot undergoes a metamorphosis process from the egg stage, larva, prepupa, and pupa, until it becomes an adult BSF. Maggots, rich in protein (up to 42%) and fat, are a highly nutritious and eco-friendly feed for broilers. The Black Soldier Fly (BSF), which undergoes a complete metamorphosis from egg to larva, prepupa, and pupa, is a key source of this feed, making it an attractive alternative to traditional animal feeds (Salahuddin et al., 2024). However, managing the proper quantity, quality, and consistency of maggot feed for large-scale poultry farms remains a challenging task.

Previous research by (Setiawan, 2023) applied IoT to monitor broiler chicken cage conditions but did not consider the integration of maggots as a sustainable protein source for poultry. This gap in research underscores the need for an IoT-based system that can monitor and control maggot feed provision in a more efficient and automated manner.

This article delves into the development of an IoT-based automated system that can monitor and regulate the feeding process, ensuring optimal maggot provision for broiler chickens. By integrating sensors, real-time data processing, and automation, the system aims to enhance feed efficiency, reduce human error, improve farm productivity, and contribute to a more sustainable poultry farming model.

METHOD

The methodology of the research consists of a hardware system and software design on a cloud platform..

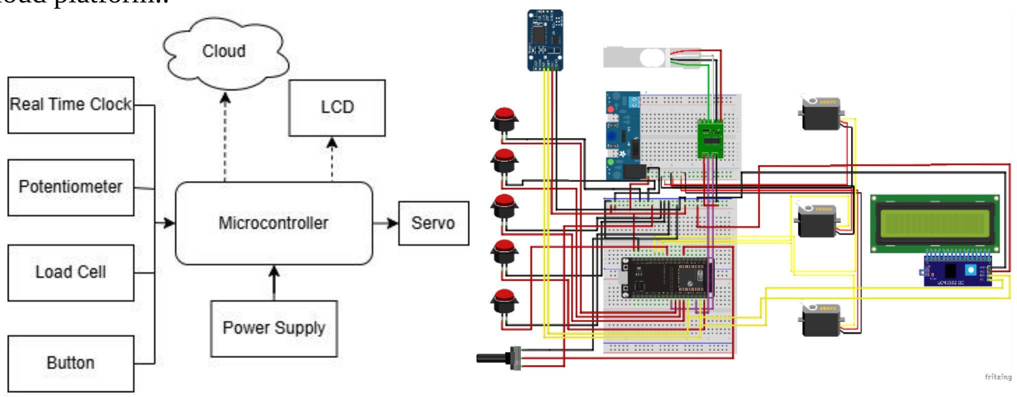

Figure 1. Rancangan perangkat keras

Figure 1 represents the hardware designs. Push On Button as a button to select the chicken feed category to be provided. RTC functions as a timer to schedule when the automatic feeding system will operate. Load Cell measure and monitor the weight of the feed provided to the chickens, including the main feed and maggot as a supplement. Potentiometer as a controller to set the desired number of chickens in the chicken coop. Breadboard Power Supply as an additional power supply to ensure all components operate normally.

Servo open and close the valves of the Chicken Feed and Maggot Reservoirs, as well as the mixed feed reservoir, automatically according to the time and amount of feed that has

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been determined. LCD as a display to show information to the user when entering the desired number of chickens.

Microcontroller as the main control center for the entire automatic chicken feeding system. The ESP32 controls various connected inputs and outputs, including sensors, actuators, and communication modules. Thus, the ESP32 ensures that the entire chicken feeding process operates automatically and efficiently according to the predefined settings.

The input and output pins of the hardware design are shown in Table 1. Each sensor device is connected through the input or output pins of the microcontroller to operate the feed mixing system from the boiler.

Table 1. Input and Output Pins of the Hardware

Pin input/output	Function		Pin
MAGGOT_SERVO_PIN	Servo Maggot	Output	14
PUR_SERVO_PIN	Servo Pur	Output	12
MIX_SERVO_PIN	Servo Fix	Output	13
POT_PIN	Potensiometer	Input	32
BUTTON1_PIN	Category 1st	Input	5
BUTTON2_PIN	Category 2 nd	Input	18
BUTTON3_PIN	Category 3rd	Input	19
BUTTON4_PIN	Category 4th	Input	23
CONFIRM_BUTTON_PIN	Confirm Button	Input	27
HX711_dt	Load Data	Input	17
HX711_sck	Scale Clock	Output	16
SDA	Data	Output	21
SCL	Clock	Output	22
RTC_SDA	Data RTC DS3231	Output	21
RTC_SCL	RTC DS3231	Output	22

The prototype of the chicken coop for maggot feed measurement is shown in Figure 2. There are three funnels: the first funnel is for poultry feed (pur), the second funnel is for maggots, and the third funnel is for weighing the maggots and poultry feed. The weighing is conducted according to the standard ratio percentages outlined in Table 2. The servo on the third funnel will open if the weighing meets the specified ratio category. Button1 is for selecting the chicken age category of one week, as shown in Table 2. Button2 is for selecting the chicken age category of two weeks, Button3 for the chicken age category of three weeks, and Button4 for the chicken age category of four weeks.

Figure 2. IoT Prototype for Chicken Coop

Table 2. Ratios of Maggot Weight and Poultry Feed Weight

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Chicken Age In aWeek	Persentase	Maggot (g)	Pur(g)	Total
1	10%	2	18	20
2	20%	8	32	40
3	20%	12	48	60
4	30%	27	63	90

The software design is the application interface of the Blynk platform, as shown in Figure 3. The integration of the ESP32 with the Blynk app allows the automation system to be monitored and controlled remotely via the internet. This process involves several important steps, including hardware and software configuration. To begin, some essential information from the Blynk app is required, such as the Auth Token, Device Name, and Template ID. This information is necessary to connect the ESP32 to the Blynk platform.

The use of Blynk is not limited to just one platform. Blynk can be accessed through the mobile app available for Android and iOS, as well as through a web dashboard in a browser. By using the mobile app, the system can be monitored and controlled from anywhere as long as it is connected to the internet. The web dashboard provides a larger interface, making it easier for detailed configuration and monitoring. Both platforms offer flexibility in managing and monitoring the automation system in real time.

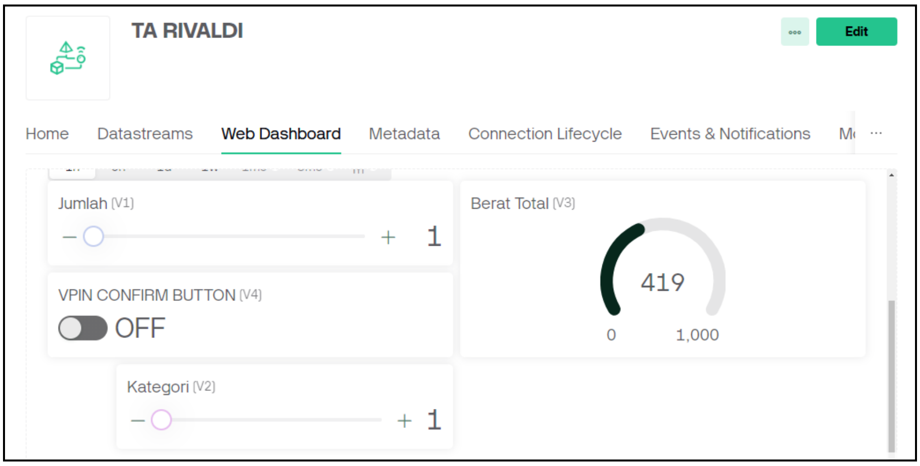

Figure 3. Dashboard display of the Blynk platform

RESULTS AND DISCUSSION

The analysis consists of testing the load cell sensor device, servo, and testing integration with IoT platforms. The test is compared with a device that is considered valid and the accuracy of each sensor device is analyzed with the equation (1).

$$Acuration(\%) = \frac{Values\ of\ sensors - Values\ of\ valid\ sensors}{Values\ of\ valid\ sensors} \tag{1}$$

1. Load Cell Sensor Testing

The analysis consists of testing the load cell sensor, potentiometer, servo, and overall system testing. The tests are compared with devices considered valid and the accuracy of each sensor device is analyzed using equation (1).

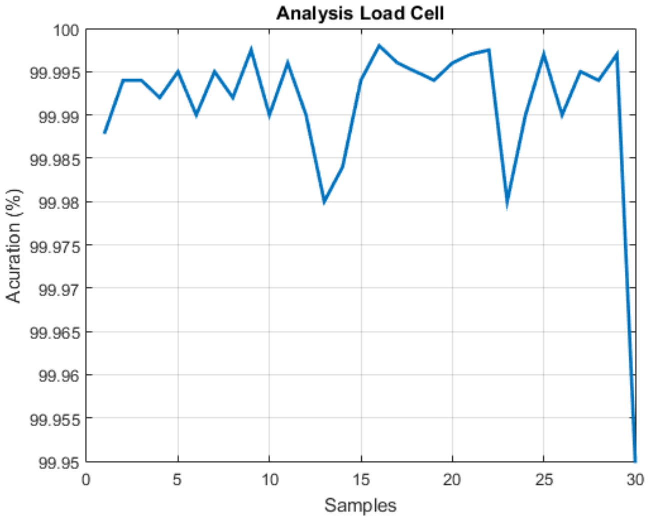

Figure 4. Acuration of Load Cell

Based on the test results of the Load Cell weight sensor in Figure 4 with various small objects and Figure 5 with Maggot weight, the average accuracy obtained was 99.9%. This result indicates that the difference between the weight measured using the Load Cell sensor and the weight measured using a digital scale is relatively small. This suggests that the Load Cell sensor can be relied upon to measure weight with good accuracy in the implementation of the automated chicken feeding system. This precise performance is crucial to ensure that the amount of feed provided matches the chickens' needs, thereby supporting the efficiency and effectiveness of the system.

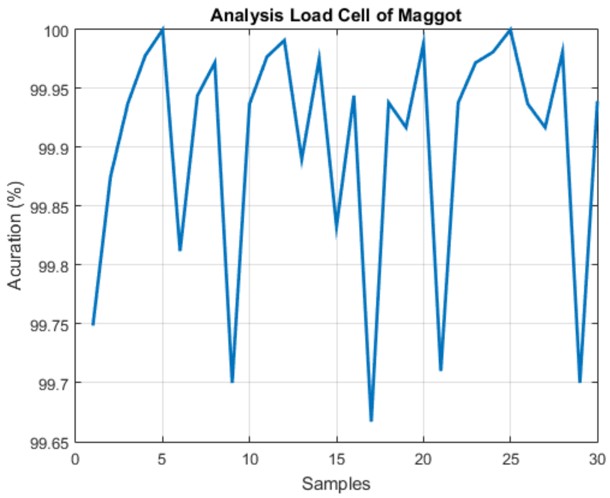

Figure 4. Acuration of Load Cell for Maggot

2. Servo Testing

The servo testing aims to evaluate the accuracy and precision of the servo motor in reaching a specific angle, compared to the angle measured using a protractor. This test is crucial to ensure that the servo motor can be controlled accurately, as required for the desired application in the automatic poultry feeding system.

Table 3. Result of Servo Testing

No	Servo Degree	Protactors Degree	No	Servo Degree	Protactors Degree

1	0	0	16	150	150
2	10	10	17	160	160
3	20	20	18	170	170
4	30	30	19	180	180
5	40	40	20	15	15
6	50	50	21	25	25
7	60	60	22	35	35
8	70	70	23	45	45
9	80	80	24	55	55
10	90	90	25	65	65
11	100	100	26	75	75
12	110	110	27	85	85
13	120	120	28	95	95
14	130	130	29	105	105
15	140	140	30	115	115

Based on the results of the servo testing in Table 3, comparing the servo angle with the protractor angle, it was found that the difference between the two angles is very small. The average error or deviation observed is less than 2 degrees. This indicates that the servo performs with high precision in following the given position commands. This accuracy is crucial in the automatic poultry feeding application, where precise servo positioning is required to distribute the feed in the correct amounts.

3. Testing of Monitoring and Control Results with Blynk

The purpose of this test is to evaluate the accuracy and responsiveness of the Blynk monitoring and control system in the automatic poultry feeding device. The test is conducted to ensure that inputs from the chicken count slider, the confirmation button for the chicken count, and the chicken category slider produce the correct output on the total weight gauge.

Table 4. Result of Blynk

No	Number of Chickens	Confirmation Button	Category	Total Weight Gauge.
1	2	On	1	40
2	3	On	2	120
3	4	On	3	240
4	5	On	4	450
5	1	On	1	20
6	2	On	2	80
7	3	On	3	180
8	4	On	4	360
9	5	On	1	100
10	6	On	2	240
11	7	On	3	420
12	8	On	4	720
13	9	On	1	180
14	10	On	2	400
15	1	On	3	60
16	2	On	4	180
17	3	On	1	60
18	4	On	2	160
19	5	On	3	300
20	6	On	4	540
21	7	On	1	140
22	8	On	2	320
23	9	On	3	540

24	10	On	4	900
25	1	On	1	20
26	2	On	2	80
27	3	On	3	180
28	4	On	4	360
29	5	On	1	100
30	6	On	2	240

Monitoring and control testing using Blynk showed that the system was responsive to every user input, such as the chicken number slider (1-10), the confirmation button, and the chicken category slider (1-4). Every change in Blynk was directly reflected in the system with high accuracy, especially in calculating and displaying the total weight of feed on the gauge. These results confirm that the use of Blynk in controlling the automated feeding system runs as expected, supporting operational efficiency and reliability.

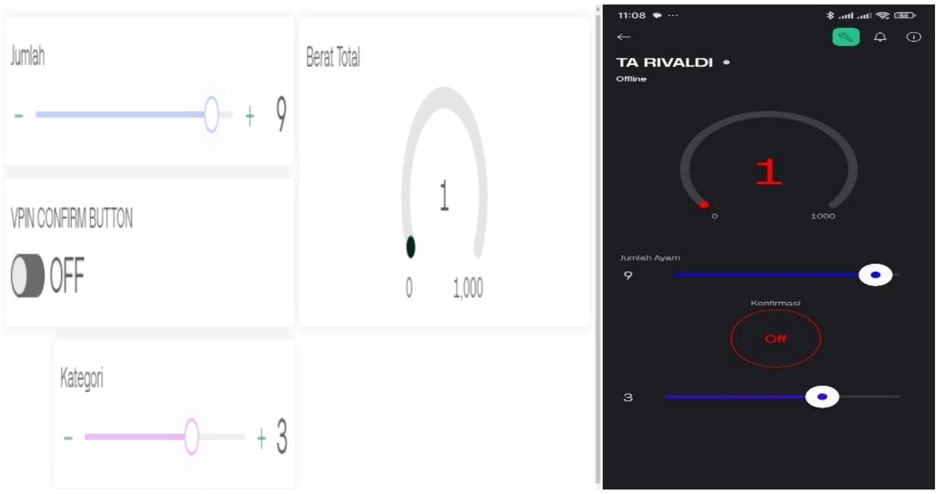

Figure 5. Dashboard of Blynk

CONCLUSION

Based on the results of the analysis test, the control and automatic system can be applied to feed Chicken with Magot. The Load Cell Sensor provides a good 99.9% performance for weighing the mixture of pur and Magot. The servo to open the pur and Magot containers can work 100% in opening the feed. The integration of the Blynk IoT platform with the device can work well. This research can be developed by utilizing more complete IoT features.

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