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A Prototype Platform for Automated Chicken Feeding Control with an Embedded System

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ABSTRACT

In this paper present a prototype platform for automated chicken feeding control with an embedded system. This prototype is an automated real-time chicken feeding mixing system that will help chicken farmers become more automated, which will be highly beneficial for the expansion of the chicken poultry farm in Phra Nakhon Si Ayutthaya, Thailand. This machine may take the role of a person in the chicken-feeding process, solving the farm's labor shortage. The apparatus for feeding chickens makes use of an Arduino Uno board as the heart of an embedded system controller. The two major components of this device are an Arduino that controls the servomotor opening for the food container and another Arduino that controls the servomotor opening for the food ingredients in a mixed food container. The prototype platform will have an alarm when the food ingredients are at the minimum quantity. This also helps the chickens get the amount of food and nutrients that are appropriate for their age while reducing labour costs, saving food, and controlling chicken feeding on time.

1. Introduction

The foundation of a sustainable economy is agriculture. It is crucial to long-term economic prosperity, Agriculture used to be only concerned with growing crops and producing food [1]. However, it has changed during the past years to include the processing, production, marketing, and distribution of crops and livestock products. Chicken is the only type of poultry that has a high commercial value because the need for chicken meat is very large. Chicken farming is one of the agricultural activities that has significantly contributed to Phra Nakhon Si Ayutthaya provincial development through employment creation and the improvement of nutrition and food. Currently, agricultural activities serve as the basic source of livelihood, enhancing GDP. There are various issues in the poultry farming sector that require resolution. Hand feeding and automation may be classified into two categories when comparing the conventional method of feeding chickens to modern automation. The chicken business is one of the key sources of protein for human consumption since the primary production of meat and eggs in poultry management is essential. A manual feeding schedule presents difficulties for managing production costs effectively in chicken farming. The cost of production in poultry management could be traced to the expenses of feeding is

75% [2]. It has been demonstrated that there is a direct relationship between the high cost of chicken farming and the participation of people in this agricultural system. This has led to a significant rise in the overall cost of labor for this farming technique [3].

Previously, breeders sowed food on the ground and cause the food to be contaminated by feces and insects. It may cause the chicken to consume unwholesome food that is prone to germs and bacteria, which may result in a chicken with an unhealthy comb, eyes, beaks, hackles, feet, and spurs. Additionally, sick chicken has no appetite, which prevents it from consuming enough nutrients and ultimately leads to death. Food should be stored in a container that protects it and preserves its freshness during the period between feedings. While providing chicken that is not wholesome and nutritious, excess food that has been exposed to dirt and mixed with soil has resulted in a variety of losses. To prevent food waste, a sufficient fixed amount of the grains needed for chicken must be identified and effectively handled.

The current system still lacks an autonomous chicken feeding system even though a solution for monitoring and regulating poultry farm operations and environmental conditions is available [4]. As a result, a system for an autonomous chicken feeder is suggested and created in order to provide the food efficiently and manage chicken feeding time. This system offers a practical alternative for hassle-free automated feeding and a sufficient amount of food to fulfill demands [5]. The desired time can be specified by users and saved to an embedded system. As a result, even when they are away from home, the chicken feeder will feed the chicken automatically and on time.

This paper presents a prototype platform for an automatic chicken feeder system that offers the right amount of feed ratio for the needs of the chickens with an embedded system. This section provides and overview of necessary knowledge on real-time automatic system using Arduino. The section begins with a brief description of mechanism for feeding poultry concept, various poultry feeding methods and related work in poultry feeding system.

A. Mechanism for feeding poultry concept

Raising domesticated poultry like chickens, ducks, turkeys, and geese with the intention of producing meat or eggs for human use is known as poultry farming. Every year, around 50 billion chickens are grown for food. There have been several initiatives to lower the high capital costs connected with poultry farming operations, which discourage investors from expanding their businesses [6]. Over-involvement of humans in poultry feeding systems can result in illness occurring, excessive exhaustion, and deficient diseases in the poultry [2]. Prior to the invention of automatic feeder technology, humans had been accustomed to manually filling containers with grains and other items to feed chickens. The biggest issue with this approach is that breeders must constantly offer food while also being aware of any food that may be left in cages. Since there is a lot of waste, it is impossible to accurately estimate how much food is delivered. Breeders also struggle to efficiently run their businesses since they frequently need to visit the cages to check on the animals. Feeding apparatuses come in a variety of designs that differ from nation to nation. Regardless of the method of design, the guiding principles in feeder design are that it must be simple to small/medium scale poultry farms, fill and clean; built to avoid waste; positioned so that birds cannot roost on them and constructed with durable materials in such a way that the birds will be able to reach it as long as it contains feed with adequate feeding space.

B. A various poultry feeding method

A machine or control system designed to automatically carry out a predefined sequence of tasks or respond to predetermined instructions, as well as a machine or control system that runs

independently, are both examples of automation [7]. The poultry will be able to access the feed with enough room to consume as long as they contain any grain at all. Such a system is created to prevent waste, is easy to fill and clean, is placed so that poultry cannot roost on it, and is built of durable materials [8].

Because it takes longer to go from a massive flock to the feed store, more work may be required. It was necessary to mechanize the feeding in chicken farming, which led to the invention of automatic feeders, to eliminate the constant involvement of anybody to refill the feeder on the farms. With larger flocks than smaller ones, mechanical feeders demand less yearly labor and a cheaper investment per 100 chickens. The average yearly work for hand-feeding systems steadily reduces as flock sizes increase. But the average investment in hand-feeding methods is mostly unaffected by the flock's size. The goal of this project was to create a mechanically operated automated feeder that would reduce labor requirements and feeding time for backyard hens and small- to medium-sized poultry farms. The most cost-effective technique of feeding may be demonstrated for each flock size when labor and equipment expenses are added together [2] [9].

C. Related work

K. A. Sitaram, et al., [10] , present robots on meat poultry farms utilizing Internet of Things technology to achieve various impacts of connect function. Household responsibilities including diet, water monoxide force system and cleanliness are maintained, along with environmental aspects like temperature, sultriness, bulbs, and gas that have an effect on people's health. If all of these restrictions are satisfied, however, the danger and quality of the funk rise. Accordingly, methane gas, which is formed from stinky ordure and stored in batteries, is used to create power. A web-based solution may also be used for farm management and monitoring. A meat farm business can be found below, wherever and whenever.

In research provided by Md. Mahfujul Islam et al., [11], the authors aimed to give a concept of a self-employed poultry farm that included essential components like the provision of dry food, the provision of liquid water, the accumulation of eggs, etc. Additionally, it was noted that each component was repeated in a highly consistent manner when an archetype was displayed that described each facet of the task indicated above and from the archetype.

Muhammad Faiz Haji Hambali et.al., [12], presented a technique for manufacturing salted birds and reducing chicken mortality rates brought to the inadequate management and care of poultry farms. They feel that effective leadership and productivity are precisely the same as constant monitoring. IoT components are used in the system's implementation to provide it the ability to interact with sensors automatically. After a detection, the system installs an alert message and sends it to the user via text messages and Whatsapp. The web interface is designed to monitor these results.

Adenilson Mumbelli et al., [13], the methodology put out in this article combines hardware and software to keep track of and manage all the hardware-related parameters needed in the project. Through a smartphone app, remote access is used for all of these tasks. Temperature value and actuators are the project's parameters.

Haytham M. Dbouk et al., [14], the writers of this work have briefly covered temperature control systems used in chicken farms. They make an attempt to adjust the poultry shade's temperature to the situation. And it has been discovered that maintaining the ideal temperature is quite difficult. The authors thus suggested an IoT-based temperature control system utilizing a DHT11 sensor to get around this, which will save the owner of a chicken farm time and money.

A strategy for raising a strong, robust chicken is presented by P. Jayarajan et al. [15]. Chickens farm products use (WSN) technology to monitor and control temperature, humidity, air freshness, and food supply, which speeds up the death of poultry and enhances poultry output (IoT).

2. Materials and Method

This paper involves designing and building a prototype platform for automated chicken feeding control with an embedded system. This indicates that the machine's fundamental design is to be able to autonomously feed the chicken at predefined intervals and in predetermined amounts. Furthermore, able to control a feeder system that offers the right amount of feed ratio for the needs of the chickens during feeding time by using an embedded system controller. The hardware, software implementation and evaluation of the system are all covered in this section.

A. Hardware implementation

Traditionally, feeding the hens by hand requires the presence of human beings. The suggested design provides a time-adjustable automatic chicken feeder without the need for additional labor at each feeding interval. Figure 1 displays the first design concepts for the automatic chicken feeding system.

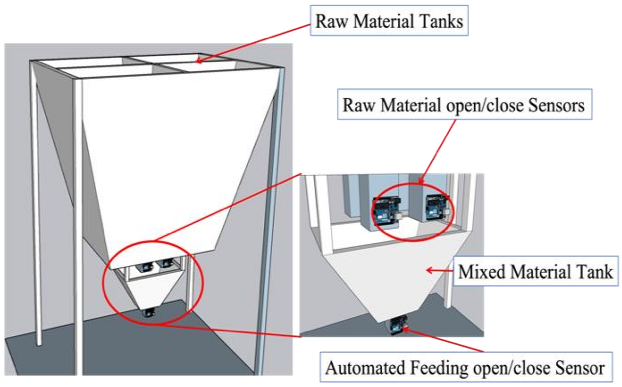

Figure 1. Model concepts for automatic feeding

This paper consists of four main hardware components such that:

1. The raw material tanks are divided into four compartments for storing a row material consisting of soybean meal, corn meal, fish meal and rice barn.

2. Arduino Board, servo motor and delay are controls to open/close raw material into mixed material tank.

3. A mixed material tank is used to mix the released raw materials to prepare for the next feeding of the chickens.

4. The Arduino Board, servo motor and delay are controlled by a sensor to an automated chicken feeding open/close sensor.

B. Software implementation

In this paper, the Arduino libraries and programming software will be used. The Arduino name refers to the main software used to program the Arduino microcontroller's system. It is open-source software that can be easily coded in C++ and is available for free download from the Arduino website. Figure 2 depicts the whole flowchart procedure for an automatic chicken feeder project.

The objective of this project is to automatically feed raw materials to mix for the feeder to chickens while the machine is being controlled by an Arduino UNO. The Arduino activates the servo motor every day during the morning at 08.00 AM and afternoon at 05.00 PM hours. The raw material will fall automatically into the mixing tank for mixing at the scheduled time for feeding the chickens. The on-off sensor control is set to rotate 180 degrees to open the valve in the corn meal material tank, rotate 135 degrees in the rich barn material tank, rotate 90 degrees in the soybean meal material tank and rotate 45 degrees in the fish meal tank. Then the raw materials will fall into the container for mixing chicken food. This servo motor delays the time for the raw material to settle before the return valve is closed. The open/close sensor control is set to rotate for open the valve. Then the raw materials will fall into the container for mixing chicken food. This servo motor delays the time for the raw material to settle before the return valve is closed. When the raw materials are in the mixing tank, the system will mix the ingredients together. The open/close sensor control opens the valve to allow the food to continue into the feeding container for the chickens.

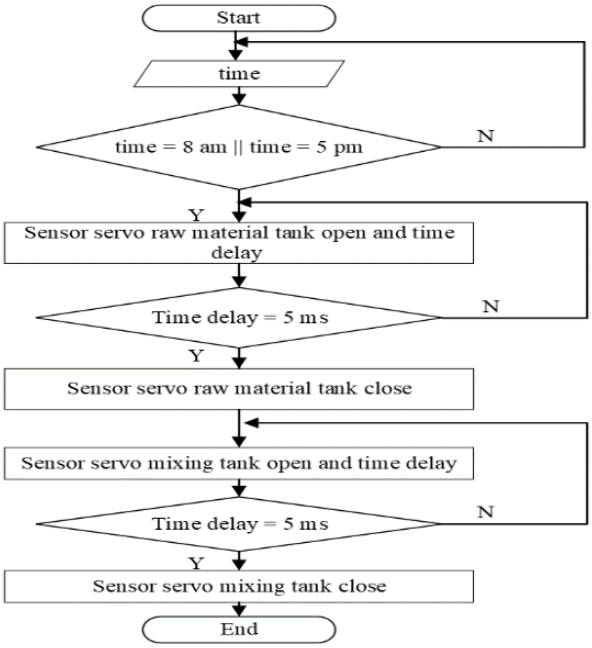

Figure 2. Flowchart of program implementation

C. Evaluation of a prototyped platform

This paper is to design and build a prototype platform for automated chicken feeding control with an embedded system. This chicken feeder can be operated which can be turned on/off the system and can be set to work time. Therefore, the percent Error and the Accuracy index are used for performance monitoring.

The basic equations are used to determine the percent Error as shown in Equation 1 and the Accuracy can be obtained according to Equation 2.

$$\boldsymbol{Error} = \left[\frac{(\boldsymbol{Xt}-\boldsymbol{Xn})}{\boldsymbol{Xt}}\right] \boldsymbol{x}\ \boldsymbol{100} \quad (1)$$

Where:

$\boldsymbol{Xt}$ is the total number of tests.

$\boldsymbol{Xn}$ is the number of times for the machine work.

$$\boldsymbol{Accuracy = 100 - Error} \quad (2)$$

The four of raw material ingredients provide different amounts of protein as follows corn meal ingredient provide 8% protein. A rich barn raw material ingredient provides 12% protein. A soybean meal raw material ingredient provides 44% protein. A fish meal ingredient provides 55% protein. The basic formula for calculating the protein from four types of raw material can be shows as Equation 3.

$$\boldsymbol{Protien = \sum_{i=1}^{4} Q_i * P_i} \quad (3)$$

Where:

$\boldsymbol{Q}$ is the quantity of raw material.

$\boldsymbol{P}$ is the quantity protein of raw material.

The example of calculate for ingredients of 1 kg of chicken feed to get the protein content of not less than 21%. The mixing of chicken feed to obtain the required amount of the proportion of the material consisting of corn meal 400 g (Protein = 0.4 * 8 = 3.2), rich barn 300 g (Protein = 0.3 * 12 = 3.6), soybean meal 200 g (Protein = 0.2 * 44 = 8.8) and fish meal 100 g (Protein = 0.1 * 55 = 5.5). The total of calculate protein is 21.1% (3.2 + 3.6 + 8.8 + 5.5) which the number of needs is not less than 21%.

3. Results and Discussion

In this section, the proposed prototype platform on two folds is analyzed. The first fold is the functional test by adjusting the sensor servo speed. The second fold is machine performance test. Figure 3 shows a prototype platform for automated chicken feeding control with an embedded system.

Figure 3. A prototype platform

A. Function test

The functionally for this test and it has two feeding times, morning at 8.00 AM and afternoon at 5.00 PM which automatic on/off feeding time delay 5 milliseconds. Form the functionally test, if the material feeding time control is 5 milliseconds, the sensor servo motor switch can be close. The servo motor control concludes four motors. The researcher tested the efficiency of the machine with servo rotates degree of four raw material. Table 1 shows the experiment result of time for function test.

Table 1. Experiment result of time

No	Servo rotates degree			
	Corn meal (180)	Rich barn (135)	Soybean meal (90)	Fish meal (45)
1	✓	×	✓	✓
2	✓	✓	✓	✓
3	✓	✓	✓	×
4	✓	✓	✓	✓
5	✓	✓	✓	✓
6	✓	✓	✓	✓
7	✓	✓	✓	✓
8	✓	✓	✓	✓
9	✓	✓	✓	✓
10	✓	✓	✓	✓

Table 2. Accuracy values of the chicken feed

Raw material tank	Number of times	Number work accurately	Error (%)	Accuracy (%)
Corn meal	10	10	0	100
Rich barn	10	9	10	90
Soybean meal	10	10	10	100
Fish meal	10	9	10	90

Table 2 shows a summary of the accuracy of the performance test of the prototype platform chicken feeding control with an embedded system. The result was found the sensor of corn meal and soybean meal raw material can be opened servo rotate degrees with an accuracy of 100%. The sensor of rich barn and fish meal raw material can be opened servo rotate degrees with an accuracy of 90%. Because the axis of rotation of the servo is not 90 or 180 degrees, this may cause the rotation to distort.

B. Machine performance test

The researcher tested the efficiency of the machine with at least 21% protein for 1 kg of chicken feed. The mixing of chicken feed to obtain the required amount of the proportion of the material consisting of corn meal 400 g, rich barn 300 g, soybean meal 200 g and fish meal 100 g. Table 3 shows the test results of the raw material discharge volume of the machine.

Table 3. Performance result of amount of raw material

No	Amount of raw material (g)			
	Corn meal	Rich barn	Soybean meal	Fish meal
1	410	305	207	105
2	400	300	200	100
3	403	300	200	100
4	400	302	203	102
5	400	300	200	100
6	402	300	200	100
7	400	300	200	104
8	400	304	200	100
9	400	300	200	100
10	400	300	200	100

Table 3 shows a performance of amount of four type raw materials. The result was found the servo controls are able to release the amount of raw material that meets the requirement with corn meal not

less than 400 g, rich barn not less than 300 g, soybean meal not less than 200 g and fish meal not less than 100 g. The first round of raw material discharge results is the largest due to the density of raw materials stored in the storage tanks.

4. Conclusion

In this paper, we present a prototype of a platform for automatic chicken feeding control with an embedded system that is successfully implemented using an Arduino microcontroller system. Concisely, because the automatic chicken feeder project is totally automatic, it can minimize the amount of labor required to feed the hens. The owner does not have to pay monthly labor costs to feed the hens. By putting into practice this idea of automatic feeding, it is possible to optimize the feeding time so that the feeding plan is more effective and the feeding time is completely automated, which may be helpful for the owner while they are away from their home. The goal of this project is to decrease labor costs and food waste for breeders working on small or medium-sized chicken farms during feeding time. Furthermore, food hygiene is ensured to keep the hens healthy throughout feeding time. With the help of an automatic chicken feeder, food contamination may be avoided. In future work, we implement a chicken behavior detection system using artificial intelligence to prediction chicken health and calculated weight for enable the device to automatically calculate food requirements for feeding.

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