Real-Time Monitoring System for Tracking and Identification of Poultry Based on RFID

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Abstract

Poultry is an important food resource that provides protein essential for human survival. In particular, in developing countries, poultry breeding not only solves the food problem but also serves as a basis for economic activity. For this reason, the management of poultry is an important issue. In this study, we propose a poultry tracking and identification system using IoT. It is possible to monitor poultry in real time through the proposed system. The system is divided into two main parts. The first part is the part that works by attaching a sensor to the poultry. The sensor embeds individual information about each poultry, which is then used to identify the poultry. The second part is an IoT device that can read information from sensors mounted on poultry. The device senses poultry information to perform tracking and identification. In addition, the sensed information was implemented to be transmitted to the IoT analysis server for real-time monitoring. Field tests were conducted through farmers, experts, and agricultural organizations to verify the manufactured system. As a result of field test verification, it was found that poultry real-time monitoring and identification worked well.

Keywords— IoT, monitoring, poultry, RFID, tracking

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1. Introduction

Many poultry farms raise chickens and ducks for commercial reasons. Poultry meat is the main food produced through the use of free farms or specialized agricultural techniques. For this purpose, night wells, organic spawning systems, cages and lighting systems are used. Many domestic farms raise chickens and ducks in different environments. In the case of chickens, individual chickens are often raised in cages, and in the case of ducks, they are raised by release. In the case of release and rearing, it may be bred together with other animals. When poultry is raised by release in this way, a system that can track and identify

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chickens is required [1-3].

Poultry raised on farms includes chickens, ducks, geese, and turkey. Among them, there are more than 200 species of chickens. Currently, chickens that have been modified for meat/eggs are mostly used. Since the 1950s, breed improvement through selective breeding has greatly increased the size of chickens and improved feed efficiency. Among them, chicken breeds can be divided into pure commercial breeds, hybrids resulting from crossbreeding, and regional breeds. In particular, commercial varieties can be roughly divided according to their main production goals. It can be divided into mainly light-laying breeds or layered breeds, and mainly heavy breeding breeds or meat-producing breeds by broilers [4-6].

According to domestic livestock statistics in 2019, 3.16 million Korean cattle, 1,164 pigs, and about 150 million chickens were raised. As you can see from the statistics, many farms raise a lot of poultry such as chickens. Similarly, poultry farming is the most active in the world. Poultry meat, which can produce a lot of meat at low cost, plays an important role in tackling poverty in developing countries. About 150 million chickens are bred in Korea, and about 10 million ducks are bred. In particular, in the case of ducks, many breeding farms are irradiating about 1,000 ducks. Many farms that are irradiated spend a lot of time and resources for the safety of chickens and ducks. This is because they receive a lot of damage from external animals and theft due to the breeding environment. It is necessary to introduce poultry tracking technology in order to operate the farm efficiently and control the poultry. Although it can be costly to introduce such a poultry tracking technology, we want to build an efficient system while minimizing the cost by using the latest IoT technology [7-9].

Poultry farms around the world raise chickens in different environments. As such, poultry is an important animal in almost all countries. Poultry is an important source of animal protein among human food elements. Such poultry can be reared in various environments such as cay and grazing. As such, poultry breeding has become an essential resource for human life. The main goals of many farms are generally the same. We aim to achieve maximum production at minimum cost, and we want to take minimum risk. As such, successful poultry companies need a reliable market for their products. For this, a system capable of managing and monitoring poultry is absolutely necessary. In this study, we intend to build a poultry management system using IoT and provide it to the farm [10,11].

2. Related Works

2.1. RFID Tag

RFID refers to a technology that recognizes information from a long-distance using radio waves, that is, electromagnetic induction [10.11]. Instead of reading barcodes using light from a short distance, RFID is a technology that uses radio waves, and can be read from a long distance and can even receive information through objects in between. It is a technology that embeds all information from production to sales into an IC chip so that it can be tracked by radio frequency. Although RFID is being used in many places recently, it is typically used in books in libraries, things in marts, or in warehouse organization. Figure 1 shows an RFID

tag.

Fig. 1: Example of RFID tag

RFID tags are divided into three types of tags based on power. Passive type that reads and communicates chip information only by power, the tag has a built-in battery, so the power is used to read the chip information and the reader's power is used for communication. All of them have active tags that use the tag's power.

Passive tags have a semi-permanent lifespan because there is no power supply. However, a reader with a simple structure, low cost, short read distance, only reading and high power is required. Semi-passive tag is a tag with its own power added to passive tag to solve short recognition distance, which is a disadvantage of passive tag. It is possible to add a sensing function by attaching an additional sensor using the power of the semi-passive tag, but unlike the active tag, it cannot generate an RF signal by itself, so it has a short recognition distance of 10~30m compared to the active tag. - The active tag can be used for up to 10 years by using the built-in battery, and memory of various sizes is possible, and it is possible in a wide range of 30~100m [12,13].

2.2. RFID Reader

RFID reader consists of RF Signal Generator, Microcontroller and Receiver/Signal Detector that generates RF signals. Figure 2 shows an RFID reader. In addition, there is a handheld

reader and there is an RFID door type that can be seen at the entrance of a mart, and there are various shapes and sizes. RFID tag is composed of Transponder and Rectifier circuit, Controller and Memory that receives radio waves from Reader. RFID tags are also classified by the frequency of radio waves used for communication instead of power. At a short distance, inductive coupling electromagnetic induction is used, load modulation is applied, and at a long distance, it is received through a back scattered signal, that is, an incoming signal. RFID tags are also classified by the frequency of radio waves used for communication instead of power [14].

Fig. 2: Example of RFID Reader

- LFID (Low Frequency Identification): RFID using low frequency is called LFID, which uses 125khz or 134khz and recognizes a short distance of about 10cm.

- HFID (High Frequency Identification): HFID uses 13.56Mhz and recognizes distances up to 1m

- UHFID (Ultra High Frequency Identification): UHFID uses radio waves in the 860Mhz to 960Mhz band and recognizes up to 10 to 15m.

3. Prior Study

Prior to designing the system, preliminary data analysis was performed. Preliminary data analysis was conducted by poultry raising farmers and related animal experts. For this purpose, a questionnaire was filled out and asked to farmers and experts. The survey was conducted a total of two times. The first was conducted for a preliminary study. In the survey, various sensors were suggested and recommended for tracking and identifying poultry. The second survey was conducted after the system was developed. Contents such as how effective the developed system is and which parts need to be modified were included. In addition, interviews were conducted at the same time to improve the system.

3.1. Loss of Poultry

The loss of poultry was identified through the questionnaire. In order to understand the loss, five farms were selected and intensively identified. The loss is divided into three major

categories and is shown in the figure. In Figure 3, the loss of poultry was divided into three groups: loss by external predators, loss by thieves, and unknown. The results show that theft occurred the most, followed by damage caused by animals outside the farm. In particular, it was found that in the case of occurrence by a predator outside the farm, it occurred late in the evening to early in the morning. In this case, the farmer is often late in identifying and unable to take action.

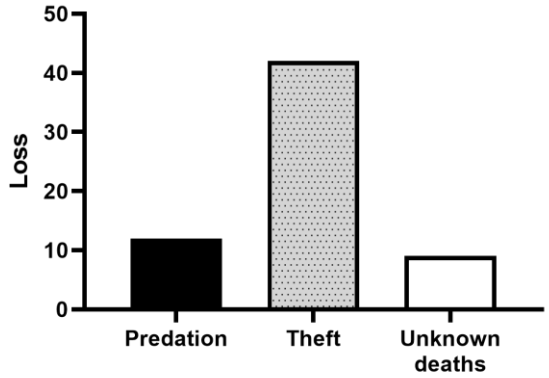

Fig. 3: Poultry loss of poultry in farm

3.2. IT technologies for farm

In the questionnaire, farmers were asked to choose IT that could prevent loss of poultry. Figure 4 shows the preferences for IT technologies chosen by farmers and animal experts. Many farmers and experts agree that IT skills are necessary, but about 47% do not choose specific skills. Next was CCTV at 31% and GPS at 22%.

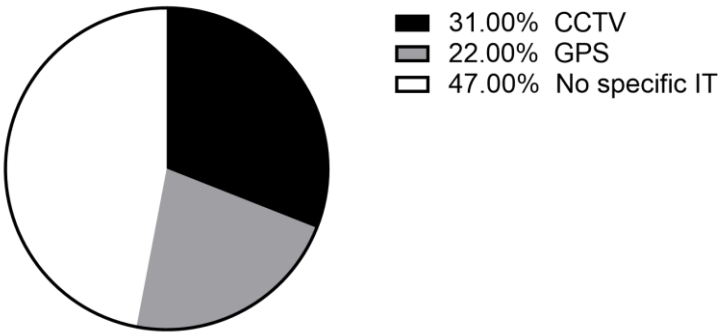

Fig. 4: IT technologies for farm

4. System Architecture

In this chapter, the poultry monitoring system proposed in this paper is proposed. This system reflects the contents of questionnaires from farmers and animal experts as much as possible. To monitor the poultry, the poultry is equipped with RFID. The reason for using RFID is that it can be manufactured in a size small enough to be used in poultry. The small RFID was mounted on the legs of the poultry and an Arduino board, which is often used to read

information, was used. The Arduino board is equipped with an RFID reader, and an Ethernet expansion board is used to transmit the information read through the reader to the server. The Arduino board was able to continuously transmit data by connecting it to a wired LAN through the Ethernet expansion board. It enables real-time monitoring by transmitting unique information to the IoT data server through RFID. Figure 5 briefly shows the structure of the system described above.

4.1. Embedded system with RFID reader

In order to configure the system proposed in this text, Arduino board and passive RFID reader, which are often used for IoT system configuration, were used. Several colored LEDs were used to check whether the system was operating or not. The manufactured system is connected to a wired network and transmits data read by RFID to the server. The upper left of Figure 4 shows a part of the configured system. The system reads data from the poultry's RFID tag, pre-processes the data, and sends it to the IoT data server. In this study, *ThinkSpeak* was used as the IoT data server. *ThinkSpeak* is widely used as an IoT data server and provides various protocols to collect IoT data [15,16]. In addition, a dashboard is provided for easy real-time monitoring.

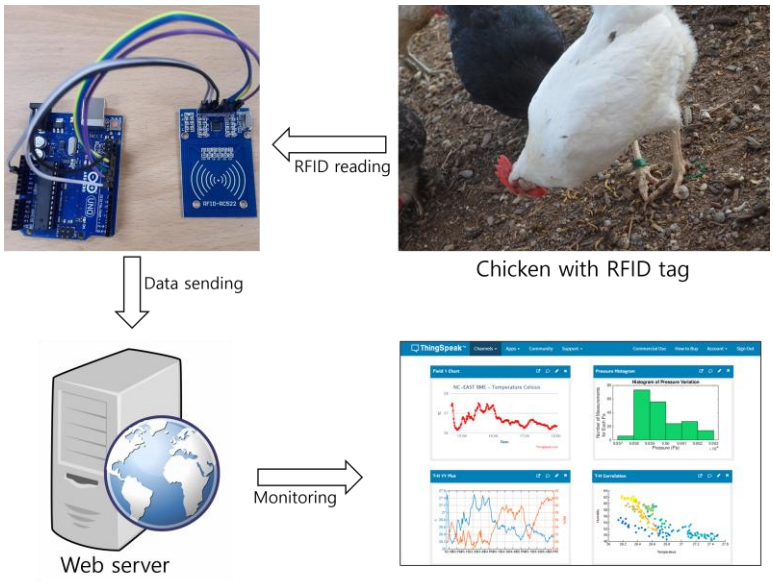

Fig. 4: System architecture using RFID tag

4.2. RFID Tagging

In the system, an RFID reader reads information from tags attached to the poultry's legs, and the embedded board processes the data and sends it to the server. Accurate data processing is required for the system to operate normally. That is, accurate data transmission must be performed between the RFID reader and the RFID tag. It should be ensured that tags mounted on the poultry's legs should be tagged on the reader. With this part, we need to increase the probability of tagging as much as possible because a person cannot do it manually every time. In order to increase the tagging probability, the system should be installed by understanding the breeding environment of poultry. Tagging can be done when the poultry is driven into a barn or other place in the evening to avoid being harmed by outside animals. In addition,

tagging can be intensively carried out when giving feed. Since the poultry raised by each farm is different, it is necessary to write a tagging scenario accordingly.

5. Test Results

An experiment was performed to check whether the system and components limited in this study operate normally. For the experiment, a prototype was made using an Arduino board. The prototype system includes an embedded board, an RFID reader, and an RFID tag mounted on the poultry. Data transmission/reception of RFID reader and RFID tag was tested. In addition, the data received from the reader is sent to the server after pre-processing and receiving and monitoring from the server is verified. In addition, small elements required for the system were also identified.

In the experiment, it was checked whether the manufactured prototype operates normally. In particular, each module was tested, such as an RFID reader and RFID tag module constituting the system. In addition, an experiment was performed to check whether the entire system in which each module is combined operates normally. In addition to the operation of the hardware system, it was also checked whether the data received from the RFID reader mounted on the Arduino device was abnormal.

Previously, hardware and software module unit experiments were described. In the integration test, verification was performed by binding the software module as a whole. For the first verification, the experimenter performed an experiment to read a number of tags with RFID without using poultry. The tag was read and the status was checked, and the data was transmitted to the server and recorded. These tag reading experiments are preliminary experiments for the identification of poultry. The reason for conducting the pre-experiment is that testing of data reception is difficult in the uncontrolled state of experimenting with tagging poultry.

The system used in the experiment was programmed according to the design criteria. An RFID sensor was used in the experiment, but an Arduino microcontroller was used so that various sensors could be used in the future. C language is used to control Arduino microcontroller. In addition, a database was used to confirm and store the normal reception of RFID tag data, and SQL was used for this. In addition, in order to check the data received from the web page, PHP was used to create a web page that can visualize the data stored in the database. In addition, an IoT analysis server was used to monitor the data received from the tag in real time at a remote location.

Table 1 shows the results of user testing the manufactured system. The test was divided into three groups. The experimental group was divided into general farmers working on farms, farm experts, and finally, farm associations. The first question was the tracking of poultry. Farmers and farm associations rated the poultry tracking as good, but the expert group rated it a problem. As a result of figuring out the problem, when two or more poultry pass at the same time as they move and pass an RFID reader, or when they jump and pass, sometimes it is not

recognized. The second question was the perception of poultry. It was confirmed that the satisfaction of the farmer was the highest, and the satisfaction of the expert and the farm association was low. In general, it was confirmed that monitoring is done using a computer, etc., that recognition is good when poultry is moving, but it was desired to visually confirm immediately. The third was satisfaction with system use. It was confirmed that the satisfaction of the experts was low. The reason was that the satisfaction was lowered while suggesting the need for additional functions rather than the basic functions of the system.

Table. 1: Result of field test using prosed system

	Poultry tracking	Poultry identification	Satisfaction
Famers	8	9	8
Expert	7	8	7
Farmers association	8	8	8

6. Conclusion

In this study, a system for tracking and identification of poultry using IoT equipment and sensors was proposed. Poultry is a valuable food resource for mankind, and management is essential. However, in the current farm, the system was operated only by manpower without using the latest IT technology. To solve this problem, we developed a poultry tracking/identification system that can be applied to farms using Arduino microcontroller and RFID sensor. The fabricated system has been shown to be applicable to farms through actual field experiments. In the future research, we plan to proceed in two major ways. The first is to modify the jumping dust of poultry. This problem occurs in the poultry recognition stage when the poultry jumps over the area with the RFID reader. To solve this problem, to improve the detection capability of the RFID reader, we plan to consider two methods of solving the system and modifying the moving path of poultry. The second is the problem of visual verification requested by the expert group.

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