A Study on the RFID based Livestock Estrus Detection System

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Abstract

The need for identifying the estrum cycle has been increased in livestock industry as it has the direct effect on productivity and earnings. If failed to detect in timely manner, it may cause a huge loss. In this study, RFID-based estrum detection system on a real-time using RFID tag is proposed. The system is to measure the frequency of approaching by cow to ox using RFID tag and when the frequency reached to certain level, it's considered estrum and notifies the users of the data using alarm service. Fertilizing in timely manner after detecting the estrum through this system is expected to improve the productivity and income of the farmers.

Keywords: *RFID, WSN, Livestock, Estrus, Detection*

1. Introduction

Enhancing the competitiveness of the farmers is a must to develop the livestock industry and particularly farmer's productivity improvement is very important [1]. Productivity is the key factor to determine the earnings and competitiveness and such detection system is absolutely needed. The system to detect the estrus has been far behind and to increase the earnings of the farmers, such detection system is necessary. Failure of detection in timely manner would cause the economic loss and impact on competitiveness. Despite of the studies on estrus detection system, detection is still mostly dependent on examination with naked eyes[2]. Existing examination with naked eyes is dependent on user's experience which causes a wide range of error and the detection would be possible when the user is available at the farm. Thus, RFID based estrus detection system is hereby proposed to deal with the problems[3, 4].

In response to the consumer's need in quality of livestock, history tracing is implemented using RFID tag on livestock. The proposed system is to measure the frequency of female's approaching to male using this RFID tag. The female during rut tends to approach to male and the frequency of approach is measured using RFID reader [5]. The female detected in estrus cycle is identified by RFID tag and the information is sent to the farmer on a real-time base.

This system would improve the accuracy, reduce the time to detect so as to save the labor and increase the pregnancy rate and economic gain. RFID tag system will not require additional cost for the farmers as well.

This paper is organized as follows. The related research section explains about the existing RFID system, and the system design section describes the proposed system structure and its system algorithm. The conclusion section would like to discuss advantages of the system and the future study direction.

2. Related Research

2.1. Livestock Estrus and Detection

In general, a weaning livestock begins estrus around 5 to 20 days after weaning livestock estrus duration for each varies, it is not easy to determine the exact fix optimum time of insemination [6].

Particularly for artificial insemination, much smaller number of sperms and smaller amount of seminal fluid are inserted comparing to natural breeding and the motility or surviving rate of sperms and surviving time in the reproductive organ of a sow are relatively low, so it is necessary to monitor estrus carefully for insemination at optimum time. However, due to difficulty with continued monitoring, a manager generally checks estrus of a sow two times a day through observation with a naked eye. This method requires much labor as well as high level of skills and rich experience, and has limitations in finding exactly when estrus began with only two checks a day and judging optimum time of insemination exactly because estrus begins mostly at dawn.

When artificial insemination takes place at optimum time even when detecting estrus, conception rate is low, which causes economic loss. Because of this problem, artificial insemination is conducted 2 to 3 times, but costs and labor involving this procedure are another factor of adding burden to livestock farms [7].

2.2. RFID Tag and Reader

RFID is the kind of auto identification using radio frequency such as bar code, magnetic and IC-card, and to deal with the problems with bar code and magnetic card, it identifies the data by radio using microwave or low frequency. It' the contactless system which identify the object at near and long distance and has the large storage space.

It also identifies while moving and multiple number of tags simultaneously. The advantage among others is semi-permanent service life and reusability[8].

Figure 1. RFID Tag Applied to Livestock

Figure 2. RFID Reader

2.3. Existing RFID System Applied to Livestock

Among RFID systems applied previously is u-pork uniform growth management system using u-IT developed by Gyeongsangnam-do Province and Bukyung Agricultural Cooperatives, which identified the data on feeding frequency and amount and weight using RFID. Such information gathered was used to diagnose the disease at early stage and deal with the disease[9].

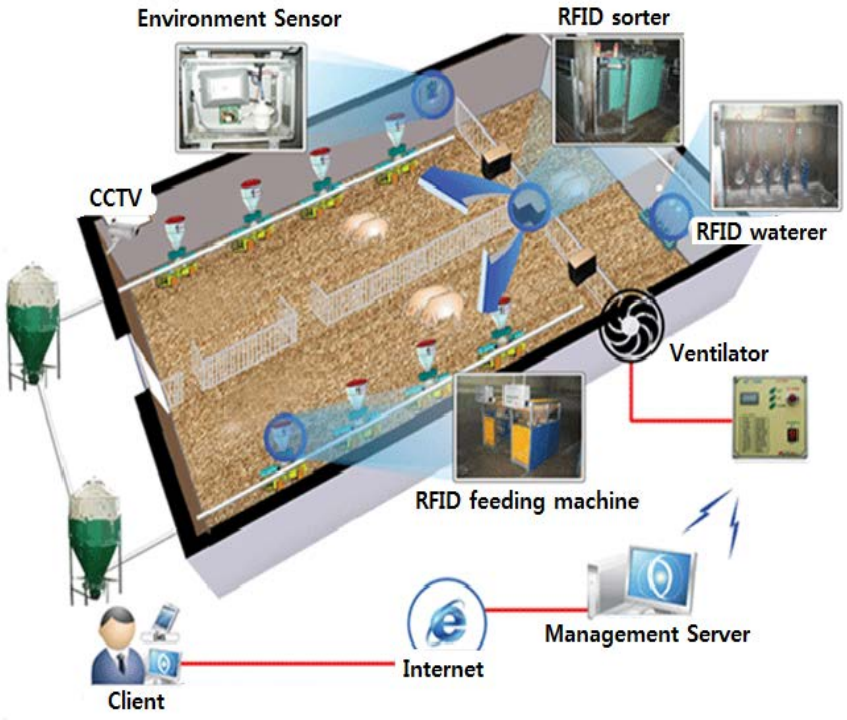

Figure 3. u-pork Uniform Growth Management System

A hog farm HACCP system based on u-IT technology developed by Jeju Province was used to sort out the pork and manage the shipping and history data. However RFID has yet to be used for estrus detection in Korea, but has been mostly applied to history tracing.

3. System Design

RFID-based estrus detection system proposed in this study is designed to identify RFID tags by reader to collect the information and transmit to the server for storage at database after reformatting. Database functions to store the information of identity at the table and management server located between the user and database is to determine the estrus.

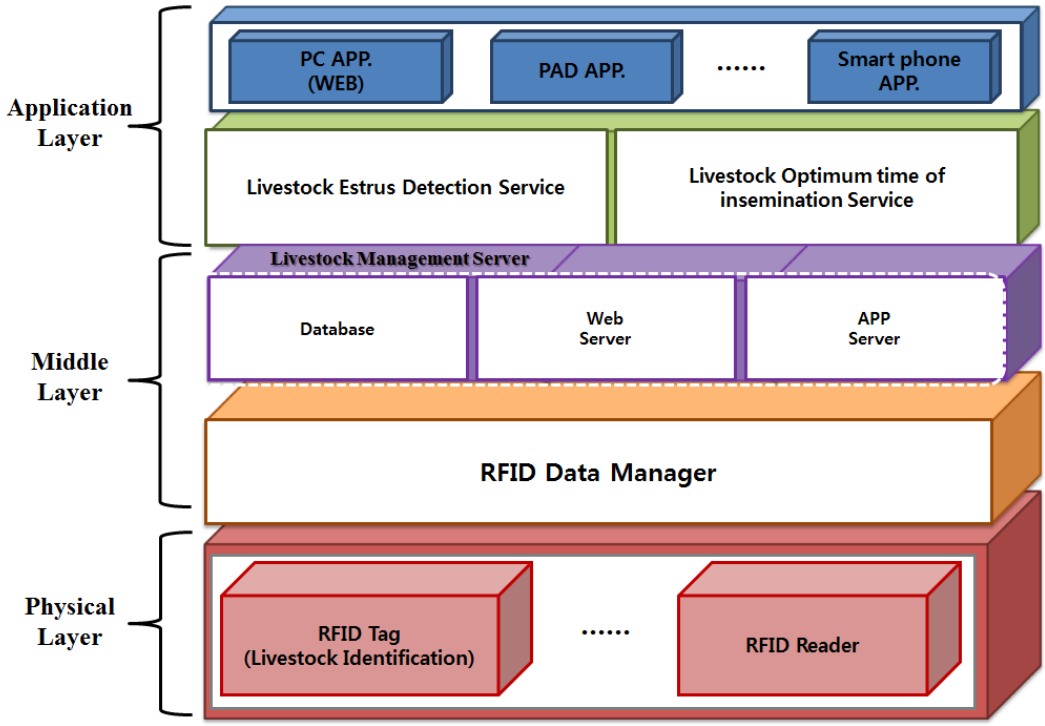

Figure 4. System Structure

The proposed RFID based Livestock Estrus Detection System consists of physical layer, middle layer and application layer, as shown in Figure 4. The physical layer consists of RFID Tag and RFID Reader for collecting livestock identification.

The RFID Date manager stores the information collected through the RFID Reader in the livestock management server database through storable format processing, measurable unit conversion and update inquiry of processed data.

The livestock management server plays the role of storing in each table the data collected through the RFID Tag and Reader, as well as the livestock identification data collected through the standard values for status notification. And livestock management server database store livestock identification and access number.

The livestock management server is located between the user and livestock farm database, and periodically notifies the user the data stored in the database. It automatically controls the corresponding estrus notification upon comparing the estrus standard values stores in the table and the status notification table, or comparatively analyzes the existing livestock estrus information stored in the database and the measured livestock estrus information to notify the producer in real-time of any values that exceed or fall short of the standard values through web and SMS notification services.

The application layer consists of application services that support various platforms such as laptop, web, PAD and smart phone and provides to users livestock estrus detection information service, livestock optimum time of insemination service.

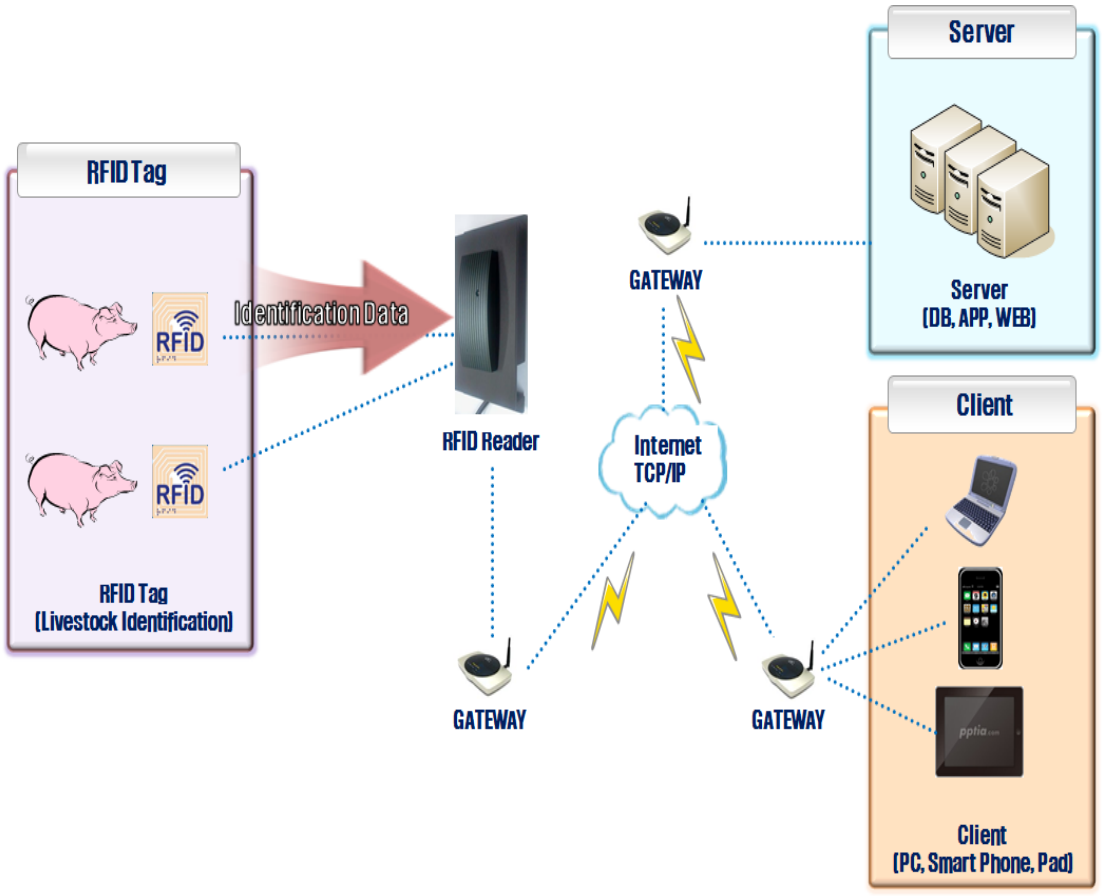

Figure 5. Proposed Livestock Estrus Detection System Configuration

The entire architecture of the RFID based Livestock Estrus Detection System is shown in Figure 5. This system consists of RFID Tag and RFID reader of detecting estrus, and data base of storing the collected data, management server of analyzing data. And PC and smart devices that can be used anywhere.

Estrus detection system is designed to measure the frequency of female's approach to male which are at stall. Livestock identification and access number data measured through RFID is transmitted to database, which stores processed data in database. Server compares collected data with data standard range of information; and when detecting estrus beyond the range, the system notifies situation to the user in real-time.

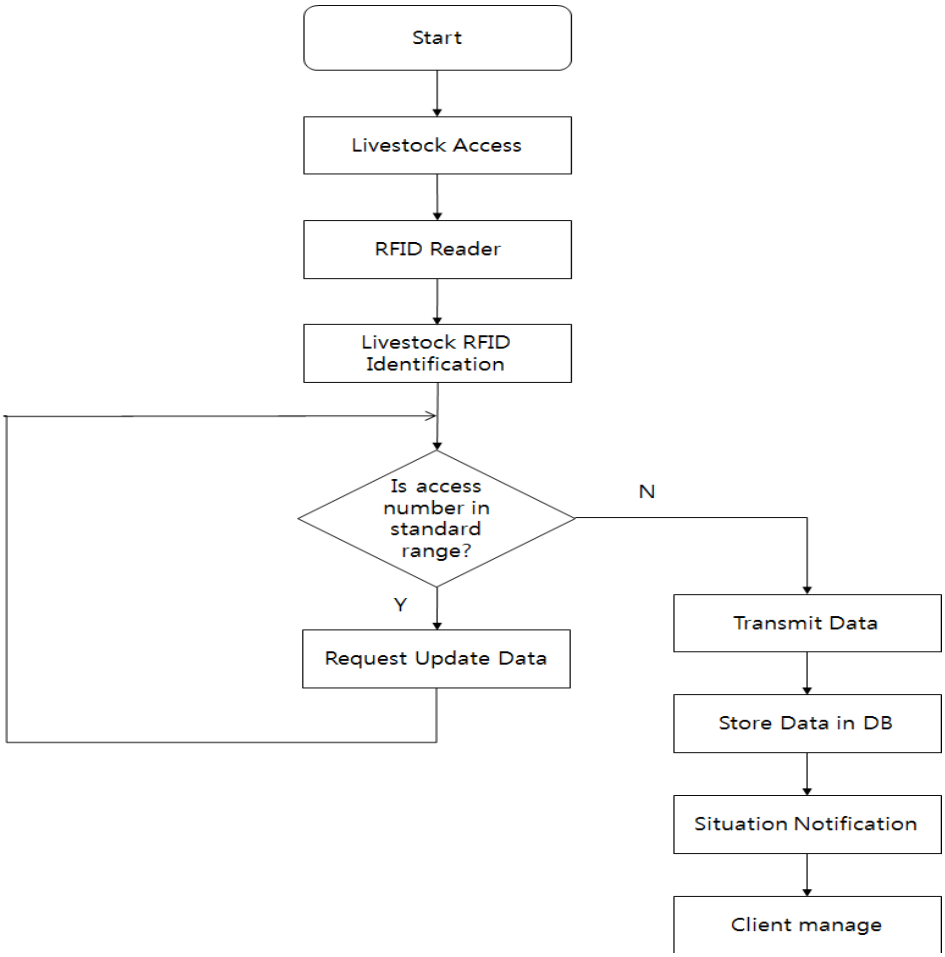

Figure 6. Livestock Estrus Detection System Algorithm

The RFID based Livestock Estrus Detection System operate as shown in Figure 6 Algorithm. RFID reader functions to identify the female approaching to male and notify the user when the frequency exceeded the certain level after storing the data at database. It transmits the activity measured through RFID administrator that conducted format processing and unit conversion of the transmitted data and the processed data is stored in the database. The information on identity is sent to the user on a real-time base so as to take proper measure in timely manner by the user.

4. Prototype

Figure 7 is the GUI providing to users, where ① is the menu to set the standard range of access number. ② represents the livestock individual classification ID and access number, its standard range and whether or not to be in estrus, and estrus time. ③ is graph, which represent the change of access number by date. ④ is the menu to inform the right time to fertilize by calculating time after detecting the estrus.

In case of prototype, the reader identified RFID tag directly by date. And detected once on February 8, detected the estrus by comparing the given reference.

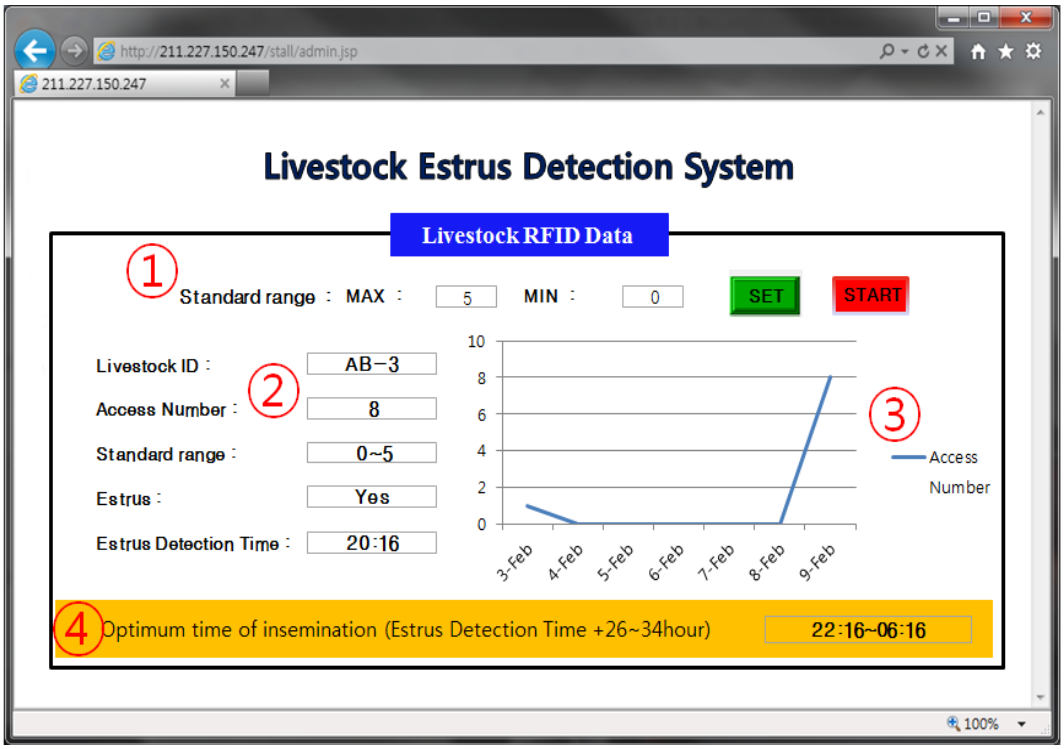

Figure 7. Prototype System GUI

5. Conclusions

Estrus detection system has been attracting the interest as part of the way to increase the productivity and earnings of the farmer. Many studies have been underway recently but the system to accurately detect the estrus has yet to be developed and behind compared to other advanced countries in livestock industry. To deal with such problems, it's necessary to develop the system for accurate detection. The system proposed in this study is expected to supplement the problems facing the domestic livestock industry by enhancing the accuracy as well as reducing the time. The system will also make commitment to increasing the productivity and earnings of the farmers and reducing the labor. Using RFID which has been previously applied to history tracing will ease the cost burden to the farmers and sharpen the competitiveness of domestic livestock industry.

The reliability of the system will be further improved by gathering more data in estrus cycle and the effort will continue to further develop the detection system which will be optimized to each livestock by kind.

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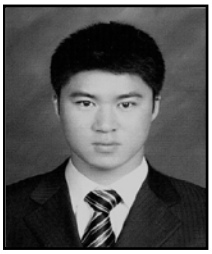

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