Design of Livestock Farm Integrated Control System

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Abstract - This paper proposes livestock farm integrated control system based on wireless sensor network. The conventional livestock farm control monitoring system based on the WSN realizes a higher value-added livestock farmhouse, however, it has a disadvantage that is difficult to carry out the integrated control of multiple livestock farmhouses by a system that could use for a single livestock farmhouse. Therefore, the proposed system stores the environmental information received from the individual livestock farm management server of the integrated livestock farm control system based on the distributed processing platform in a DB, carries out the integrated management and comparative analysis for the collected environmental information, and provides information on the integrated environmental information and the abnormal symptom of the livestock farm through the text service and the GUI of devices that could communicate when there is an abnormal symptom in the livestock farm. It could carry out the integrated management of individual livestock farm by applying the proposed integrated livestock farm control system based on the distributed processing platform, and could quickly cope with a dangerous situation of the livestock farm by informing it in real time when there is an abnormal symptom.

Keywords: WSN, Livestock, Distributed Framework

1 Introduction

The WSN(Wireless Sensor Networks) is a technology that deploys sensor nodes with computing and wireless communication capabilities to the application environment, forms a network autonomously, and then collects physical information acquiring from the sensor nodes by wireless to utilize it for the purpose of monitoring/controlling etc. The WSN technology has been applied through a variety of fields including defense, medicine, road transport, security, and realizes advancement of the living standard[1,2,3,4].

In particular, the agriculture field improves productivity and increases customer's reliability by utilizing the RFID/WSN technology to apply into production, shipment and distribution stages of agricultural products, and carry out the advanced enhancement of agriculture[5,6].

For the recent domestic livestock industry, its scale of breeding and the number of entities is increased to grow greatly in quantitative terms, however, it experiences difficulties due to the feed price advance caused by rising the international grain price, and it is unavoidable to have a head-to-head contest with the advanced livestock countries due to signing of the FTA. In particular, it suffered a vast damage by various livestock diseases such as the foot-and-mouth disease, AI etc., and it led to the increase of mortality rate to bring economic damages of livestock farmhouses[7,8].

In order to solve such problems of domestic livestock industry, studies have been actively carried out on the livestock farm environment monitoring and livestock disease forecasting system utilizing the WSN technology, and this system could increase productivity and produce high-quality livestock products by creating the optimum livestock breeding environment and reducing the mortality rate and the production cost[9,10].

However, the existing developed systems have been developed in terms of a single livestock farm to be difficult to carry out the integrated management of multiple livestock farmhouses, and there is a problem that the rapid initial reaction is difficult because the information on the disease could not been understood in advance when the livestock diseases occur[11].

Therefore, this paper proposes a livestock control system based on the distributed platform in order to solve these problems. The proposed system connects computers with peripheral devices distributed in multiple places via the communication networks, could construct the complicated information system rapidly through modularization of components, and provides user management, output management, environmental control based data management, notification event management and data output management. Thus, by carrying out the integrated management of multiple livestock farmhouses' monitoring system and sharing their information, the rapid reaction is possible when the livestock diseases or the abnormal symptoms of the livestock farm occur, so that it could minimize damages.

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This paper is organized as follows. Chapter 2, 3 and 4 describe the livestock control system's structure, service process and system implementation, respectively, finally, Chapter 5 finishes with a conclusion.

2 Design of the proposed system

2.1 System structure

The livestock control system proposed in this paper is based on the distributed processing system, and its structure is as the figure 1.

The livestock control system proposed in this paper is based on the distributed processing system, and its structure is as the figure 1. The overall system consists of environmental sensors collecting environment data in a livestock farm, sink nodes collecting them to transmit, and a control system providing control and various information with the collected data. The control system not only carries out the integrated management of data collected in real time but also analyzes the collected information to provide information on functions, which could keep the optimum environment through the environmental control devices in the livestock farm, and whether or not to be abnormal, and the component for supporting various application services to user's environment in the livestock control system is composed of 5 modules such as the user management, device control management, environment control reference data management, notification event management and data output.

The figure 2 shows the components and interface structure of the livestock farm control system. The user management module provides information on users managing each livestock farm, the environment data management module is one to carry out the integrated management of each livestock farm's environmental information, the environmental information reference data management module provides reference values for creating the optimum environment in the livestock farm, the notification event management module is one to inform each user via a communication method such as SMS etc. when the important event such as livestock diseases occurs, and the data output management module is an interface one to deliver information necessary to users and represent it on the screen through the GUI.

2.2 System process

Data is collected through the environment sensors installed in the livestock farm, and then the collected data values are stored in the DB, the livestock farm's environment is controlled as the optimum environment through the environmental control devices. At this time, the operating procedure of each component is as follows. The user management module distinguishes the corresponding user with the stored data, the data output management module instructs to output data to the GUI screen of the corresponding user, the environment control reference data management module analyzes whether the collected data value is compared with the reference value to carry out the environment control through the control devices, the notification event management module informs users when it is different from the reference value or there is a problem in the livestock farm, and data is output on the user's GUI screen through the data output management module. The figure 3 shows the process of the distributed processing system.

3 Service process

This distributed platform based livestock farm control system provides the livestock farm management service, which offers the environment control and monitoring service for individual livestock farm, and the event notification service that quickly informs all users when capturing an abnormal symptom based on the collected environmental information.
3.1 Livestock farm management service

The livestock farm management service collects temperature, illuminance and humidity etc. of each livestock farm through the environment sensors installed in the livestock farm, and the collected environmental information is compared and analyzed on the server managing each livestock farm to use for controlling as the optimum environment.

The automatic control service in the figure 4 stores information collected from the livestock farm into the DB, the control system calls it to compare the reference values stored in the DB with the collected data, and then it carries out the environment control suitable to the reference values.

3.2 Event notification service

The event notification service is one to prevent the livestock diseases or the dangerous condition of the livestock farm in advance by informing users in real time when capturing an abnormal symptom in the livestock farm. The environmental information collected from individual livestock farm is transmitted to the control system, and the control system analyzes the collected environmental information to send an event to all users if capturing an abnormal symptom in the certain livestock farm. In addition to this, a user could inform all the users by requesting an event directly. The figure 6 shows the operating process of the event notification service.
4 Implementation of the proposed system

4.1 Individual livestock farm management system

In order to implement the distributed platform based livestock farm control system proposed in this paper, the control system is constructed first for each individual livestock farm. The figure 7 is the block diagram of individual livestock farm management system.

![Block diagram of individual livestock farm management system](image)

**Figure 7.** Block diagram of individual livestock farm management system

In the individual livestock farm management system, environment sensors are installed in the livestock farm to collect the livestock farm environment information such as illuminance, temperature, humidity etc. affecting the breeding of livestock, and a GW is installed to send the environmental data collected from the sensors to the livestock farm management server. The installed environment sensors transmit the collected livestock farm environmental information at regular intervals, which is sent to the livestock farm management server through the GW. The transmitted livestock farm environment information is processed into the format that could be stored in the DB, its unit is converted to correspond with the measurement element, and the processed data is stored in the DB by using the update query through the sensor manager of the livestock farm management server. In addition, the IP based surveillance cameras are installed to collect image information of the livestock farm and the livestock, and they are used to investigate the cause when there is a theft or accident, or to check current conditions of the livestock farm. Images collected from the surveillance camera are transmitted to the livestock farm management server, and they are divided into the livestock farm ID and the camera number etc. to store in the DB. In order to control the livestock farm conditions such as illuminance, temperature, humidity and CO2 etc. affecting the breeding of livestock, the livestock farm control facility such as lighting, humidifier, fan heater, air conditioner, ventilator etc. are installed, and the relay modules are installed to control them by wireless. The figure 8 is the livestock farm model.

![A prototype of livestock farm](image)

**Figure 8.** A prototype of livestock farm

The figure 9 is livestock farm management system’s GUI applying the individual livestock farm management system.

![Livestock farm management system’s GUI](image)

**Figure 9.** Livestock farm management system’s GUI

4.2 The Integrated livestock farm control system

The integrated livestock farm control system stores the livestock farm environment information collected from the individual livestock farm management system in the DB, and carries out the integrated management and comparative analysis of the collected environment data values to determine the abnormal symptom of the livestock farm. When an abnormal symptom occurs, the server could inform it to every user through the message transmission service and the GUI of devices that could communicate, and could inform the certain
livestock farm's abnormal symptom to each user according to a user's request.

In order to construct the integrated livestock farm control system, the WAS used Tomcat-6.0.20, and the DB used the Mysql of version 5.0, the most stable one of currently released ones. The figure 10 is the GUI of the integrated livestock farm control system, which ① provides information on each user and the livestock farm information, ② represents the livestock farm environment information collected from the environment sensors installed in each livestock farm, and ③ indicates conditions such as the occurrence time, environment information etc. when an abnormal symptom occurs in the certain livestock farm.

![Figure 10. The GUI of the integrated livestock farm control system](image)

The services provided through the GUI are offered by 5 modules mentioned earlier, the user management module distinguishes the corresponding user, the data management module carries out the integrated management of each livestock farm's environmental information, the environment value reference data management module compares the collected environmental information with the reference value to determine whether or not to be abnormal, and the event management module indicates it to users on the GUI through the data output management module when it is greatly different from the reference value or there is a problem in the livestock farm. The livestock farm control system works with these operations.

The figure 11 is a graph that represents the environment data measured for each livestock farm as the proposed integrated livestock farm control system was operated.

![Figure 11. The graph of measured environment data](image)

It could be known that the livestock farm A and B continue to keep uniform temperature and humidity condition, and the livestock farm C keeps uniform temperature and humidity like A and B but the rapid temperature change occurs at 20:02 through the graph above.

5 Conclusions

This study constructed the integrated livestock farm control system based on the distributed platform as a control system to carry out the integrated management of livestock farm environment in the ubiquitous agriculture environment.

It listed building blocks required for implementing the proposed system, interaction between the building blocks, operating process of the designed system, implementation and results of the system, the software structure is based on the distributed framework, the services to support the livestock farm control service were defined, it made the complicated information system could be rapidly constructed by modularizing the system components, and it is composed of the user management, output management, environment control reference data management, notification event management and data output management modules.

It is considered that the proposed system could give much assistance to high productivity and production of high-quality livestock by carrying out the integrated management of multiple livestock farmhouses' monitoring systems and sharing the information, in addition to this, it is expected to minimize damages by enabling to rapidly deal with when there is livestock disease or an abnormal symptom in the livestock farm. It is expected that domestic livestock industry would be competitive because this system could provide reduction of labor force, production of high quality livestock and improvement of productivity etc. to the labor-intensive livestock industry.
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