A Study on the Real-Time Livestock Monitoring System using Mobile Platform

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Abstract

This paper proposes a real-time livestock monitoring system that could use a mobile platform to diagnose the livestock's estrus and livestock diseases in early stages. The proposed system enables users to monitor livestock's biometric and image information, which is collected from sensor nodes and CCTV, via smart phones anytime and anywhere in real time, and abnormal conditions of livestock are determined to inform users about them based on such collected livestock-related information, so that users could quickly cope with livestock's estrus and livestock diseases. It could provide convenience to users through the proposed system, and detect livestock's estrus and livestock diseases in advance by livestock information to improve productivity resulting from realizing timely fertilization and to cope with livestock diseases beforehand, so that damage could be minimized.

Keywords: *Livestock, Monitoring, Mobile platform, Smartphone, Mobile application*

1. Introduction

As smartphones are prevalent recently, users want applications to obtain rapid and accurate information or to use it anytime anywhere, as a result, it becomes important to develop mobile applications based on a mobile platform such as Android, iOS and *etc*., [1, 2].

Mobile applications are the core of smartphones, which have currently been variously developing in a diversity of fields from applications related to personal entertainment and everyday life to ones for business [3]. Such developed mobile applications are made to quickly use them in common and to efficiently use anytime anywhere [4].

Therefore, this paper would like to propose a real-time livestock monitoring system that could monitor livestock's biometric and image information anytime anywhere in real time using these features of mobile applications.

In the livestock industry, the livestock's estrus and livestock disease are a very important issue [5, 6]. It is because that the livestock's estrus is directly related to the livestock farmhouse's productivity, and the livestock disease may do extensive damage if it does not cope with the occurrence of livestock diseases [7, 8].

The proposed system would like to minimize the damage by using a mobile application to monitor livestock's biometric and image information, to detect livestock's estrus and livestock diseases in advance, and to cope with them beforehand in real-time.

The proposed system collects livestock's biometric and image information from sensor nodes and CCTV, sends the collected livestock's biometric and image information to a management server via a gateway, and periodically transfers livestock-related information managed by the management server to mobile clients via TCP/IP communications, so that

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provides users a monitoring service of livestock's biometric and image information and a notification service of abnormal symptom occurrence.

As users detect abnormal symptoms of livestock in advance via mobile devices in real time through the proposed system, they could cope with problems resulting from livestock's estrus and livestock diseases in advance, as a result, it is expected to improve livestock's productivity and to minimize damage of livestock diseases.

This paper is organized as follows. Chapter 2 explains structures and functions of the proposed real-time livestock monitoring system using a mobile platform, Chapter 3 describes a result of implementing the proposed system, and finally Chapter 4 finishes this paper through a conclusion.

2. Design of the Proposed Real-time Livestock Monitoring System

2.1. System Structure

The real-time livestock monitoring system proposed in this paper is composed of sensor nodes, which detect livestock's biometric information in real time, a CCTV, which collects livestock's image information, a gateway, which sends livestock's biometric information collected from nodes and livestock's image information collected from the CCTV to a server and transfers control signals sent from the server to the nodes and CCTV, a management server, which receives and manages data sent from the gateway and supports connections with mobile clients, and mobile clients that communicates with the server via TCP/IP communications and notifies users of an abnormal symptom when it occurs as Figure 1.

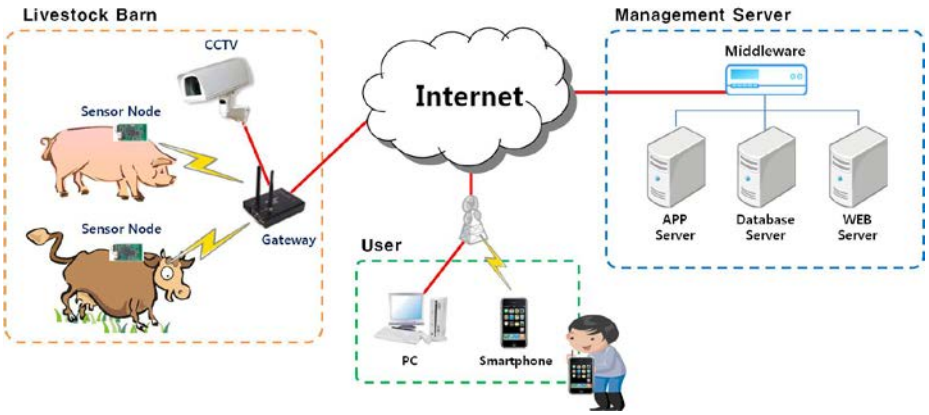

Figure 1. The Structure of the Proposed Real-time Livestock Monitoring System

The sensor node, which measures livestock's biometric information, is composed of sensors that could measure activity, body temperature and electrocardiogram *etc.*, of livestock, and measures livestock's biometric signals through them in real time and converts the measured livestock biometric information into a form suitable for signal processing to send it to the gateway.

The CCTV collecting livestock's image information is installed in the livestock barn to collect real-time images of livestock, and the collected images are sent to the server via the gateway.

The gateway is responsible for building and maintaining a network of sensor nodes to collect livestock's biometric information, and it not only provides organic communication environments with the management server but also carries out a function of gathering livestock's biometric and image information collected from the sensor node and CCTV to deliver it to the management server.

The management server activates the real-time livestock monitoring system, then registers information of the gateway and sensor node according to the network built by the gateway, stores livestock's biometric and image information sent from the sensor nodes and CCTV into a database and maintains it. In addition, it provides livestock's biometric and image information through mobile clients in real time.

A mobile client is comprised of application services supporting the mobile platform, and provides a livestock monitoring service and livestock's dangerous situation notification service *etc.*, to users via the management server and TCP/IP communications.

2.2. Service Process

The proposed system provides users with the livestock monitoring service with which they can monitor the livestock information and livestock barn environment information, the livestock barn facility control service for optimal management of livestock breeding environment, and livestock's dangerous situation notification service to inform a danger of the livestock when emergency situation occurred.

2.2.1. Livestock Monitoring Service: The livestock monitoring service is a service which enables livestock producers to monitor through a GUI important breeding environment information such as illumination levels, humidity, temperature, CO2, *etc.*, which were collected by environmental sensors and CCTV, and livestock biometric data such as livestock’s temperature, livestock’s weight and activity level, and image information of the livestock barn. Figure 2 shows operation process of the livestock monitoring service.

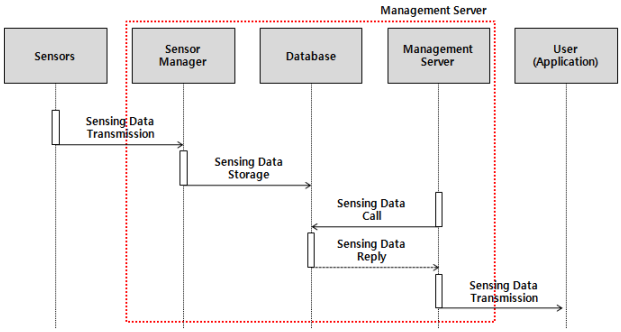

Figure 2. Operation Process of the Livestock Monitoring Service

2.2.2. Livestock Barn Facility Control Service: The livestock barn facility control service is a service which controls the livestock barn control facility automatically in order to maintain an optimal livestock breeding environment based on the collected information from the livestock barn or helps users controlling the facility manually. Figure 3 shows operation process of the livestock barn facility service.

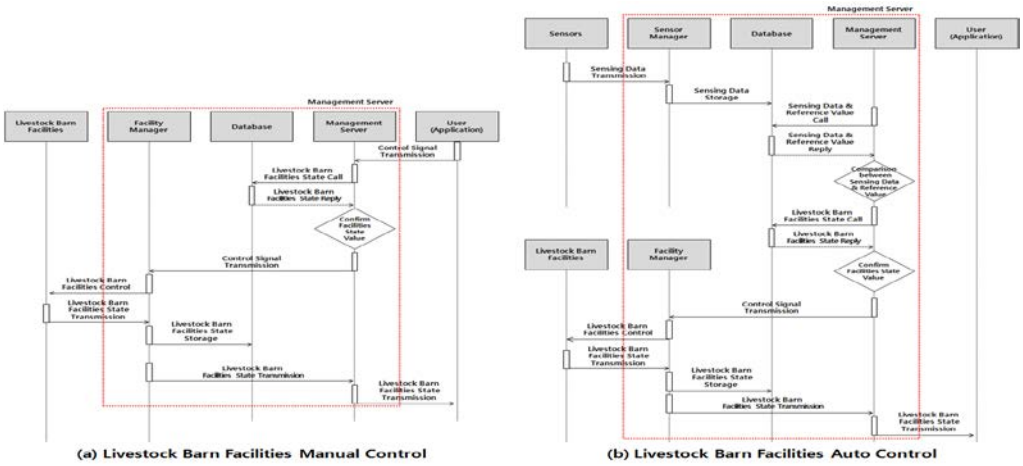

Figure 3. Operation Process of the Livestock Barn Facility Control Service

2.2.3. Livestock's Dangerous Situation Notification Service: The livestock's dangerous situation notification service is a service that informs users like farmers of livestock status changes or any situation changes so that users can take necessary actions to prevent such a dangerous situation. Figure 4 shows operation process of the livestock's dangerous situation notification service.

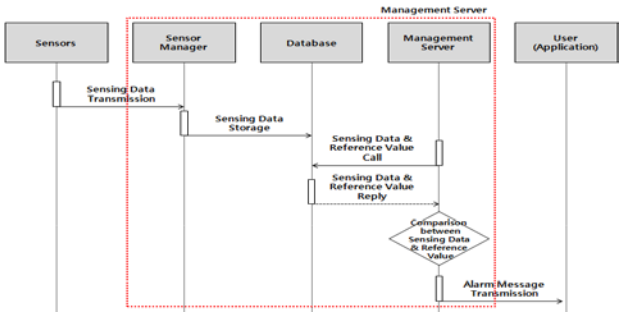

Figure 4. Operation Process of the Livestock Barn Facility Control Service

3. Implementation of the Proposed Real-time Livestock Monitoring System

In order to evaluate performance of the real-time livestock monitoring system using a mobile platform proposed in this paper, a model of the livestock barn was fabricated first, and then the proposed system was applied to it.

Figure 5. Livestock Barn Model (Test-bed)

To monitor livestock's biometric and image information collected from the sensor node, it was implemented a server application, client application for PC and mobile client application.

PC application development environment that is equivalent to management server is set according to general PC environment, and the sensor node environment for sensing is set according to an ideal environment for using Zigbee sensor. In addition, Tomcat-6.0.20 was used as WAS and the most stable version 5.0 of MySQL was used for the database.

Table 1. Hardware Development Environment

	Type	Details
Server PC Environment	CPU	Intel Xeon 3.2 Ghz
	RAM	1 GB
	OS	Microsoft Windows XP

Table 1. Software Development Environment

	Type	Details
PC Development Environment	OS	Microsoft Windows XP
	Programming Languages	JAVA (JDK 6), C#
	RDBMS	MySQL 5.0
Sensor Node Environment	OS	TinyOS 1.0
	Linux Environment	Cygwin
	Programming Languages	NesC
	JAVA	JDK 1.4.1

The server application executed on the management server uses the base node as an input port to receive information such as livestock's temperature and activity sent as a packet, and to store it into the integrated database. In addition, it communicates control signals and sensing data with clients via TCP socket communications.

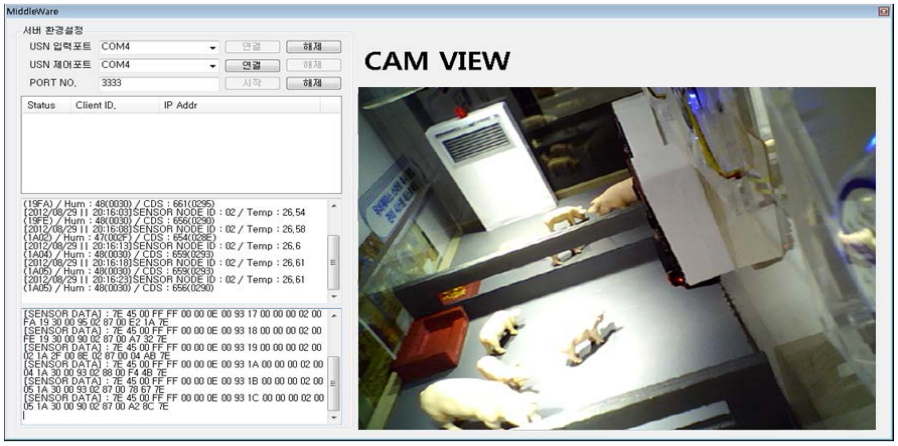

Figure 6. Server Application for PC (Middleware)

The PC client and mobile client applications were implemented to receive sensing data from the server application via TCP socket communications for monitoring the remote site, and to control devices by sending control signals such as CCTV to the server application.

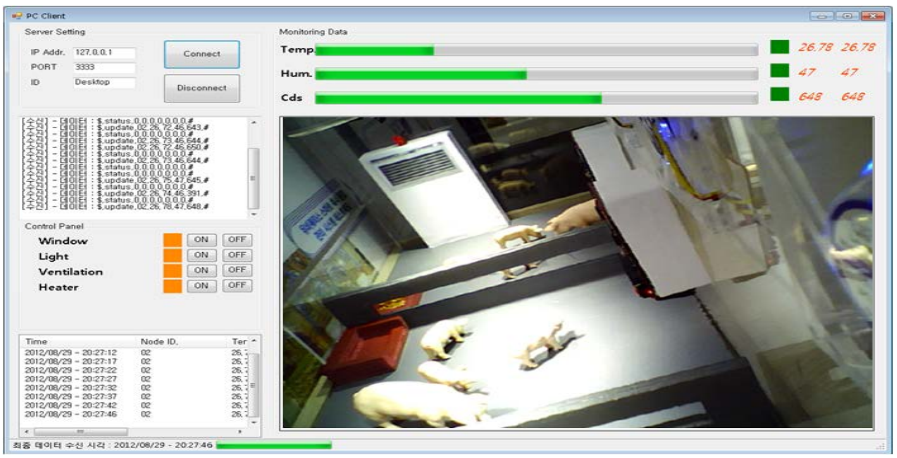

Figure 7. Client Application for PC (Monitoring and Control Application)

The system development environment for developing the mobile client was operated by JDK version 1.6 on the Windows XP operating system, Eclipse 3.6 (Helios) [9] was used as a basic tool for developing Android, the Android operating system was developed by Android SDK version 4.0 (Ice Cream Sandwich)[10], and the Figure 8 is a screen of executing the mobile client based on the developed Android operating system.

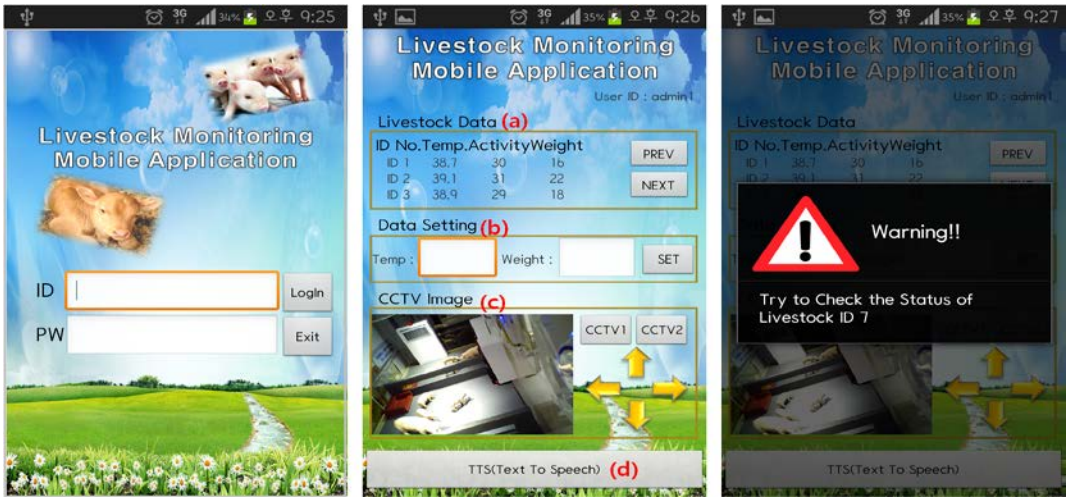

Figure 8. Android OS based Mobile Application

(a) shows sensing values measured from the sensor node installed on the livestock, (b) is the part to control the CCTV and images collected from it, (c) is the part to enter standard values of livestock's biometric information, and (d) was implemented to prompt voice commands that guide people with low vision and senior people handling the livestock monitoring information by using the Google API(Application Program Interface).

In addition, it was implemented to use a notification function in the Android to inform users by using a push notification function of the mobile device when an abnormal symptom is discovered in the biometric information for individual livestock, and the preference was used to make sound/vibration could be selected.

Additionally, the implemented system was tested through the whole error checking and modification. First, the problem of not enabling to delete resources effectively was solved by deleting unnecessary sources and images, and the problem of lowering the UI(User Interface) design sense was solved by modifying the UI structure.

4. Conclusions

This paper proposed the real-time livestock monitoring system to monitor livestock's biometric and image information by using the mobile applications.

The proposed system is composed of the sensor node to collect livestock's biometric information, CCTV to collect livestock's image information, gateway to send the collected livestock-related information to the server and to send control signals received from the server to the nodes and CCTV, management server to receive and manage data sent by the gateway and to support connections with mobile clients, and mobile clients to communicate with the server via TCP/IP communications and to notify users of an abnormal symptom when it occurs.

For performance evaluation, the livestock barn model was fabricated, then the proposed system was applied to it, and the server application, client application for PC and mobile client application were implemented for monitoring livestock's biometric and image information.

It is expected that the system proposed in this paper could diagnose livestock’s estrus and livestock diseases conditions in early stages based on livestock's biometric and image information to improve the livestock farmhouse's productivity and to minimize damages of livestock diseases.

For the future works, it is planned to implement the system proposed in this paper on a real livestock barn and to modify and complement it.

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