An Implementation of the Salt-Farm Monitoring System Using Wireless Sensor Network

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Abstract. In producing solar salt, natural environmental factors such as temperature, humidity, solar radiation, wind direction, wind speed and rain are essential elements which influence on the productivity and quality of salt. If we can manage the above mentioned environmental elements efficiently, we could achieve improved results in production of salt with good quality. To monitor and manage the natural environments, this paper suggests the Salt-Farm Monitoring System (SFMS) which is operated with renewable energy power. The system collects environmental factors directly from the environmental measure sensors and the sensor nodes. To implement a stand-alone system, we applied solar cell and wind generator to operate this system. Finally, we showed that the SFMS could monitor the salt-farm environments by using wireless sensor nodes and operate correctly without external power supply.

Keywords: Solar Salt, USN, Salt-farm, Environment Monitoring System, Renewable Energy.

1 Introduction

The information technologies, wireless sensors, ubiquitous computing and communication devices techniques are applied to various industrial fields. But solar salt industry didn't receive above IT technologies yet. The solar salt is very sensitive to salt-farm environments. If we collect precision salt-farm environment data, the productivity and quality rate of products will be improved.

For producing high quality salt, we propose the Salt-Farm Monitoring System (SFMS) that uses hardware and software IT technologies. This system monitors and collects the information of salt-farm environments with a renewable power supply.

The rest of this paper is organized as follows: Section 2 is related works, Section 3 describes the system architecture of the SFMS and Section 4 presents implementation of the system. Finally, we discuss conclusions and future works in Section 5.

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2 Related Works

There are five requisites for growing corps [1]. They are temperature, light, air, water and soil. A project of plant growth monitoring system was developed by Go-heung agriculture technology & extension center in Korea. They applied environment monitoring sensors and software to Hanabong farm [2]. This system measures the greenhouse environment status by using sensors adhered to plant and sends information to grower's home via internet.

Fig. 1. The Hanabong monitoring system by Go-heung agriculture technology & extension center

Floating buoy is developed to monitor ocean environments via Orbcomm satellite and a method is proposed to increase measurement accuracy of sea water temperature with common low price temperature sensor [3].

The feasibility of the developed node was tested by deploying a simple sensor network into Martens Greenhouse Research Foundation's greenhouse in Närpiö town in Western Finland. They are the number of wireless sensor networks with tree structure form integrating sensors of the same category. In addition, three commercial sensors capable to measure four climate variables [4, 5].

By using above technologies, agricultural sensors and nodes are proposed, and various applications are developed.

3 Salt-Farm Monitoring System (SFMS) Architecture

The Salt-Farm Monitoring System (SFMS) is a collect real time environmental field data from various sensors. Figure 2 shows the architecture of the SFMS.

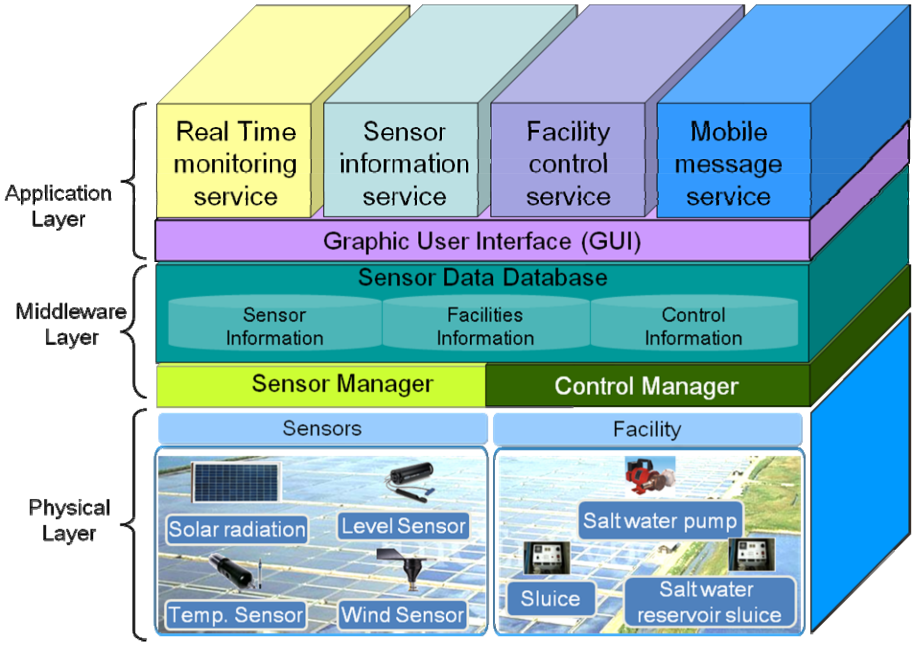

Fig. 2. Salt-Farm Monitoring System's architecture consisting of three layers

The SFMS divided into three layers. The physical device layer includes sensors and facilities. Sensors are temperature, humidity, solar radiation, wind direction, wind speed, rain and salt water level sensor. Facilities are salt water reservoir sluice, salt-farm sluice and salt water reservoir pump. SFMS is a self-charging stand alone system using renewable energy. We supply solar-power, wind generator into the system without any electric power.

The middle layer has the sensor manager, control manager, salt-farm database. The sensor manager manages the information from environments sensors [6]. The control manager controls the facilities device using the salt-farm database. The sensor data database provides environment information from physical layer devices to application layer via sensor, facilities control information.

The application layer provides with the real time monitoring service, sensor information service, facility control service and mobile message service [7]. These are provided with laptop GUI (Graphic User Interface), web GUI and mobile phone GUI. Three layers are integrated into the SFMS. By interacting with each layer, the system provides users with salt-farm environment information.

3.1 Environment Monitoring Service

The salt-farm should be real-time sensing, because it is very sensitive to environment element such as temperature, humidity, illumination, etc.

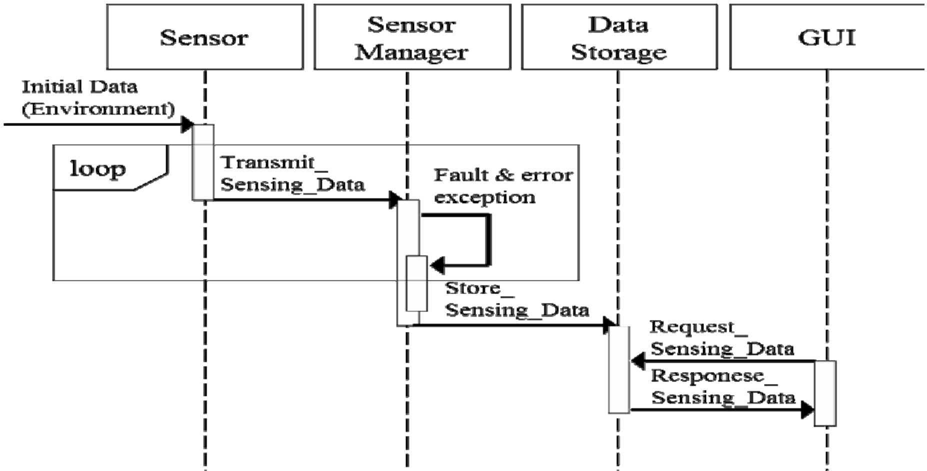

Fig. 3. Environmental Information Service sequence diagram

Figure 3 shows procedure of the environment monitoring service. First, this service sends the raw data of environment sensors to the sensor manager. The raw data are temperature, humidity, salinity and intensity of illumination information. Sensor manager verify which the raw data is error data or not. Wireless sensor network has virtually the low reliability in an open area. In order to reduce the risk of collecting environment information it needs to data filtering. A simple filtering such as compared with previous raw data through the classification and then stored in the database. A GUI obtained the sensor data from data storage then offers the environment information to users.

3.2 Control Services

Figure 4 shows procedure of automatic control services facilities. Database provides the factors information such as facilities state and sensing data to GUI. GUI send the

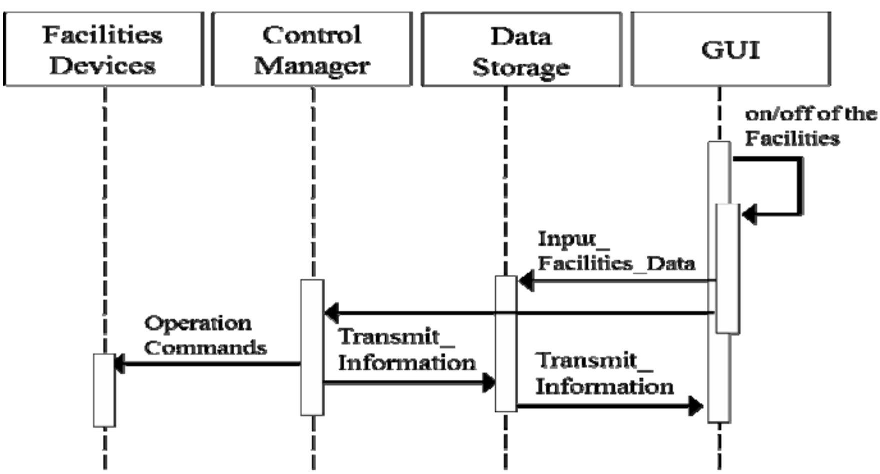

Fig. 4. Facilities Automatic Control Services Sequence Diagram

on/off command signal to control manager through database by Logical analysis of response factors data [8].

4 Implementation of the SFMS

In this chapter, we implement the SFMS by implementing the system's components. Figure 5 is the system model.

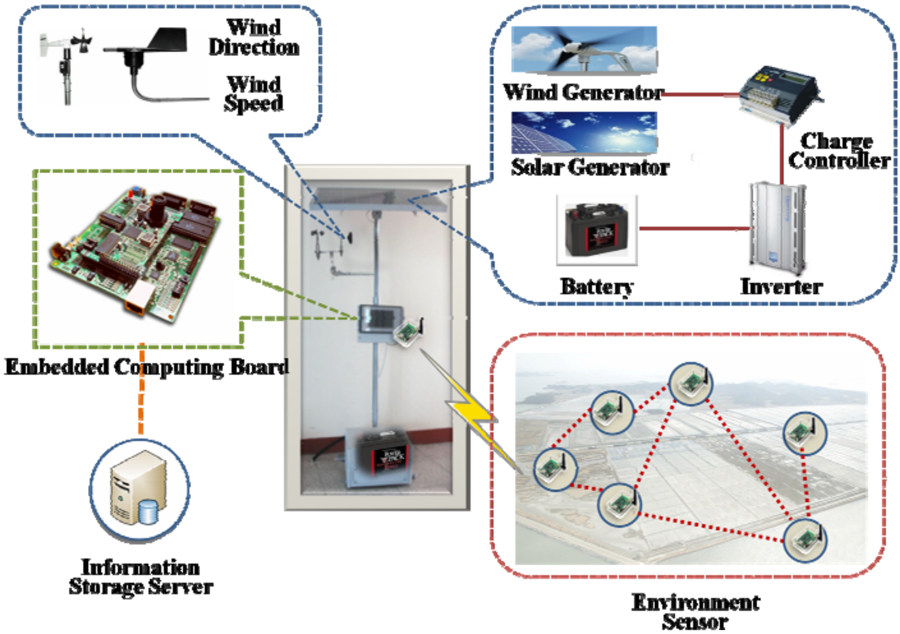

Fig. 5. SFMS model including embedded board, renewable charging devices and sensors

The SFMS was applied a renewable energy system. The system has solar cell, wind generator and storage battery. The system stores power in the daytime and using in the night time.

4.1 System Components

This system includes of physical devices and software modules. The physical devices have sensing and information gathering devices. You can see the devices in Figure 6.

Table 1 is showing the power consumption of equipped modules and power supply of solar and wind in the SFMS. The total power consumption of equipped modules like embedded board, salinity sensor and environment sensor is 11.95W. The solar cell and wind generator supplies with electric power of the maximum 200W for each in the 25℃ test environment. This is enough to operate the SFMS. You can see the main system installed sensors' data receiver and database in Figure 7 and a charging battery in Figure 8.

Fig. 6. Wind turbines, Solar cell, Network sensor node, temperature sensor in the SFMS

Table 1. Power consumption of each module and Power supply of charging battery

Module	**Power consumption**		
	Voltage	Current	Power
Embedded Board	DC 9V	500mA	5W
Environment Sensor	DC 3V	2.3A	6.9W
Salinity Sensor	DC 5V	10mA	0.05W
TOTAL	DC 17V	2.81A	11.95 W
Module	**Supply Power**		
	Voltage	Current	Power
Solar Cell	DC 26.4V	7.6A	200W
Wind generator	DC 24V	7.7A	200W
	Avr Wind Speed 12.5m/s		
Battery	Voltage	Capacity(20HR)	
	DC 12V	64A	

Fig. 7. Embedded board including environment sensor receiver and database

Fig. 8. salinity sensor receiver, integrated battery

Now, we integrate above components into the system. Figure 9 shows the SFMS's prototype including the software modules. The SFMS can apply various environments such as precision agriculture, aquaculture, fishing industry, livestock industry, greenhouse monitoring and salt farm monitoring.

Fig. 9. Prototype of the SFMS

4.2 Implementation Results

Figure 10 is the SFMS's GUI. The (a) shows the sensing value from the temperature sensor. The (b) is sensing value for humidity. The (c) showing the solar radiation sensing value, and the (d) is the sensing value from the wind speed, direction sensors. The (e) shows control of floodgate.

To confirm the successful operation of the SFMS using self-supply of electric power, we perform field test on a sunny day with a mean temperature of 25□ degree and wind speed 12.5m/s. As a result, during the daytime solar cell, wind generator generated power together and night time only wind generator generated the power. If there is windless and cloudy day, SFMS could be supplied power by recharged battery.

Hence, our SFMS can operate with the support of solar cell and wind power in the field without power supply from wired link or additional recharging process. Figure 11 shows a graph of field test result in power consumption.

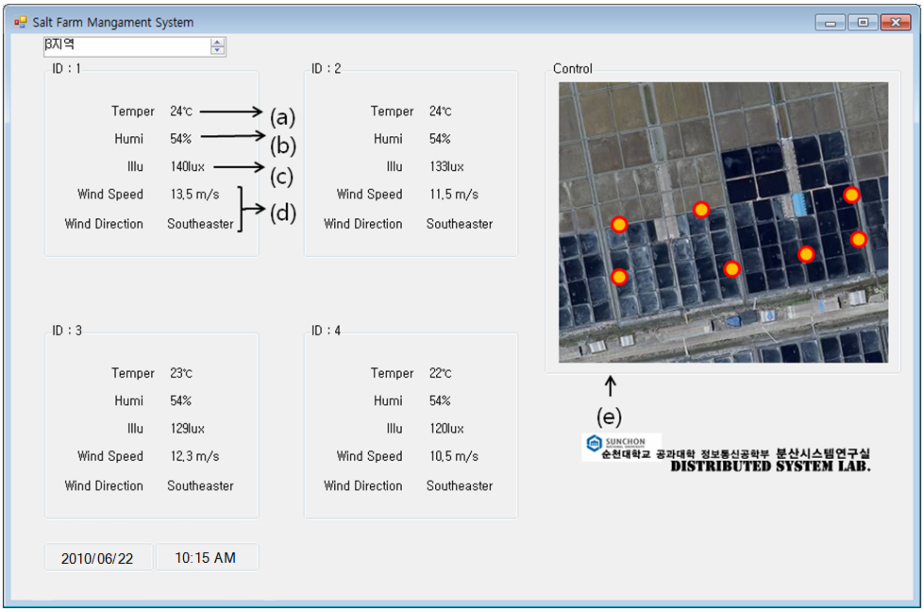

Fig. 10. FMSS's GUI

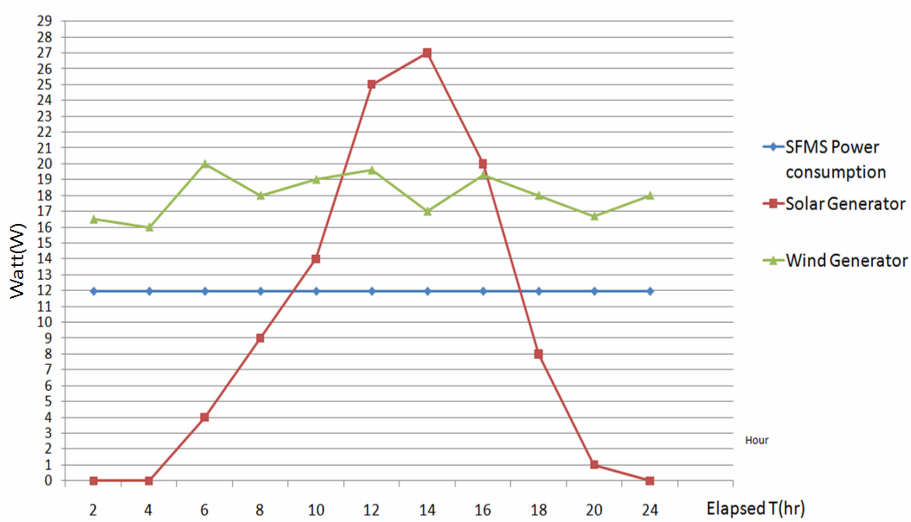

Fig. 11. Field test result of generate power and consume power

5 Conclusions

This paper proposed the Salt-Farm monitoring service (SFMS) that could monitor environments of salt-farm using renewable energy. Also, for verifying the execution of our system, we implemented system's components and made the SFMS prototype. Then we showed the executing results of the system. From this result, we confirmed that our system could monitor the salt-farm conditions by using various sensors and facilities. Also, we show that renewable energy can make operating the SFMS without any external power.

For future works, we aim to developing an improved monitoring system which operates based USN and applies into the salt storage inventory. Also, it's challenge for us to keep a good condition from salt wind, salt water and extreme weather.

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