Remote Monitoring System for Cold-Storage Using Serial Communication

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Abstract: This paper describes a remote monitoring system of temperature control for cold-storage of farm produce. In cold-storage, it is important that farm produces are stored as fresh. Unfortunately, when an operator goes out from the cold-storage, the temperature could be changed due to the various reasons, for an example, a valve of cooler is broken. The temperature change results in a serious problem of the quality of farm produce. To prevent the problem, the operator has to look to the current state of the temperature of the cold-storage, even he is in long away. Thus, the monitoring system to show the temperature is required to the operator who can move away. Therefore, this paper describes the remote monitoring system of the temperature. The proposed system is expected to help the operator's facilities, and the management of farm produce.

Keywords: Remote Monitoring, Temperature Controller, Cold-Storage.

1. INTRODUCTION

Remote measure and control that user can operate machine or system in remote area or factory outside have been studied in several fields. A technology of connecting and collecting data that produce situation and action state was studied. The checking of work of factory and analyzing is available in network through internet[1][2]. Also if Control Area Network(CAN) and internet are connected together, the system attains the characteristics of a distributed control system and a remote control system simultaneously[3]. Fieldbus provides real-tome data communication among field devices in the process control and manufacturing automation system[4]. A tele-robot through an obstructed space was evaluated by navigation experiments[5]. An operator can monitor the robot state and working environment through the monitoring system using the graphics. When the robot model is changed, the graphic environment could be updated easily by using that of robot simulator[6].

Nevertheless, the example of management system for farm produce has not been studied. This paper describes a remote monitoring system of temperature control for cold-storage of farm produce. It is important that the temperature of cold-storage is stable at low temperature for fresh saving. In the field of cold-storage industry, the operating of temperature adjusting and storaging method depend of the experience of expert operator. There is the problem that an operator always stays in the cold-storage to adjust the temperature and manage the system. To overcome the problem, we propose a remote monitoring system. The system increases the efficiency of operator. Also, the conventional monitoring system is very expensive. And the conventional system is difficult to farmers, because the system has complex functions. Therefore, we developed a simple and cheap monitoring system.

2. REMOTE MONITORING SYSTEM

2.1 Structure of Remote Monitoring System

The structure of the proposed remote monitoring system is shown as Fig. 1. To monitor the temperature of cold-storage, communication is essential. The Temperature sensors detects the temperature of cold-storage. The detected temperature is transferred to the temperature controller. The temperature controller displays the temperature value in the field, and transfers to the data collection device. The data collection device receives the input information, from an operator and sends the temperature value to main server through the serial communication.

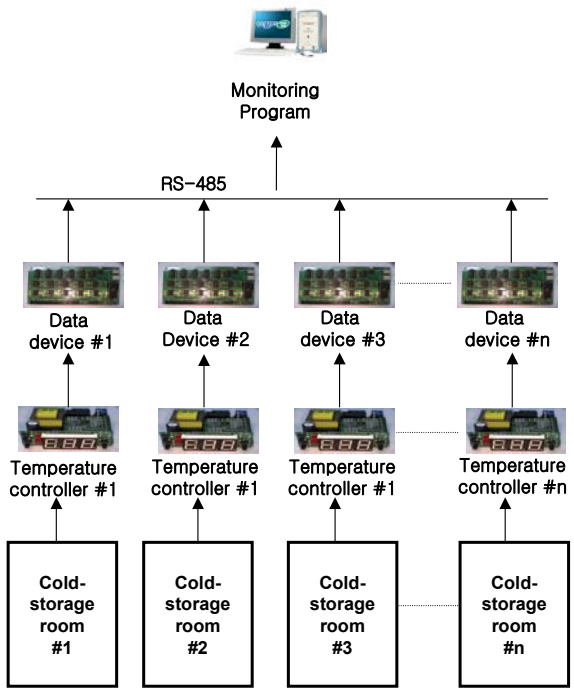

Fig. 1 Structure of Remote Monitoring System.

2.2 Structure of Cold-Storage

Most of cold-storage does not include remote monitoring system. Because, it is very expensive and difficult to farmers. The structure of general cold-storage is shown as Fig. 2. A

cold-storage is composed inside part and out side part. The inside of a cold-storage is insulated. It includes unitcoolers and temperature sensors. The outside of a cold-storage outside includes a temperature controller and freezing unit. For operating a cold-storage, the temperature of inside is detected by the temperature sensors and compared with the setpoint by the temperature controller. The controller drives the freezing unit. The condenser converts hot gas to cool gas. The cool air fuenced by the cool gas is injected to the inside of the cool-storage by the unitcooler.

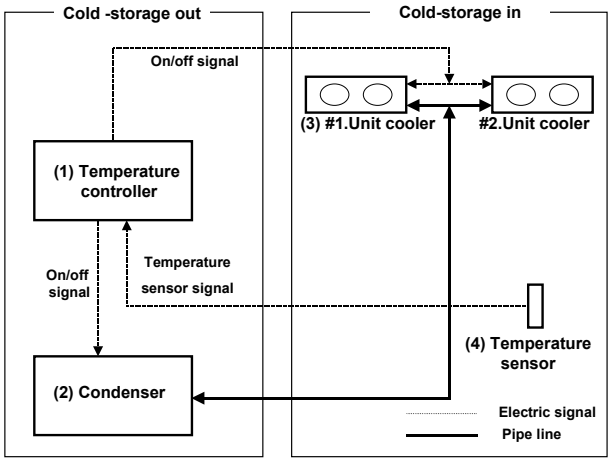

Fig. 2 Structure of cold-storage.

2.3 Structure of Freezing Unit

Freezing unit means a machine which makes cool air. It is composed of a condenser, a compressor, an unit cooler, etc. In this paper, the used freezing unit is a compression type. A compression type freezing unit uses a compress for evaporation, compression, and liquefaction repeatedly to make cool gas.

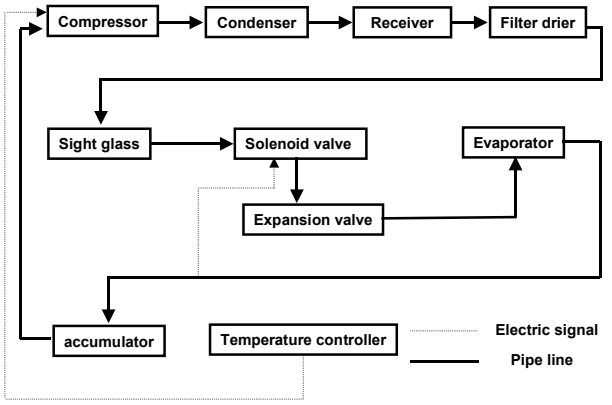

Fig. 3 Structure of freezing Unit.

2.4 Temperature Controller

Temperature controller detects the temperature by the sensor and control the condenser to turn on or off. There are many kinds of thermal sensors like RTD, IC, and DIODE, etc. In this study, a diode thermal sensor was used. The output of the controller is a contacting of a relay. So, the control method is on-off control. The detected temperature is transferred to the data collection device using serial communication. The used serial communication is RS-485. The program development by Visual C++ can monitor the transferred temperature. Therefore, an operator can monitor the temperature of the cold-storage, and make a good decision. The damage of farm produce by temperature change can be reduced. Fig. 4 show the used temperature controller. The temperature controller includes a 8-bit microprocessor. As show Fig. 4, in the controller is composed of temperature displays, buttons for function set, and buttons for temperature up and down. Also, power supply circuit, connectors for sensors, and relays are embedded. On-off control algorithm is used for the controller. The operation of on-off control is show as Fig. 5. The current temperature is acquire by and A/D converter, compared with setted temperature. By the comparing, the controller produces the turn on or off of the condenser.

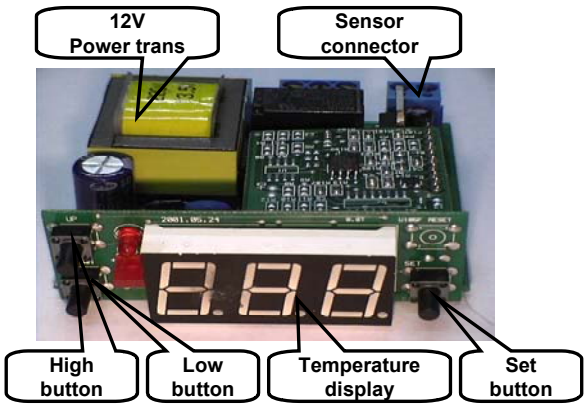

Fig. 4 Temperature Controller.

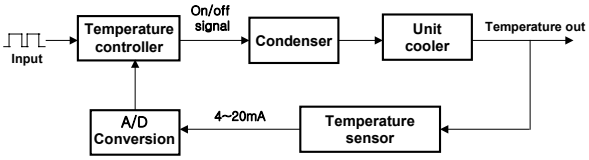

Fig. 5 Signal Diagram Temperature Controller.

2.5 Data Collection Device

The data collection device was developed using a 8-bit microprocessor. Photo couplers are used to protect the circuit

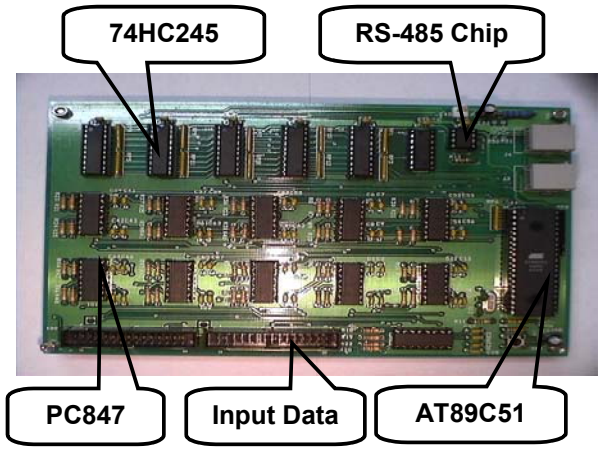

Fig. 6 Data collection device.

from over current. The device includes 44 digital inputs and outputs, and a serial communication circuit using RS-485.

Using the developed data collection device, it is possible that an operator monitor from convertional temperature controller in field remotely.

2.6 Remote Serial Communication Device

Fig. 7, shows the serial communication device. The device is composed of a RS-232 connector to a main computer, and RS-485 communication to a data collection device. The communication protocol of RS-232 is simple and easy, while it can not be used for a long distance. Therefore, the protocol of RS-485 is used for the data collection device in this study. In the protocol of RS-485. An synchronous serial communication is granted to 1.2km distance, and supported to 11.2kbps transfer speed. Through the serial communication, the temperature controller is connected to the main computer. The temperature values are managed in the main computer.

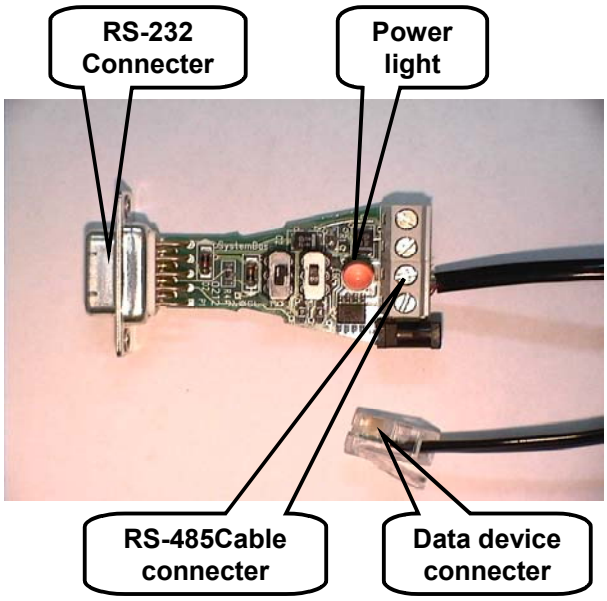

Fig. 7 Remote serial communication device.

2.7 Monitoring Program

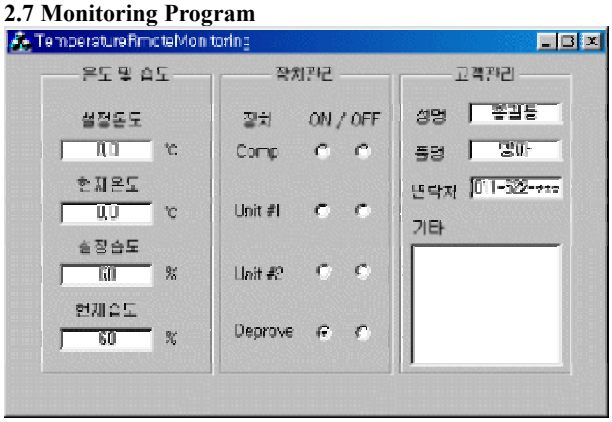

Fig. 8 Monitoring Program.

The developed monitoring program is shown as Fig. 8. The management of temperature, device and system, and customers. The program support an operator to manage a cold-storage using a computer. In the part of temperature management, the current and setted temperature are displayed. The operating states of condensers, compressor, and unit coolers are managed in the part of device and system. The program was developed by using Visual C++. The customer part is programmed for the information of customers, and form produce. The developed program can be very cheap, because it has compact functions which focuses to small-size cold-storage and farmer.

3. Conclusion

In this paper, a remote monitoring system using a serial communication was described. The system is useful for managing a cold-storage. The composition of the system includes a cold-storage, a freezing unit, a temperature controller, a data collection device, a communication device, and monitoring program. Because the system can use a convertional temperature controller, the cost of the system was reduced. Also, a farmer can operate the developed monitoring program easily, because the program has compact function customized for a farmer. The proposed remote monitoring system is useful for a farmer to mange a cold-storage.

ACKNOWLEDGMENTS

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