DEVELOPMENT OF AN AUTOMATIC ENVIRONMENTAL CONTROL SYSTEM FOR LOW TEMPERATURE STORAGE HOUSE USING INTERNET

H.CHUNG, H.S.YUN, W.O.LEE, K.H.LEE, Y.K.CHO, W.K.PARK

National Agricultural Mechanization Research Institute,
Rural Development Administration
Suwon, Kyungggi-Do 441-707, Korea
E-mail:hjeong@namri.go.kr

ABSTRACT

For high quality storage of agricultural products, temperature, humidity and gas conditions in a storage house should be controlled properly. But most of the low temperature storage house is depending on temperature control.

This study aimed to develop an automatic control system for low temperature storage house that can control storage conditions such as temperature, humidity and CO_2 gas concentration. The developed system alarms the user, by telephone or beeper, when abnormal condition has occurred. The farmer can also monitor the inside condition of warehouse in his residence, by Internet.

From the results of the performance test, the temperature and relative humidity in the warehouse is controlled within the range of ±0.5°C and ±2%, respectively.

Key Word : Low Temperature Storage House, Environmental Monitoring, Internet

INTRODUCTION

Low temperature storage house is used for extending freshness of agricultural produce. But, if the temperature falls below the freezing point because of abnormal control of temperature, the produce gets damaged due to cold air. If the inside temperature is higher than set temperature, there is rapid increase in respiration rate also resulting in damage of stored products. However most of the low temperature storage house held in the farmhouse have problems of non-accuracy of temperature and humidity control causing

much damage of produce. Thus, a supervisor of low temperature storage house has trouble of confirming the status of its storage condition at any time. It is especially necessary to monitor the abnormal condition of storage house when the supervisor is away to warn him of such condition.

This need prompt the researchers to develop an automatic environmental control system for low temperature storage house that can monitor storage condition by Internet, make an alarm by cellular phone or beeper when abnormal conditions have occurred and control storage environment accurately.

MATERIALS AND METHODS

The developed system is composed of the environmental control system, which controls the environment of low temperature storage house by computer system, and the remote monitoring system, which monitors the storage environment by telephone line or Internet.

Environmental control system

The developed environmental control system is composed of control box, touch screen, telephone warning device, temperature sensor, humidity sensor, automatic ventilation device, etc.

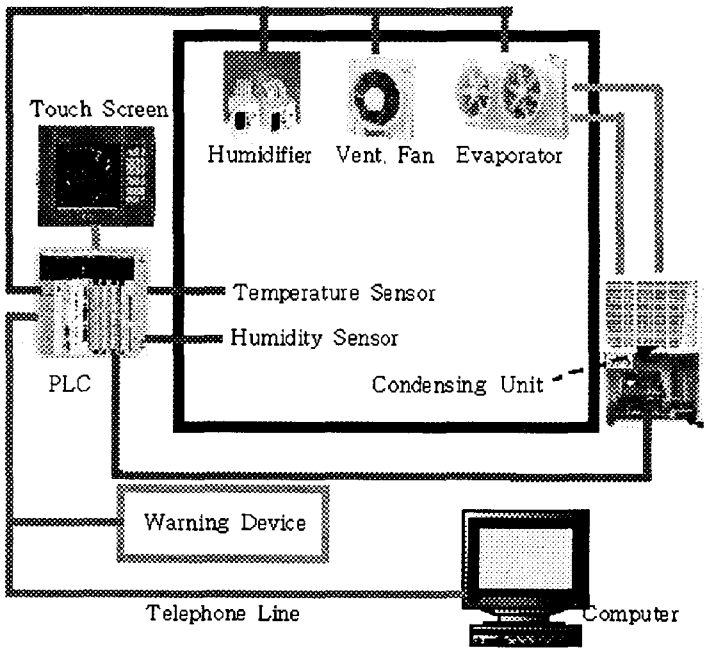

Fig. 1 The schematic diagram of the control system

Fig. 1 shows the schematic diagram of the environmental control system. The PLC(Programmable Logic Controller) is composed of the CPU, Input unit(16ch), RTD unit(4ch), A/D unit, etc. The major role of the PLC is to control complex environment comparing sensing signals of temperature, humidity and CO_2 gas concentration with set parameters. It sends storage environment data to remote monitoring computer and operates the telephone-warning device when abnormal conditions occur.

The functions of touch screen is setting temperature, humidity, ventilation condition and defrost time for an environmental control inside storage house and monitoring the variations of storage environments. If one touches the correspondence button, he can check the status of the storage condition.

The telephone-warning device operates when compressor stops, and when abnormal storage temperature and abnormal defrost have occurred. When abnormal conditions occur, the warning signals are sent to telephone, cellular phone or pager.

The automatic ventilation device is operated by the concentration of CO_2 gas or elapsed time. When the concentration of CO_2 gas is bigger than the set parameter, the ventilation door opens and ventilation fan operates.

Remote monitoring system using Internet

Fig. 2 shows the notion diagram of the remote environmental monitoring system using

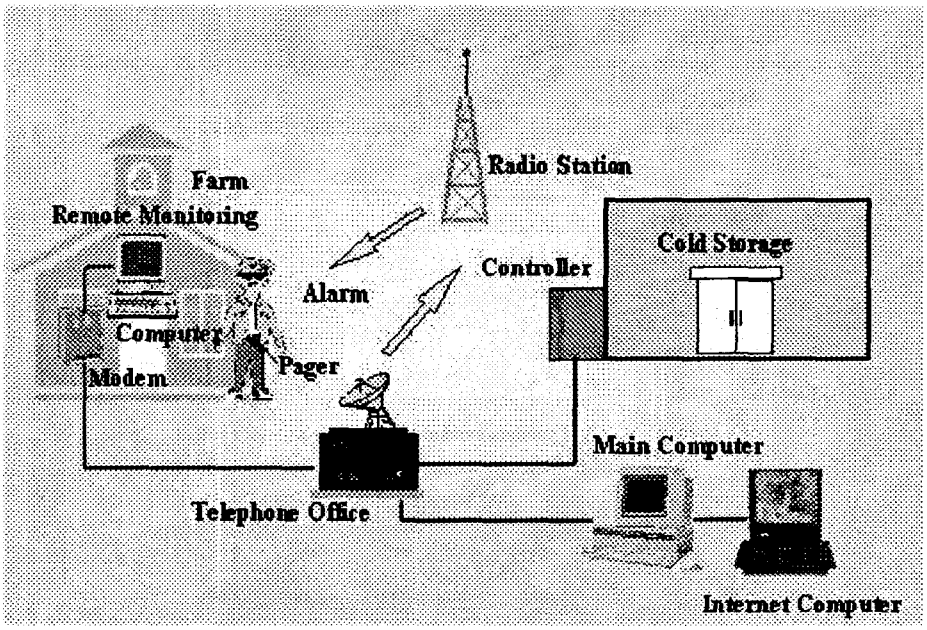

Fig. 2 The notion diagram of monitoring system

Internet. If the supervisor can make phone call to the control box of storage house or connect to Internet home page by computer, he can check storage conditions.

Also, the farmer can watch the monitoring data by computer in his residence through direct communication line or telephone line. If the farmer's residence is located within 1km from storage house, he can communicate directly by communication method of RS485 type. When the distance exceeds 1km, he can connect using communication method of RS232 type through telephone line whth external modem.

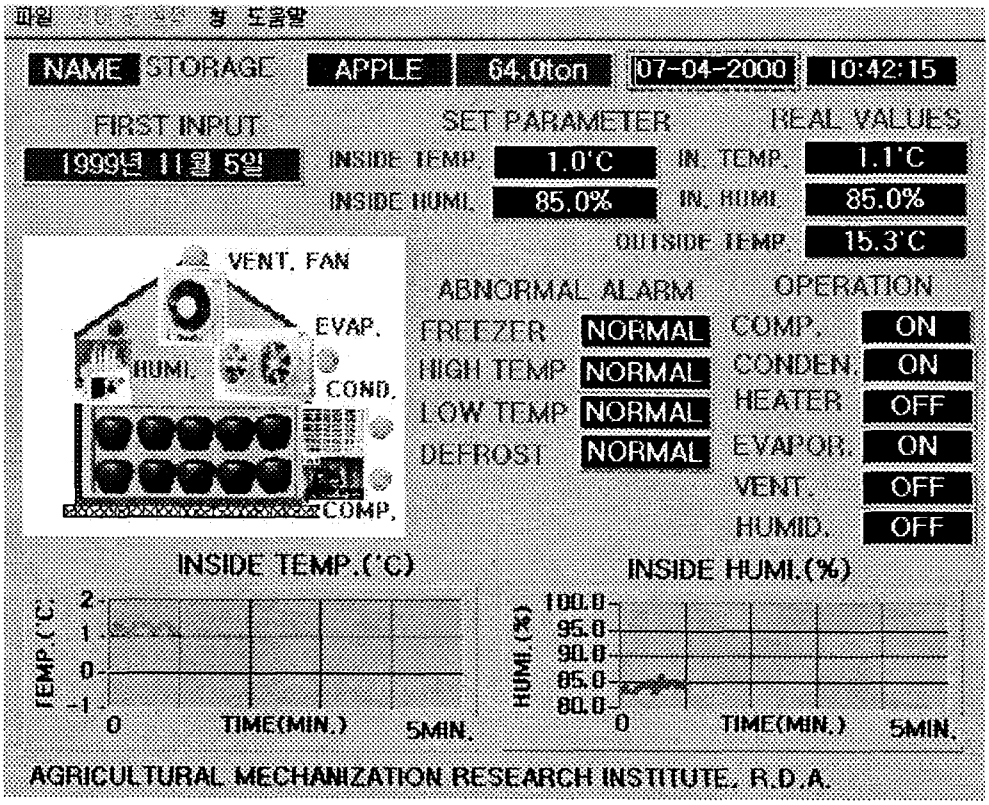

Fig. 3 Display of an environmental monitoring

The remote environmental monitoring program was developed by LabWindows/CVI program language. Fig. 3 shows a computer screen of an environmental monitoring system. The monitored data are provided to farmers or common Internet users by HTML file in real time. The server computer for Internet is installed in research institute or managing company of storage house.

On the monitoring screen, the temperature, humidity, and concentration of carbon dioxide, operating status of freezing equipment, each kind of abnormal warning and graphs of inside temperature and humidity are displayed. The contents of warning are on

the status of freezer, inside temperature and defrost. Table. 1 shows operating criteria of the alarm system.

Table. 1 Operating criteria of the alarm system

Kinds of abnormal status	Criteria for operating alarm system	Remarks
Freezer stop	High pressure of freezing gas	Alarm to cellular Phone or pager and display to computer monitor When abnormal status occurred
	Lack of lubrication oil	
	Over heat of compressor	
Abnormal high temperature	Over 2°C than set temperature	
Abnormal low temperature	Under -1°C than set temperature	
Abnormal defrost	Under -20°C evaporator coil temperature	

RESULTS AND DISCUSSIONS

Performance of environmental control

Fig. 4 and Fig. 5 show the comparison of inside temperature and humidity variations between developed system and existing system. The temperature deviation of developed system and existing system were ±0.5°C and ±1~2°C, respectively. The humidity deviation of developed system and existing system were ±2% and ±3%, respectively.

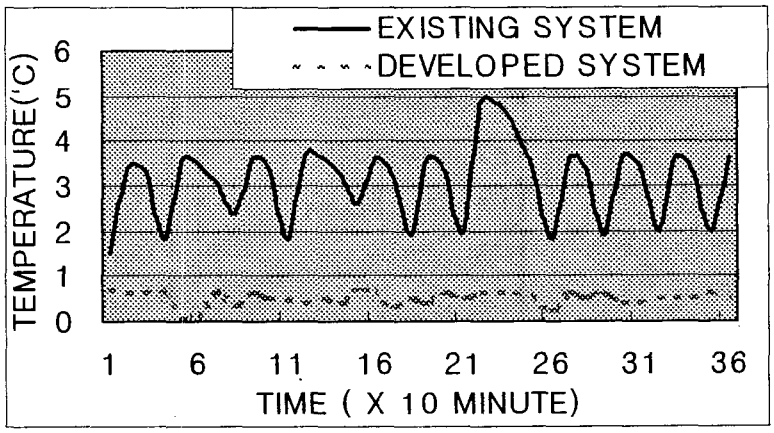

Fig. 4 Comparison of temperature variation by the system developed in this study and the existing system

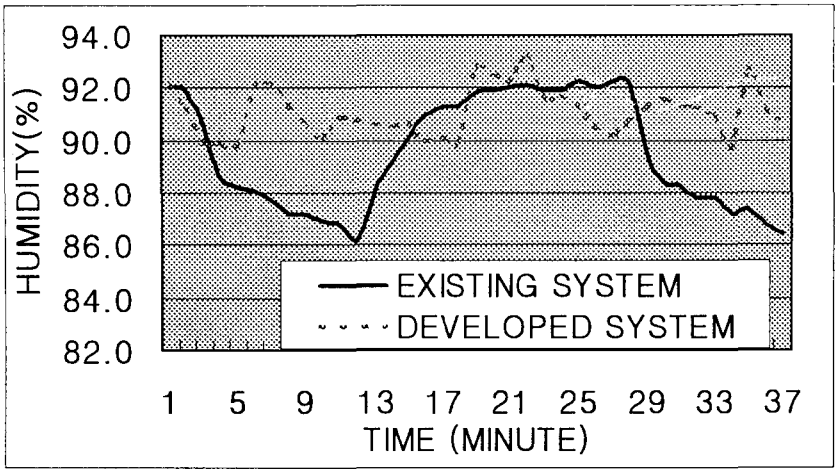

Fig. 5 Comparison of relative variation by the system developed in this study and existing system

Comparison of function

Table. 2 shows the comparison of functions between developed system and existing system. In case of existing system, a farmer cannot get alarm when he is far from the storage house because it has no function of alarm by telephone and computer. So he cannot respond quickly when abnormal operations have occurred in the storage house.

Table. 2 Comparison of performance

Functions	Developed system	Existing system
Remote monitoring Using Internet network	Remote monitoring using Internet(No distance limit)	No Existing
Remote monitoring	Remote monitoring using telephone line (No limit)	No existing
Remote abnormal Warning	By telephone or pager (Alarm functions when you leave the house)	By buzzer(Alarm does not function when you leave the house)
Complex environmental Control	Accurate complex control by PLC Automatic control by gas sensor or timer	ON/OFF control by temperature & Humidity controller Manual control

In environmental control, the existing system roughly controls temperature and humidity by On/Off controller. The developed system can control temperature and humidity accurately by PLC controller. So the deviations in temperature and humidity are rougher than the developed system.

In ventilation, the existing system was more troublesome because the ventilation fan is operated manually while the developed system is operated automatically.

Farmers' response

Table. 3 show the farmers' response on the developed system. In the accuracy of operation, 52% of farmers responded to accuracy and 45% of farmers responded to normal. On usage, 69% of farmers responded to convenience and 28% of farmers responded to normal. In the necessity of commercializing, 83% of farmers responded to need to the developed system and 28% of farmers responded to normal. Results indicated that most of farmers have responded favorably.

Table. 3 Farmers' response about the developed system Unit : %(men)

Division	Accuracy of operation				Usage				Necessity of commercializing		
	Good	Fair	Poor	No resp.	Good	Fair	Poor	No resp.	Need	No need	No resp.
Cheon-an	46 (6)	46 (6)	-	8 (1)	62 (8)	30 (4)	-	8 (1)	85 (11)	-	15 (2)
An-dong	56 (9)	44 (7)	-	-	75 (12)	25 (4)	-	-	81 (13)	6 (1)	13 (2)
Average (Total)	52 (15)	45 (13)	-	3 (1)	69 (20)	28 (8)	-	3 (1)	83 (24)	3 (1)	14 (4)

CONCLUSIONS

Storage products may have serious damage when abnormal operation of freezing device occurs. So, the operation status must be monitored every time and abnormal operations must be corrected quickly. But it is very difficult and inconvenient to confirm the operation status of storage house at anytime.

The developed system for an automatic environmental control have some functions which are: to monitor storage condition, make an alarm by cellular phone and beeper remote when abnormal conditions have occurred, and control the storage environment accurately. With this innovation, the farmers and general Internet users can check the status of their storage environment anywhere using Internet. This can reduce the risk of farmers' products from damage brought about by abnormal operations of storage devices. Therefore, it is concluded that the developed system is very useful for management of low temperature storage house, and most farmers have favorable response to the new system in terms of accuracy, usability, convenience and commercialization.

REFERENCES

1. D.E.Kim, H.K.Cho. 1998. Control of environments in Greenhouse Using Programmable Logic Controller. Proceedings of the KSAM '98 Winter Conference. 3(1) : 174 – 179 (in Korean)
2. Fred Graham. 1998. Plug and Play Options for Computer-Based Electronics in Fixed Agricultural Equipment. ASAE Paper No. 983197
3. H.Chung, H.S.Yun, P.K.Oh, K.H.Cho, Y.H.Kim and Y.K.Cho. 1998. Development of an Automatic Environmental Control System for Low Temperature Storage Warehouse. Proceedings of the KSAM '98 Winter Conference. 3(1) : 180 – 186 (in Korean)
4. H.Chung, H.S.Yun, W.O.Lee, K.H.Lee, Y.K.Cho and W.K.Park. 2000. Development of an Environmental Monitoring System for Low Temperature Storage House by Way of the Internet. Proceedings of the KSAM 2000 Winter Conference. 5(1) : 542 – 547 (in Korean)
5. Seth D. Hughes, James D. Leary, Michael W. Annucci. 1998. Real-Time Display of Building Test Facility Data Using the Internet. ASAE Paper No. 983123.