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Reagent Cabinet Management System Using Danger Priority

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Abstract

Recently, as the number of safety accidents caused by reagents increases, researches on a system that can reduce safety accidents are underway. Existing systems managed reagent cabinet through various sensors. On the other hand, there are disadvantages in that countermeasures against simultaneous danger situations are insufficient at multi-reagents cabinet. In order to solve this problem, this paper proposes a system to manage the reagents cabinet through danger priority. Danger priorities are selected through domestic chemical accident cases and the Chemical Safety Management Act. If a danger situation occurs in the reagent cabinet, make sure it is from a single or multiple reagent cabinets. For multiple reagent cabinets, compare the reagent cabinet priorities and run the device sequentially from the reagent cabinet with the highest priority. Thus, by operating the device according to the danger priority, the chain reaction can be prevented in advance and the reagent cabinet can be safely managed.

Index Terms: Danger priority, IoT, Safety management, Sensor

I. INTRODUCTION

Recently, safety accidents caused by chemical substances in Korea are occurring in various forms. A total of 377 accidents occurred during the period from 2013 to 2016 [1, 2]. Occurrence of safety accidents occurred in the order of fire, explosion, chemical reaction, etc. Fire and explosion were the most common cause of death, followed by leakage and chemical reaction [3–5].

Depending on the type and size of the safety accident, the damage to the chemical, property, and damage of human life appears differently. Accordingly, recently, reagent cabinet systems for safely managing chemical substances are being developed. Existing systems identified danger situations according to internal environment and sent warning messages to the manager. On the other hand, there were problems that could not be coped with when danger situations occur simultaneously in several reagent cabinets [6–9].

In this paper, we propose a system that sets the danger priority in the reagent cabinet and automatically operates the equipment according to the danger priority in case of simultaneous danger situations. The danger priorities used in this system are set through accident cases and the Chemical Safety Management Act. The dangerous situation in the reagent cabinet is confirmed in real time through the sensor. If a hazardous situation arises, make sure it is from single or multiple reagent cabinets. If the single reagent cabinet has a danger situation, the device of the reagent cabinet is automatically operated. Compare the priority of the reagent cabinets when they occur in multiple reagent cabinets. After comparing the priorities, the reagent cabinet devices

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are operated sequentially according to the order. This allows rapid management of reagent cabinets by quickly responding to high-danger reagent cabinets.

II. SYSTEM DESIGN

The proposed system automatically operates the reagent cabinet's equipment according to the danger priority in case of simultaneous danger situations in several reagent cabinets. Through accident cases and chemical safety management laws, each reagent cabinet is assigned a danger priority, which determines the order of operation of the equipment. In addition, when the average value of the minimum and maximum thresholds set by the manager is close, the apparatus is stopped to provide an appropriate environment for reagent management.

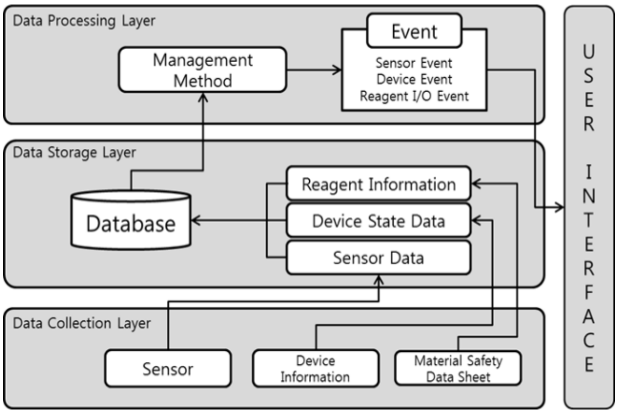

Fig. 1. System architecture.

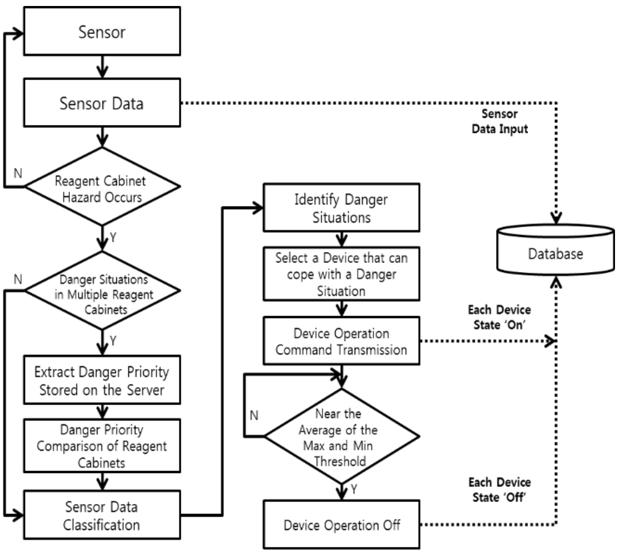

Fig. 2. System flow chart.

Fig. 1 shows the structure of the system. The data collection layer collects the real-time sensor data of the reagent cabinet, the status of the instrument, and the information of the reagent to be managed. The collected data is transferred to the data storage layer and stored in the database. Management method of the data processing layer requests data stored in the database. After receiving the requested data, check whether the reagent cabinet is in danger. When a danger situation occurs in the reagent cabinet, the corresponding event is executed. The results for the event are provided to the manager via the user interface.

Fig. 2 shows the flow of the proposed system. The internal environment of the reagent cabinet is measured in real time through sensors. The measured sensor data is stored in a database and used to determine if a dangerous situation has occurred at the reagent cabinet. If there is no dangerous situation inside the reagent cabinet, continuously measure the internal environment of the reagent cabinet. However, if a dangerous situation occurs in the reagent cabinet, first check to see if there is one or more reagent cabinets in which the dangerous situation occurs. When a dangerous situation occurs in a multiple reagent cabinets, the danger priority of the reagent cabinets set in the server is extracted and the priority is compared. When the comparison of the priorities is completed, the sensor data of the reagent cabinet in which a dangerous situation occurs is classified to identify a dangerous situation in the reagent cabinet. On the other hand, if a dangerous situation occurs in one reagent cabinet, the sensor data classification operation is performed without comparing the danger priorities. When a dangerous situation is identified, select the devices that can cope with such a dangerous situation that has occurred and transmit the operation command to the device. If the internal environment of the reagent cabinet is close to the average value of the maximum and minimum threshold values set by the manager after the device is operated, the operation of the device is stopped.

Fig. 3 shows the danger priorities used in the proposed system. Category 3 and 4, which require preferentially management, generate ignitable or flammable gases when in contact with water or generate flammable vapors at temperatures above a certain level. This can lead to fire or explosion safety accidents. Category 2 and 5 may ignite

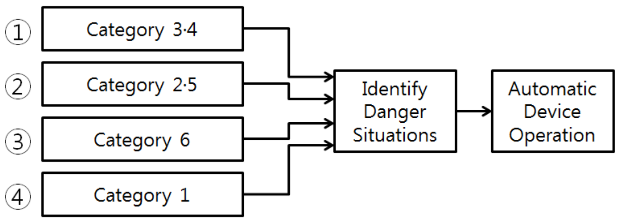

Fig. 3. Danger priority setting.

when metal powder comes in contact with water or spontaneous ignition by oxidation reaction. In addition, when a fire occurs, toxic gas is generated. Category 6 is an oxidizing liquid that has strong corrosiveness and has a characteristic of generating heat upon contact with water. Category 1 releases oxygen when exposed to heat, impact and other chemicals. It also has that can help in safety accidents around.

III. SYSTEM IMPLEMENTATION

This section deals with the implementation of the proposed system. Fig. 4 shows the main page of the application.

On the main page, you can monitor the temperature, humidity, volatile organic compound (VOC) real-time and instrument status measured by the sensors attached to the reagent cabinet. When the device is in operation, the toggle button is activated and changes to the ON state. When the device is in the Stop state, the toggle button is inactivated to indicate the OFF state. You can also move to another page with the four buttons below. The Reagent Output page allows you to check the I/O history of the reagents you are managing. The Log page provides a record of the danger situation in the reagent cabinet and the Search page provides information on the reagents managed. The Control page also allows the manager to remotely control the reagent cabinet through the application.

Fig. 5 shows the remote control page of the application. The temperature and humidity can be set to the value desired by the manager through the increase and decrease buttons. The instrument can be controlled on or off via the toggle button. After the manager changes the temperature, humidity and control status of the instrument, click the set button and the changed values are stored in the database.

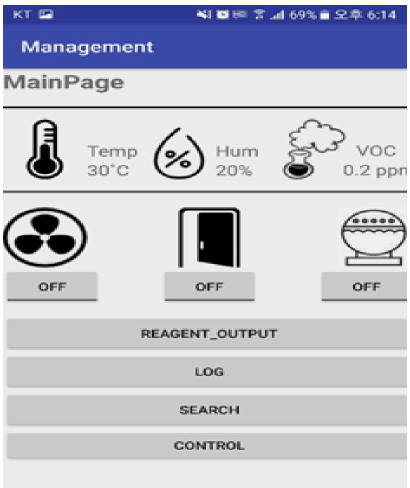

Fig. 4. Application main page.

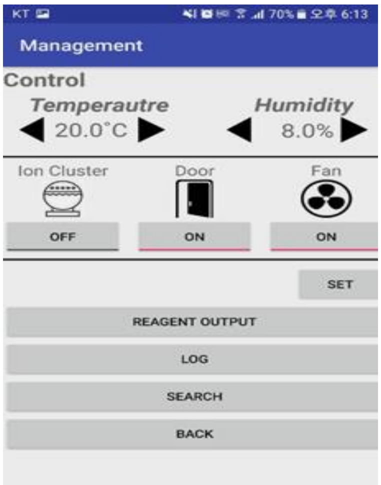

Fig. 5. Application control page.

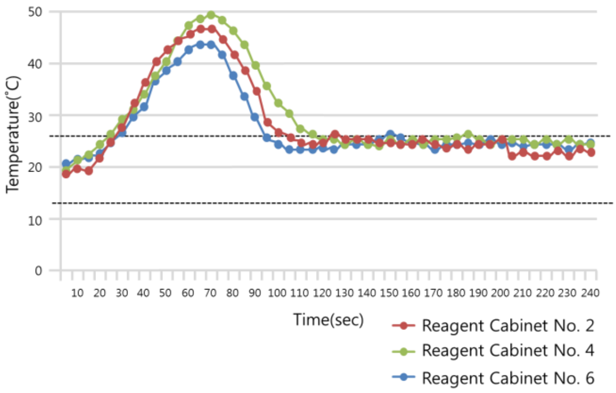

Fig. 6. Experimental results of system without danger priority applied.

IV. REVIEW

In this paper, danger priority is set for each reagent cabinet. Also, when the simultaneous dangerous situation occurs, the equipment of the reagent cabinet is operated sequentially according to the set priority. In this way, it is possible to prevent the spread of secondary damage and danger situation by preferentially operating the equipment of the high danger reagent when the danger situation occurs.

Fig. 6 shows the experimental results of the system without applying the danger priority. If a hazardous situation occurs simultaneously in reagent cabinet's No. 2, 4, and 6, the equipment is operated under the control of the manager. The manager operated the device of the reagent cabinet No. 6 first, and the devices of the reagent cabinet No. 2, 4 reagent sequentially. This operation sequence can be changed by the manager choice. On the other hand, in case of the danger priority, the operation of the device should be performed first because the reagent cabinet No. 4 is the most

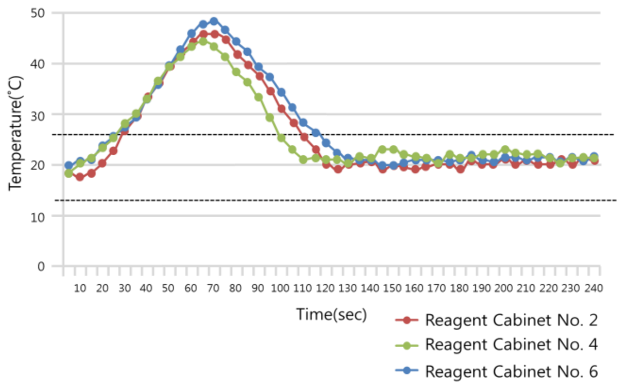

Fig. 7. Experimental results of systems with danger priority.

dangerous. In case of a danger situation, the delay of the operation of the equipment of the high danger reagent may lead to the spread of secondary damage and danger situation. Also, regardless of the threshold set by the manager, if the temperature is lower than the maximum threshold value, it is identified that the danger situation has ended and the temperature of the reagent temperature is maintained close to the maximum threshold value.

Fig. 7 shows the experimental results of the system applying the danger priority. No. 2, 4, 6 when the danger situation occurs simultaneously in the reagent cabinet, operates the devices sequentially according to the danger priority. Since the reagent cabinet No. 4 is the most dangerous in the danger priority, the equipment is operated first and the equipment of the reagent cabinet's No. 2 and 6 are operated sequentially. It also stops the device when it approaches the average value of the minimum and maximum thresholds set by the manager.

V. CONCLUSTIONS

In this paper, we propose a system to set the danger priority and to operate the device according to the priorities in case of simultaneous danger situations. The system measures the internal environment in real time through the sensors attached to the reagent cabinet and identifies the danger situation. It also identifies the danger situations of a single or multiple reagent cabinet when a hazard occurs. In a single case, the appliance of the corresponding reagent cabinet is automatically operated, but in the case of multiple reagent cabinet, the appliance is automatically operated in sequence after comparing the priorities. In this way, priority can be given according to the danger of the reagent cabinet, so that it can be coped more quickly than the existing system by automatically coping with a high danger reagent cabinet when a simultaneous danger situation occurs. Therefore, the reagent cabinet can be safely managed by preventing the secondary damage and the spread of the danger situation due to the safety accident of the reagent cabinet. Future research should verify efficiency through various experiments.

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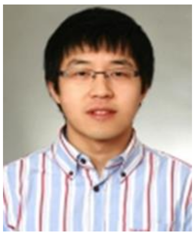

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