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Implementation Method of Optimal Monitoring System for Reliable Operation of Computational Equipment Installed on In-Rack System

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Abstract

As the need for increasing the efficiency of the air cooling equipment in the data center emerges, all countries and companies around the world are working to increase the cooling efficiency in the data center. Thus, the study of the monitoring system for the stable operation of computerized equipment installed on the IN-RACK system was performed through the paper, "Building the monitoring system for efficient operation of data computerized equipment". Furthermore, based on the sensor network, one step advanced energy efficiency measure is to be proposed through the optimal monitoring system's implementation for the reliable operation of computerized equipment installed on the IN-RACK system.

Keywords: Cooling Rack, IDC, IDC, In-Rack System, Monitoring

1. Introduction

As the performance of the server equipment making up the infrastructure is being improved together with the rapid development of IT and its size is increased over the years, it is the trend that the power consumption is significantly increases and also the total power consumption by cooling equipment is also increasing[1].

Especially in case of the data center, while it's being expanded into the internet business environment, the energy cost is rapidly increasing due to the performance improvement of IT equipment and the expansion of facility in size according to it. The current data center industry is consuming approximately 1.5% of the total world energy (power)[2].

In this study, one step advanced energy efficiency measure is to be proposed by building the real-time monitoring and controllable monitoring system of the In-Rack system which was obtained through the study, "Applying In-Rack system and wind-tunnel formation technology for the data center's cooling efficiency improvement".

2. Introduction

2.1 Related Study

The cooling of the data center is done by CRAC(Computer Room Air Conditioning) equipment. The air flowed into the CRAC equipment is cooled down through the chiller and the cooled air flows into IT equipment as cooling air by the air conditioning equipment[3]. The IT equipment discharges the occurred heat though the cooling fan and this hot air flows into the CRAC equipment again[4].

In such circulation process, the hot/cold aisle layout method and raised floor area method have been broadly used for the deployment within the data center racks in order to increase the cooling efficiency[5].

While the room based cooling which has been used in the data center for a long time is to maintain the average temperature by continuously mixing indoor air, it is effective only if the power density per server is small enough such as 1~3kW[6]. As recently, the power density of the equipment exceeds 20 kW per rack, it's a situation that the room based

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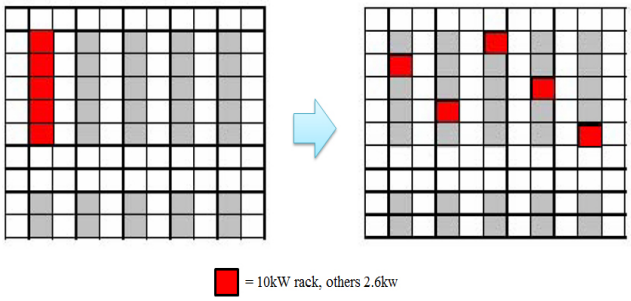

Figure 1. Data center where high-density racks are distributed.

cooling system is no longer applicable[7]. In order to solve this problem, the new cooling design focusing on the row based cooling or rack based cooling has been proposed[8].

Also, it is effective because it can borrow unused cooling capacity from neighboring racks when high power racks are separated from each other by distributing the heat load due to high-density rack through installing a stand-alone high-density device or distributing high-density racks[9].

Sensor network technology uses sensor and wireless network to translate analog data measured from physical space to digital signal, and then, it performs a role of input system sending Root connected to electronic space like Internet to Node. Due to its feature of connecting physical space and cyber space, it applies to various areas such as intelligent environmental monitoring, Location-based Services, intelligent medical system, intelligent robot system, etc[10,11].

3. Monitoring System

The schematic diagram of 'Implementation Method of Optimal Monitoring System for Reliable Operation of Computational Equipment installed on In-Rack System' is shown in the following figure. The data measured from temperature/humidity sensors installed on In-Rack system and Power Distribution Unit metering power consumption is transferred to embedded system via RS-485 and stored in database.

Monitoring system analyzes various information and provides them to users. It notifies alerts to users through alarm function when the temperature level exceeds threshold set for stable operation of the equipment.

3.1 Control Unit of Monitoring System

Monitoring system's control section includes measuring step that measures temperature/humidity level, cooling

Figure 2. Schematic diagram of 'Implementation Method of Optimal Monitoring System for Reliable Operation of Computational Equipment installed on In-Rack System'.

Figure 3. Single control system of In-Rack system (1:1).

step 1 that activates cooling inside the In-Rack system when the measured data exceeds the temperature level 1, cooling step 2 that maximizes cooling output when the measured data reaches to the temperature level 2, and open step that opens door when the measured data reaches to temperature level 3.

Control section performs a role of controller for operation of cooling system including temperature/humidity measurement, exhaust fan, cooling section, network section, humidification section, heating section, etc. And it also includes data processing unit, memory, application program storage, etc. Based on measured data, it controls cooling section to cool inside In-Rack

system, or controls heating section to heat inside In-Rack system.

While the difference usually exists in computerized equipment by manufacturer, the appropriate temperature is determined within about 5°C–40°C[12,13]. Therefore, the first temperature where the control unit judges that the cooling is necessary is determined to the temperature between 15°C and 30°C.

The temperature and humidity measurement unit collects information by continuous sensing during the cooling unit's cooling operation controlled by the control unit and the outlet fan helps enhance the cooling efficiency by discharging the air inside of the in-Rack system to outside during the cooling operation being performed.

Also, the outlet fan helps maintain the proper temperature for the computing equipment's operation with air exhaust operation only by performing the air discharge operation regardless of the cooling unit's cooling operation.

If the temperature measured from the temperature and humidity measurement unit rises to more than the first temperature by a predetermined value and reaches the second temperature during the cooling operation of the cooling unit according to the control command from the control unit, the control unit controls the cooling unit to perform the cooling operation at maximum power.

Also during the cooling unit's cooling operation, the temperature and humidity measurement unit controls the cooling output gradually to increase as the temperature rises by continuously measuring the internal temperature and humidity of the In-Rack system.

And, when the temperature inside of the In-Rack system reaches the second temperature, the control unit controls the cooling unit to perform a cooling operation at full power.

It includes the outrage management system which controls the control unit to open the door of the In-Rack system once the temperature detected from the temperature and humility measurement unit rises above a predetermined value from the second temperature and reaches the third temperature while the cooling unit carries out the cooling operation at full power under the control of the control unit.

If the temperature rises above a predetermined value from the second temperature and reaches the third temperature by continuous sensing of the temperature inside while the cooling unit carries out the cooling operation at full power, it controls the In-Rack system's door to be open and performs the cooling operation by allowing outside air to flow into the inside of the In-Rack system.

In this case, the third temperature can be determined to a temperature above the second temperature by 3°C–7°C so for example, the third temperature becomes 30°C–34°C if the second temperature is 27°C.

When the door of the In-Rack system is open, the control unit can reduce the power consumption by controlling the cooling unit to stop the cooling operation

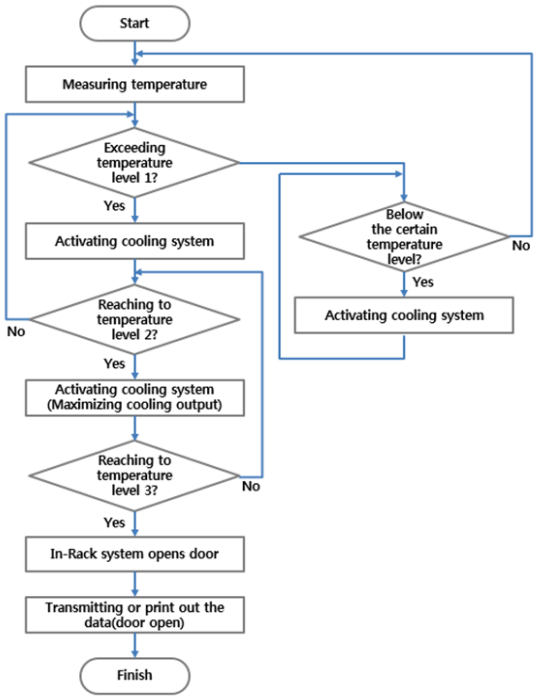

Figure 4. Flow Chart of monitoring system's control section.

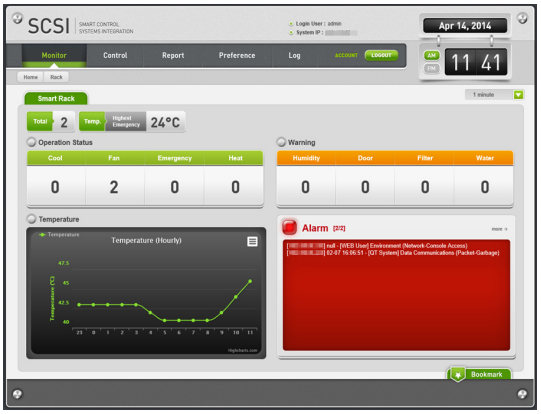

Figure 5. Operation Status and Warning view in many In-Rack systems.

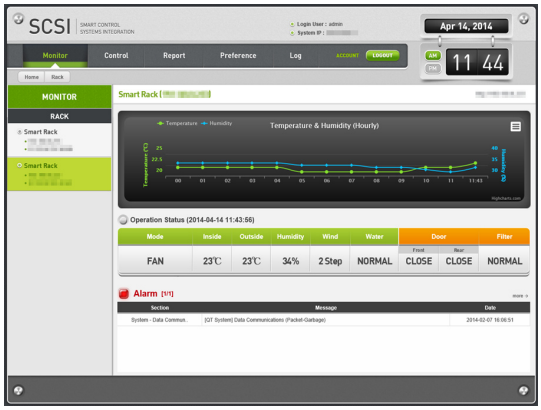

Figure 6. Specific In-Rack system monitoring.

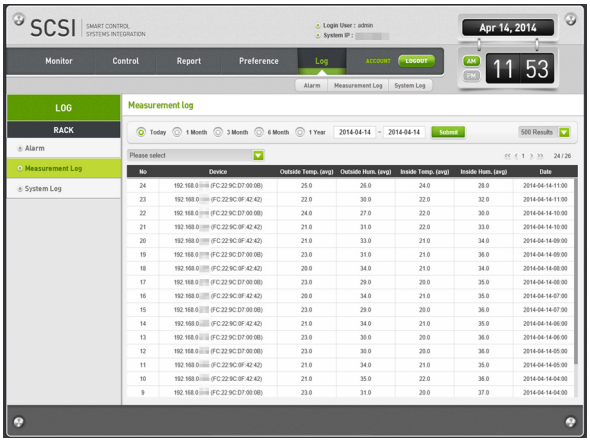

Figure 7. Logs list of sensed data.

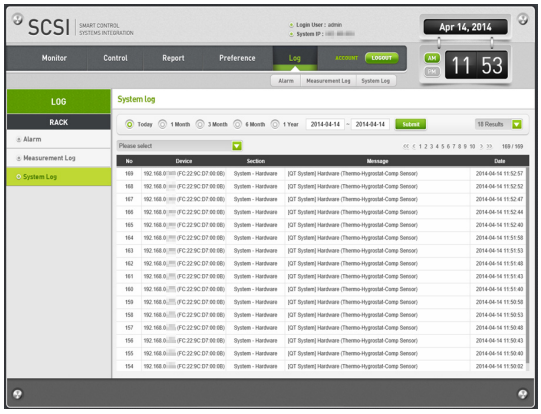

Figure 8. System log list.

inside of the In-Rack system or the exhaust fan to stop the air discharging operation.

Typically in the environment of less than 35% relative humidity, the damage to circuit components can happen due to static electricity and in the environment of more than 70% relative humidity environment, the oxidation on metal objects of the server or network equipment's main body can occur[14,15].

If the humidity inside of the In-Rack system exceeds a certain humidity range in the range of between 35%~ 70% relative humidity, the control unit controls the humidity inside of the In-Rack system by controlling the constant humidity unit to perform a humidifying or dehumidifying operation.

3.2 Communication Unit of Monitoring System

Monitoring system's control section transmits various event information such as sensing information, exhaust fan's operating status, cooling operation status, door status, etc… to users through network section. The measured data from In-Rack system can be transmitted via PC, smart phone, etc… and this data is printed out to help users easily monitor and promptly react to the problem

The monitoring system proposed in this study enables the reliable operation of computing equipment installed on the In-Rack system through the control of the cooling function based on the sensed information

Also it is possible to grasp the energy consumption and performance pattern of the computing equipment installed on the In-Rack system by analyzing the sensed information which is stored in the database

Through this, it is expected that the energy consumption's prediction based on the actual measurement data is possible and the proactive energy management would be possible.

4. Conclusions

Monitoring system introduced by this study enables to safely operate computerized equipment through various monitoring and controlling environmental information like temperature/humidity, etc… inside In-Rack system. Users are able to monitor and control the environmental condition inside the cabinet. This monitoring system provides statistics and predictive information of the environmental condition s and power usage in the cabinet

If the reliability and stability are secured through various tests on this monitoring system, it can be the monitoring system which can improve the efficiency of monitoring and energy for reliable computing equipment's

management of not only the data center but also small and medium-sized server room.

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