DESCRIPTION

Title of Invention

AIR CONDITIONING EQUIPMENT CONTROL DEVICE, AIR CONDITIONING EQUIPMENT CONTROL METHOD, AND PROGRAM

Technical Field

[0001]

The present disclosure relates to an air conditioning equipment control device, an air conditioning equipment control method, and a program. Priority is claimed on Japanese Patent Application No. 2023-133892, filed August 21, 2023, the content of which is incorporated herein by reference.

Background Art

[0002]

In a facility (for example, a server room) in which a large number of heat generating bodies (for example, IT equipment such as a server or a communication device) are disposed, air conditioning equipment for cooling the heat generating bodies is provided (see JP5801732B and JP2023-26104A). In such air conditioning equipment, setting conditions (for example, temperature) are generally changed for each season in consideration of power efficiency and the like.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Patent No. 5801732

[PTL 2] Japanese Unexamined Patent Application Publication No. 2023-

26104

Summary of Invention

Technical Problem

[0004]

In the air conditioning equipment control method in the related art, the setting conditions are constant in a certain season. However, a heat load of the heat generating body (for example, an increase in room temperature due to heat generation of the heat generating body) changes not only by season but also by time of day. Therefore, in reality, the original ideal setting conditions change from time to time during a day.

[0005]

An object of the present disclosure is to provide an air conditioning equipment control device, an air conditioning equipment control method, and a program that can operate air conditioning equipment under an optimal setting condition in response to a heat load that changes from time to time.

Solution to Problem

[0006]

According to one aspect of the present disclosure, there is provided an air conditioning equipment control device for air conditioning equipment including an air conditioner provided in a facility in which a plurality of heat generating bodies are disposed, the air conditioning equipment control device including an acquisition unit that acquires a measurement value including a temperature measured at a predetermined position of the facility and a setting condition of the air conditioning equipment including a set temperature of the air conditioner, a prediction unit that predicts a future heat load corresponding to each of a plurality of setting condition

candidates by using a model with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body as a response variable, and a control unit that selects, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controls the air conditioning equipment based on the selected setting condition candidate.

[0007]

According to one aspect of the present disclosure, there is provided an air conditioning equipment control method for air conditioning equipment including an air conditioner provided in a facility in which a plurality of heat generating bodies are disposed, the air conditioning equipment control method including a step of acquiring a measurement value including a temperature measured at a predetermined position of the facility and a setting condition of the air conditioning equipment including a set temperature of the air conditioner, a step of predicting a future heat load corresponding to each of a plurality of setting condition candidates by using a model with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body as a response variable, and a step of selecting, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controlling the air conditioning equipment based on the selected setting candidate condition.

[0008]

According to one aspect of the present disclosure, there is provided a program for causing an air conditioning equipment control device for air conditioning

equipment including an air conditioner provided in a facility in which a plurality of heat generating bodies are disposed to execute a step of acquiring a measurement value including a temperature measured at a predetermined position of the facility and a setting condition of the air conditioning equipment including a set temperature of the air conditioner, a step of predicting a future heat load corresponding to each of a plurality of setting condition candidates by using a model with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body as a response variable, and a step of selecting, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controlling the air conditioning equipment based on the selected setting candidate condition.

Advantageous Effects of Invention

[0009]

According to the above-described aspect, the air conditioning equipment can be operated under an optimal setting condition in response to a heat load that changes from time to time.

Brief Description of Drawings

[0010]

FIG. 1 is a diagram showing an overall configuration of an air conditioning system according to a first embodiment.

FIG. 2 is a block diagram showing a functional configuration of a control device according to the first embodiment.

FIG. 3 is a flowchart showing an example of processing of the control device according to the first embodiment.

FIG. 4 is a diagram showing an example of a model according to the first embodiment.

FIGS. 5A to 5C are diagrams for describing functions of the control device according to the first embodiment.

Description of Embodiments

[0011]

<First Embodiment>

Hereinafter, an embodiment will be described in detail with reference to the drawings.

[0012]

(Overall Configuration)

FIG. 1 is a diagram showing an overall configuration of an air conditioning system according to a first embodiment.

As shown in FIG. 1, an air conditioning system 1 includes a plurality of heat generating bodies 2, air conditioning equipment 3, and a control device 10.

[0013]

The heat generating body 2 is, for example, IT equipment such as a server or a communication device disposed in a facility R. The facility R is a server room or the like. The heat generating body 2 includes a fan 20 that takes in cold air from the outside and that discharges air heated by heat generated by the heat generating body 2. As shown in FIG. 1, the heat generating bodies 2 are arranged in a left-right direction of a paper plane and are arranged in an up-down direction of the paper plane across a passage. In this case, in the up-down direction of the paper plane, the fans 20 of the respective heat generating bodies 2 are disposed such that intake sides face each other and exhaust sides face each other. A passage in which the intake side of the fan 20 is

disposed is also referred to as a cold aisle CA, and a passage in which the exhaust side of the fan 20 is disposed is also referred to as a hot aisle HA.

[0014]

In addition, the heat generating body 2 is provided with an intake temperature sensor 21 that measures an intake temperature of the heat generating body 2 (fan 20) and an exhaust temperature sensor 22 that measures an exhaust temperature. In another embodiment, a temperature sensor that measures a temperature of a CPU, a GPU, or the like included in the heat generating body 2 (hereinafter, also collectively referred to as a CPU temperature) may be provided instead of the intake temperature sensor 21 and the exhaust temperature sensor 22 or in addition to the intake temperature sensor 21 and the exhaust temperature sensor 22.

[0015]

The air conditioning equipment 3 includes at least one air conditioner 30. The air conditioner 30 takes air in the facility R and discharges the air cooled by a heat exchanger (not shown) into the facility R. The number of air conditioners 30 may be varied as appropriate depending on a size of the facility R, the number of heat generating bodies 2, or the like.

[0016]

In addition, the air conditioner 30 is provided with a suction temperature sensor 31 that measures a temperature of the air to be sucked and a discharge temperature sensor 32 that measures a temperature of the air to be discharged (cooled air).

[0017]

The air conditioning equipment 3 may further include at least one humidifier 35. The humidifier 35 adjusts a humidity in the facility R. The number of

humidifiers 35 may be varied as appropriate depending on the size of the facility R or the like.

[0018]

The fan 20 included in the heat generating body 2 may also be used as one component of the air conditioning equipment 3.

[0019]

In addition, the facility R is provided with a temperature sensor 51 that measures a room temperature of the facility R and a humidity sensor 52 that measures a humidity of the facility R.

[0020]

The control device 10 controls the air conditioning equipment 3 such that an environment in the facility R satisfies a predetermined environmental condition. The environmental condition is, for example, a target value of the room temperature of the facility R, the humidity of the facility R, or the like, which will be described in detail later.

[0021]

(Functional Configuration of Control Device)

FIG. 2 is a block diagram showing a functional configuration of the control device according to the first embodiment.

As shown in FIG. 2, the control device 10 comprises a processor 11, a memory 12, a storage 13, and a communication interface 14.

[0022]

The processor 11 operates according to a predetermined program to cause the control device 10 to exhibit various functions. The functions of the processor 11 will be described below.

[0023]

The memory 12 has a memory region necessary for the operation of the processor 11.

[0024]

The storage 13 is a so-called auxiliary storage device and is, for example, a hard disk drive (HDD), a solid-state drive (SSD), or the like. The storage 13 stores data that is acquired, generated, and referred to by each unit of the processor 11 during processes.

[0025]

The communication interface 14 is an interface for transmitting and receiving various types of data (measurement values), control signals, and the like to and from each sensor, the air conditioning equipment 3 (the air conditioner 30, the humidifier 35), and the like.

[0026]

Next, the functions of the processor 11 will be described. The processor 11 operates according to a program prepared in advance to function as an acquisition unit 111, a prediction unit 112, a control unit 113, and a learning unit 114.

[0027]

The acquisition unit 111 acquires measurement values of each sensor.

[0028]

The measurement value of the sensor is, for example, a temperature measured at a predetermined position of the facility R. The temperature measured at the predetermined position of the facility R is at least one of the room temperature of the facility R measured by the temperature sensor 51, the suction temperature of the air conditioner 30 measured by the suction temperature sensor 31, the discharge

temperature of the air conditioner 30 measured by the discharge temperature sensor 32, the intake temperature of the heat generating body 2 (fan 20) measured by the intake temperature sensor 21, the exhaust temperature of the heat generating body 2 (fan 20) measured by the exhaust temperature sensor 22, or the temperature (CPU temperature) of the heat generating body. In addition, in a case where the air conditioning equipment 3 includes the humidifier 35, the measurement value of the sensor may further include a humidity of the facility R measured by the humidity sensor 52.

[0029]

The prediction unit 112 predicts a future heat load corresponding to each of a plurality of setting condition candidates by using a model M with the measurement value and the setting condition of the air conditioning equipment 3 as explanatory variables and the heat load due to heat generation of the heat generating body 2 as a response variable. The model M is a model that has been trained in advance by a learning unit 114 described below.

[0030]

The setting condition of the air conditioning equipment 3 includes, for example, a set temperature of the air conditioner 30. In addition, the setting condition of the air conditioning equipment 3 may include a set air volume of the air conditioner 30. In a case where the air conditioning equipment 3 includes a plurality of air conditioners 30, the setting condition may include the number of air conditioners 30 to be operated. In this case, the setting condition includes, in addition to the number of air conditioners 30 to be operated, the setting of ON (to be operated)/OFF (not to be operated) of each air conditioner 30, and the set temperature and the set air volume of each air conditioner 30 to be operated.

[0031]

In addition, in a case where the air conditioning equipment 3 includes the humidifier 35, the setting condition may include the number of humidifiers to be operated. In this case, the setting condition includes, in addition to the number of humidifiers to be operated, the setting of ON (to be operated)/OFF (not to be operated) of each humidifier 35.

[0032]

Further, the setting condition may include an air volume or a rotation speed of the fan 20 of each heat generating body 2.

[0033]

The heat load includes, for example, at least one of a power usage effectiveness (PUE) of the facility R affected by heat generation of the heat generating body 2, a room temperature of the facility R, a suction temperature of the air conditioner 30, a discharge temperature of the air conditioner 30, an intake temperature of the heat generating body 2 (fan 20), an exhaust temperature of the heat generating body 2 (fan 20), or a temperature (CPU temperature) of the heat generating body 2. In addition, in a case where the air conditioning equipment 3 includes the humidifier 35, the heat load may further include a humidity of the facility R.

[0034]

The control unit 113 selects, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value of the heat load is obtained, and controls the air conditioning equipment 3 based on the selected setting candidate condition.

[0035]

The environmental condition is a reference value (upper limit value or lower limit value) or a reference range (a range from a lower limit value to an upper limit

value) of the heat load described above. The reference value or the reference range of each heat load is set as appropriate depending on the number, the disposition, the specification, and the like of the heat generating body 2 or the air conditioning equipment 3.

[0036]

The learning unit 114 performs machine learning on the model M using time-series data of the measurement value of each sensor and the heat load calculated from the measurement value of the setting condition and the setting condition of the air conditioning equipment 3 as learning data. It is assumed that the learning unit 114 trains the model M using a predetermined number of time-series data in a learning phase and records the model M in the storage 13.

[0037]

Further, the learning unit 114 performs retraining and updating of the model M after the learning phase is completed and an operation phase is started. Specifically, the learning unit 114 calculates an actual value of the heat load at an evaluation target time from the measurement value and the setting condition acquired at the evaluation target time, and updates the model M by training based on an error between the actual value and a predicted value of the heat load at the evaluation target time, which was predicted in the past. The evaluation target time is, for example, a current time, but may be a past time (for example, n minutes before the current time).

[0038]

The predetermined program executed by the processor 11 is stored in a computer-readable recording medium. In addition, examples of the computer-readable recording medium include a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, and a semiconductor memory. In addition, the computer

program may be distributed to a computer via a communication line, and the computer receiving the distribution may execute the program. Further, the program may be a program for realizing some of the functions described above. The program may be a so-called difference file (difference program) that can realize the above-described functions in combination with a program already recorded in the computer system.

[0039]

(Processing Flow of Control Device)

FIG. 3 is a flowchart showing an example of processing of the control device according to the first embodiment.

Hereinafter, details of the processing of the control device 10 will be described with reference to FIG. 3. It is assumed that the learning phase is completed at the time of FIG. 3. Therefore, FIG. 3 shows processing in the operation phase of the control device 10.

[0040]

The acquisition unit 111 acquires the measurement value at the current time from each sensor (step S01).

[0041]

Next, the control device 10 controls the air conditioning equipment 3 (step S02) and updates the model M (step S03). It should be noted that FIG. 3 shows an example in which step S02 and step S03 are executed in parallel, but the present disclosure is not limited thereto. In another embodiment, step S03 may be executed after step S02, or step S02 may be executed after step S03.

[0042]

First, a control processing S02 of the air conditioning equipment 3 will be described. The prediction unit 112 reads out the model M recorded in the storage 13,

inputs the measurement value at the current time acquired in step S01 and the setting condition candidate of the air conditioning equipment 3 to be applied from the current time to the model M, and obtains a predicted value of the future heat load as an output (step S21).

[0043]

FIG. 4 is a diagram showing an example of a model according to the first embodiment.

As shown in FIG. 4, the model M according to the present embodiment is a neural network that receives the explanatory variable and that outputs the response variable. Here, for simplicity of description, it is assumed that the explanatory variable input to the model M is a setting condition consisting of a combination of three items of the number of air conditioners to be operated, the set temperature of each air conditioner 30 to be operated, and the number of humidifiers to be operated, and two measurement values of the room temperature and the humidity of the facility R. In addition, it is assumed that the response variable output from the model M is a predicted value of a power usage effectiveness (PUE) representing the future heat load (for example, 30 minutes later), the room temperature of the facility R, and the humidity of the facility R. The PUE is an index obtained by dividing the power consumption in the entire facility R by the power consumption of the heat generating body 2. The smaller the value of the PUE is, the higher the efficiency is. In the storage 13 of the control device 10, actual set values of the number of air conditioners to be operated at each time, the set temperature of the air conditioner, and the number of humidifiers to be operated, and actual measured values of the room temperature, the humidity, and the PUE are recorded. In addition, the trained model M recorded in the storage 13 has been trained by machine learning using the time-series data in the past

as learning data in the learning phase.

[0044]

In the operation phase shown in FIG. 3, in step S21, the room temperature and the humidity at the current time (measurement values acquired in step S01) and the setting condition candidate to be applied from the current time (a combination of the number of air conditioners to be operated, the set temperature of the air conditioner, and the number of humidifiers to be operated) are input to the model M as the explanatory variable. The response variable output from the model M is a predicted value of a future PUE, the room temperature, and the humidity in a case where the setting condition candidate is applied. That is, the prediction unit 112 can predict how the future heat load changes in a case where the setting condition is changed. In the present embodiment, the prediction unit 112 inputs a plurality of setting condition candidates to the model M to obtain a predicted value of the future heat load corresponding to each setting condition candidate as an output.

[0045]

Next, the control unit 113 selects the optimal setting condition that satisfies the environmental condition of the facility R based on the setting condition candidate and the predicted value of the future heat load (step S22).

[0046]

The environmental condition of the facility R is, for example, a reference value (upper limit value or lower limit value) or a reference range (a range from an upper limit value to a lower limit value) of the heat load. In the example described above, it is assumed that the reference value (upper limit value X degrees or less) of the room temperature and the reference value (lower limit value Y% or more) of the humidity in the heat load are set as the environmental condition to be satisfied. The

control unit 113 selects, as the optimal setting condition, the setting condition candidate in which both the room temperature and the humidity satisfy the environmental condition and the PUE is minimized (step S22).

[0047]

FIGS. 5A to 5C are diagrams for describing functions of the control device according to the first embodiment.

In addition, as shown in FIGS. 5A to 5C, the control unit 113 may generate a response surface indicating a sensitivity of the setting condition to the heat load in the current state (room temperature, humidity), and may specify the optimal setting condition by using the response surface. For each combination of setting conditions, FIG. 5A shows a PUE predicted value, FIG. 5B shows a room temperature predicted value, and FIG. 5C shows a humidity predicted value, respectively. It should be noted that FIGS. 5A to 5C show an example of a response surface representing a correspondence between a combination of the set temperatures of the two air conditioners 30 (air conditioners 1 and 2) and the heat load among the setting conditions, but the same response surface is generated for a combination of other setting conditions.

[0048]

In addition, for a portion of the heat loads, a reference value (upper limit value or lower limit value) or a reference range (a range from an upper limit value to a lower limit value) is defined in advance as the environmental condition of the facility R. For example, it is assumed that a reference value C1 (for example, X degrees or less) of the room temperature and a reference value C2 (for example, Y% or more) of the humidity are defined in advance as the environmental condition. The control unit 113 narrows down the setting condition candidate in which both the room temperature and

the humidity satisfy the environmental condition based on the response surfaces of the room temperature and the humidity shown in FIGS. 5B and 5C and on the environmental condition (the reference value C1 of the room temperature and the reference value C2 of the humidity). In addition, the control unit 113 selects, as the optimal setting condition, the setting condition candidate in which the PUE is minimized among the narrowed-down setting condition candidates with reference to the response surface of the PUE shown in FIG. 5A (step S22). The control unit 113 records the specified setting condition and the predicted value of the corresponding heat load in the storage 13.

[0049]

Next, the control unit 113 outputs the control signal to each component of the air conditioning equipment 3 (the air conditioner 30 and the humidifier 35) based on the selected setting condition (step S23).

[0050]

By repeatedly executing the above processing, the control device 10 can predict the heat load that changes from time to time, and operate the air conditioning equipment 3 under the optimal setting condition to minimize the power (power consumption).

[0051]

In addition, returning to FIG. 3, an update processing S03 of the model M in the learning unit 114 will be described. First, the learning unit 114 specifies the heat load at the current time (time t) based on the measurement value acquired in step S01 (step S31). In addition, here, as in step S02, it is assumed that the heat load is the room temperature, the humidity, and the PUE of the facility R. For the room temperature and the humidity, the measurement value acquired in step S01 may be

used as it is. In addition, the PUE is calculated, for example, by measuring the power consumption of the entire facility R with a power meter (not shown) and measuring the power consumption of the heat generating body 2.

[0052]

Next, the learning unit 114 trains the model M using an error between the "predicted value of the heat load at time t" predicted in the past and the "actual measured value of the heat load at time t", to update the model M (step S32). For example, it is assumed that the control unit 113 predicts the heat load 30 minutes later. In this case, the learning unit 114 reads out the predicted value of the heat load predicted by the control unit 113 30 minutes before the time t (current time) from the storage 13, and obtains an error between the predicted value of the heat load and the actual measured value of the heat load specified in step S31. Then, the learning unit 114 trains the model M using the weights so as to minimize an evaluation function consisting of the error, to update the model M, for example.

[0053]

The learning unit 114 can improve an accuracy of predicting the heat load by the model M by retraining and updating the model M from time to time in this way.

[0054]

(Operations and Effects)

As described above, the control device 10 for the air conditioning equipment according to the present embodiment includes the acquisition unit 111 that acquires the measurement value measured by each sensor and the setting condition of the air conditioning equipment 3, the prediction unit 112 that predicts the future heat load corresponding to each of the plurality of setting condition candidates by using a model M with the measurement value and the setting condition as explanatory variables and

the heat load due to heat generation of the heat generating body 2 as a response variable, and the control unit 113 that selects, from among the setting condition candidates, the setting condition candidate in which a predicted value satisfying an environmental condition is obtained, and controls the air conditioning equipment 3 based on the selected setting candidate condition.

[0055]

In this way, the control device 10 can predict the heat load that changes from time to time, and operate the air conditioning equipment 3 under the optimal setting condition to minimize the power (power consumption).

[0056]

In addition, the control device 10 further comprises the learning unit 114 that specifies the actual value of the heat load at the evaluation target time from the measurement value and the setting condition acquired at the evaluation target time, and updates the model M by training based on an error between the specified actual value of the heat load and the predicted value of the heat load at the evaluation target time, which was predicted in the past.

[0057]

In this way, the control device 10 can improve the accuracy of predicting the heat load by the model M as the heat generating body 2 and the air conditioning equipment 3 are operated.

[0058]

In addition, the measurement value is at least one of the room temperature of the facility R, the suction temperature of the air conditioner 30, the discharge temperature of the air conditioner 30, the intake temperature of the heat generating body 2, the exhaust temperature of the heat generating body 2, or the temperature

(CPU temperature) of the heat generating body 2.

[0059]

As described above, the control device 10 can predict the heat load and select the optimal setting condition by using various temperatures measured in the facility R. That is, since the control device 10 can use the temperature sensor already provided in the facility R, the heat generating body 2, or the air conditioning equipment 3, it is possible to reduce the cost of introducing a new sensor.

[0060]

In addition, the setting condition further includes at least one of the number of air conditioners 30 to be operated, the air volume of the air conditioner 30, or the air volume or the rotation speed of the fan 20 included in the heat generating body 2.

[0061]

In this way, the control device 10 can control the air conditioning equipment 3 by combining various setting conditions depending on the number and the functions of air conditioners 30, the specifications of the fan 20 of the heat generating body 2, or the like. In addition, the control device 10 can finely control the air conditioning equipment 3 such that the future heat load is in a more appropriate state by combining the plurality of setting conditions.

[0062]

In addition, the heat load includes at least one of the room temperature of the facility R, the suction temperature of the air conditioner 30, the discharge temperature of the air conditioner 30, the intake temperature of the heat generating body 2, the exhaust temperature of the heat generating body 2, and the temperature (CPU temperature) of the heat generating body 2, and the PUE of the facility R, and the control unit 113 selects the setting condition candidate in which the predicted value of

the heat load other than the PUE satisfies the environmental condition and the predicted value of the PUE is minimized.

[0063]

In this way, the control device 10 can control the air conditioning equipment 3 such that the future heat load is in a more appropriate state and the PUE is minimized.

[0064]

In addition, the air conditioning equipment 3 further includes a plurality of humidifiers 35, the measurement value and the heat load further include the humidity of the facility R, and the setting condition further includes the number of humidifiers 35 to be operated.

[0065]

In this way, the control device 10 can control the air conditioning equipment 3 such that the humidity is also in an appropriate state in addition to the temperature in the facility R.

[0066]

<Other Embodiments>

The embodiments have been described in detail above with reference to the drawings. However, the specific configuration is not limited to the above description, and various design changes and the like can be made. That is, in other embodiments, the procedures of the above-described processes may be changed as appropriate. In addition, some of the processes may be executed in parallel.

[0067]

<Additional Notes>

The air conditioning equipment control device, the air conditioning equipment control method, and the program described in the above-described embodiments can

be understood, for example, as follows.

[0068]

(1) According to a first aspect, there is provided a control device 10 for air conditioning equipment 3 including an air conditioner 30 provided in a facility R in which a plurality of heat generating bodies 2 are disposed, the control device 10 including an acquisition unit 111 that acquires a measurement value including a temperature measured at a predetermined position of the facility R and a setting condition of the air conditioning equipment 3 including a set temperature of the air conditioner 30, a prediction unit 112 that predicts a future heat load corresponding to each of a plurality of setting condition candidates by using a model M with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body 2 as a response variable, and a control unit 113 that selects, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controls the air conditioning equipment 3 based on the selected setting candidate condition.

[0069]

In this way, the control device 10 can predict the heat load that changes from time to time, and operate the air conditioning equipment 3 under the optimal setting condition to minimize the power (power consumption).

[0070]

(2) According to a second aspect, there is provided the control device 10 for the air conditioning equipment 3 according to the first aspect further including a learning unit 114 that specifies an actual value of a heat load at an evaluation target

time based on the measurement value and the setting condition acquired at the evaluation target time, and updates the model M by training based on an error between the specified actual value of the heat load and a predicted value of the heat load at the evaluation target time, which was predicted in the past.

[0071]

In this way, the control device 10 can improve the accuracy of predicting the heat load by the model M as the heat generating body 2 and the air conditioning equipment 3 are operated.

[0072]

(3) According to a third aspect, in the control device 10 for the air conditioning equipment 3 according to the first or second aspect, the temperature measured at the predetermined position of the facility R is at least one of a room temperature of the facility R, a suction temperature of the air conditioner 30, a discharge temperature of the air conditioner 30, an intake temperature of the heat generating body 2, an exhaust temperature of the heat generating body 2, and a temperature of the heat generating body 2.

[0073]

As described above, the control device 10 can predict the heat load and select the optimal setting condition by using various temperatures measured in the facility R. That is, since the control device 10 can use the temperature sensor already provided in the facility R, the heat generating body 2, or the air conditioning equipment 3, it is possible to reduce the cost of introducing a new sensor.

[0074]

(4) According to a fourth aspect, in the control device 10 for the air conditioning equipment 3 according to any one of the first to third aspects, the setting

condition further includes at least one of the number of air conditioners 30 to be operated and an air volume of the air conditioner 30.

[0075]

In this way, the control device 10 can control the air conditioning equipment 3 by combining various setting conditions depending on the number and the functions of air conditioners 30, the specifications of the fan 20 of the heat generating body 2, or the like. In addition, the control device 10 can finely control the air conditioning equipment 3 such that the future heat load is in a more appropriate state by combining the plurality of setting conditions.

[0076]

(5) According to a fifth aspect, in the control device 10 for the air conditioning equipment 3 according to any one of the first to fourth aspects, the air conditioning equipment 3 includes the fan 20 included in the heat generating body 2, and the setting condition further includes an air volume or a rotation speed of the fan 20.

[0077]

(6) According to a sixth aspect, in the control device 10 for the air conditioning equipment 3 according to any one of the first to fifth aspects, the heat load includes at least one of a room temperature of the facility R, a suction temperature of the air conditioner 30, a discharge temperature of the air conditioner 30, an intake temperature of the heat generating body 2, an exhaust temperature of the heat generating body 2, and a temperature of the heat generating body 2, and power usage effectiveness (PUE) of the facility R, and the control unit 113 selects the setting condition candidate in which a predicted value of the heat load other than the power usage effectiveness satisfies the environmental condition and a predicted value of the power usage effectiveness is minimized.

[0078]

In this way, the control device 10 can control the air conditioning equipment 3 such that the future heat load is in a more appropriate state and the PUE is minimized.

[0079]

(7) According to a seventh aspect, in the control device 10 for the air conditioning equipment 3 according to any one of the first to sixth aspects, the air conditioning equipment 3 further includes a plurality of humidifiers 35, the measurement value and the heat load further include a humidity of the facility R, and the setting condition further includes the number of humidifiers to be operated.

[0080]

In this way, the control device 10 can control the air conditioning equipment 3 such that the humidity is also in an appropriate state in addition to the temperature in the facility R.

[0081]

(8) According to an eighth aspect, there is provided a control method for air conditioning equipment 3 including an air conditioner 30 provided in a facility R in which a plurality of heat generating bodies 2 are disposed, the control method including: a step of acquiring a measurement value including a temperature measured at a predetermined position of a facility R and a setting condition of the air conditioning equipment 3 including a set temperature of the air conditioner 30, a step of predicting a future heat load corresponding to each of a plurality of setting condition candidates by using a model M with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body 2 as a response variable, and a step of selecting, from among the setting condition candidates, a setting condition candidate in which a predicted value

satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controlling the air conditioning equipment 3 based on the selected setting candidate condition.

[0082]

(9) According to a ninth aspect, there is provided a program causing a control device 10 for air conditioning equipment 3 including an air conditioner 30 provided in a facility R in which a plurality of heat generating bodies 2 are disposed to execute a step of acquiring a measurement value including a temperature measured at a predetermined position of a facility R and a setting condition of the air conditioning equipment 3 including a set temperature of the air conditioner 30, a step of predicting a future heat load corresponding to each of a plurality of setting condition candidates by using a model M with the measurement value and the setting condition as explanatory variables and a heat load due to heat generation of the heat generating body 2 as a response variable, and a step of selecting, from among the setting condition candidates, a setting condition candidate in which a predicted value satisfying an environmental condition that defines a reference value or a reference range of the heat load is obtained, and controlling the air conditioning equipment 3 based on the selected setting candidate condition.

Industrial Applicability

[0083]

According to the above-described aspect, the air conditioning equipment can be operated under an optimal setting condition in response to a heat load that changes from time to time.

Reference Signs List

[0084]

1: air conditioning system

2: heat generating body

3: humidifier

10: control device

11: processor

111: acquisition unit

112: prediction unit

113: control unit

114: learning unit

12: memory

13: storage

14: communication interface

20: fan

21: intake temperature sensor

22: exhaust temperature sensor

30: air conditioner

31: suction temperature sensor

32: discharge temperature sensor

35: humidifier

51: temperature sensor

52: humidity sensor

CA: cold aisle

HA: hot aisle

M: model