

Title of the Invention

Net Zero Type Air Conditioning Management Server and Air Conditioning Management Method

Technical Field

The present invention relates to a net zero type air conditioning management server and air conditioning management method, and more particularly, to an air conditioning management technology aimed at achieving zero carbon emissions through energy savings while managing building energy.

Background Art

A Building Energy Management System (BEMS) is a control, management, and operation system that enables building managers to use energy rationally, ensuring a safe, sanitary, and comfortable living environment and a functional workspace for occupants, primarily through the use of computers. Through BEMS, energy consumption, indoor environment conditions, and building carbon emissions can be monitored and managed, allowing for an average energy reduction of 10% to 30%, as well as creating a pleasant building environment and extending the building's lifespan.

As an example of prior art, Korean Patent Registration No. 10-1800310 (published on November 23, 2017) describes a cloud-based EMS system and method that provides energy-saving guides by creating an energy prediction model for a target building based on historical energy data, classifying the building into at least one of several predefined groups, monitoring energy use patterns of multiple buildings within each group, and generating

energy-saving guides based on these patterns. However, this prior art is limited in its ability to minimize carbon emissions by merely grouping buildings with similar energy consumption or production characteristics without reducing the energy consumption of each building itself.

Problem to be Solved

The objective of this invention is to provide a net zero type air conditioning management server and air conditioning management method that reduces carbon emissions by creating an air conditioning prediction model for a building to efficiently control facilities.

Another objective of the invention is to provide a net zero type air conditioning management server and air conditioning management method capable of creating air conditioning prediction models for various spaces within a building by combining multiple spaces from a single space.

Additionally, this invention aims to provide a net zero type air conditioning management server and method that captures carbon emissions generated within a building to reduce the total carbon output.

Solution to the Problem

The air conditioning prediction method of the net zero type air conditioning management server, according to an embodiment of the present invention, includes an information acquisition step for managing at least one piece of acquired information, such as air conditioning information, control information, equipment information, and environmental information from at least one IoT terminal installed inside the building; a prediction model creation step for generating an air conditioning prediction model for the building using the

acquired information; a facility control step for controlling the building's facilities using the air conditioning prediction model; a carbon emission calculation step for calculating carbon emissions based on the acquired information; and a modification step for adjusting the air conditioning prediction model if the calculated emissions exceed a predetermined threshold.

Additionally, the method may include a prediction model adjustment step to modify the air conditioning prediction model if the carbon emissions exceed the predetermined threshold.

Furthermore, the method may incorporate a carbon reduction step to capture carbon monoxide or carbon dioxide inside the building using a carbon capture filter.

In the prediction model creation step, the air conditioning prediction model may vary based on changes in building space, allowing the creation of a multi-space-based air conditioning prediction model by combining single-space-based models.

In another embodiment, the net zero type air conditioning management server includes a communication unit, processor, database, and input/output unit. The processor manages at least one piece of acquired information from at least one IoT terminal inside the building, generates an air conditioning prediction model for the building using the acquired information, controls the building's facilities based on the air conditioning prediction model, calculates carbon emissions using the acquired information, and modifies the air conditioning prediction model if the emissions exceed a predetermined threshold.

Advantages of the Invention

Thus, the invention reduces carbon emissions by generating an air conditioning prediction model to control facilities efficiently. Additionally, it can create air conditioning prediction

models for various spaces within the building by combining single spaces into multiple spaces. It also enables capturing of carbon generated within the building to reduce the total carbon emissions.

Brief Description of the Drawings

Figure 1: A configuration diagram of the net zero type air conditioning management server according to an embodiment of the present invention.

Figure 2: A flowchart of the air conditioning management method of the net zero type air conditioning management server shown in Figure 1.

Figure 3: An example comparing the predicted energy usage with the actual measured energy usage when creating the air conditioning prediction model in the prediction model creation step shown in Figure 2.

Figure 4: An illustration of how the air conditioning prediction model is varied between single-space and multi-space configurations in the prediction model creation step shown in Figure 2.

Figure 5: An example illustrating the acquisition of environmental information using an unmanned aerial vehicle in the air conditioning management method shown in Figure 2.

Figure 6: An example illustrating the addition of a carbon reduction step to the air conditioning management method shown in Figure 2.

Detailed Description of the Invention

Hereinafter, detailed embodiments of the present invention will be described with reference to the accompanying drawings. Terms used in the embodiments are selected considering the functions within the embodiments, and the meanings of these terms may vary depending on user or operator intent or precedent. Therefore, in the following embodiments, terms specifically defined in this specification should be interpreted based on those definitions, and

otherwise, they should be interpreted based on their generally accepted meanings in the field.

Figure 1 shows the configuration of a net zero type air conditioning management server according to an embodiment of the present invention. Referring to **Figure 1**, the net zero type air conditioning management server according to the embodiment includes a communication unit (110), a processor (120), a database (130), and an input/output unit (140).

The communication unit (110) communicates with other devices or networks and may be implemented using various communication technologies, such as WiFi, WCDMA, HSDPA, HSUPA, HSPA, Mobile WiMAX, WiBro, LTE, Bluetooth, IrDA (Infrared Data Association), NFC, Zigbee, or wireless LAN technology. For example, the communication unit (110) enables the processor (120) to transmit and receive various data by connecting to external IoT terminals or a manager terminal. When providing services over the internet, the communication unit can follow the TCP/IP (Transmission Control Protocol/Internet Protocol) standard.

The processor (120) may be a general-purpose CPU, microprocessor, ASIC (Application-Specific Integrated Circuit), or one or more integrated circuits designed to execute programs for the solutions of this invention. The processor (120) comprehensively controls the communication unit (110), database (130), and input/output unit (140), and can be connected to them via a communication bus, such as a Peripheral Component Interconnect (PCI) bus or an Extended Industry Standard Architecture (EISA) bus.

The database (130) stores and manages various data used to support the public bidding system (100) of the present invention's embodiment. The database (130) may include storage media of types such as flash memory, hard disk, multimedia micro cards, card-type memory (e.g., SD or XD memory), RAM, SRAM, ROM, EEPROM, PROM, magnetic memory, magnetic disks, and optical disks. It is not limited to these and may include any medium capable of storing data.

The input/output unit (140) specifically includes output and input devices, with the output devices communicating with the processor (120) and capable of displaying information or outputting audio in various forms. Examples include an LCD (Liquid Crystal Display), LED (Light Emitting Diode) display, OLED (Organic Light Emitting Diode) display, and speakers. The input devices communicate with the processor (120) and receive user input in various

ways, such as through a mouse, keyboard, touchscreen, or sensor device.

Figure 2 is a flowchart of the air conditioning management method of the net zero type air conditioning management server shown in Figure 1, **Figure 3** is an example comparing predicted and actual energy usage during the prediction model generation step of the air conditioning management method shown in Figure 2, **Figure 4** illustrates variations in the air conditioning prediction model based on single and multi-space configurations during the prediction model generation step of Figure 2, and **Figure 5** shows an example of obtaining environmental information using an unmanned aerial vehicle in the air conditioning management method shown in Figure 2.

Referring to **Figures 2 through 5**, the air conditioning management method of the net zero type air conditioning management server according to the present invention's embodiment is performed by the processor (120) of the air conditioning management server (100). Specifically, the air conditioning management method includes an information acquisition step (S110), a prediction model generation step (S120), a carbon emission calculation step (S130), and a facility control step (S140).

In the information acquisition step (S110), at least one piece of acquired information, such as air conditioning information, control information, equipment information, and environmental information, is obtained from at least one IoT terminal installed inside the building and managed. Here, air conditioning information refers to data about the current status of the air conditioning system, such as ventilation, cooling, and heating. Control information refers to the air conditioning system's settings, maximum demand power, and operational status.

Equipment information may include data, such as showcase temperature and automatic door usage, to help distinguish factors affecting the indoor air conditioning environment. Environmental information may include humidity, fine dust (PM), carbon monoxide, and carbon dioxide levels in designated indoor spaces and may also include external weather and fire information. The types of acquired information are not limited to these and may include additional information based on administrator settings.

Furthermore, the information acquisition step (S110) may obtain at least one piece of acquired information, such as air conditioning information, control information, equipment information, and environmental information, at a preset time interval. This allows tracking of

how various types of information change within the building over time. This acquired information serves as basic data for training the air conditioning prediction model in the prediction model generation step (S120). For instance, at least one day's worth of acquired information from the building is required to train the air conditioning prediction model in the prediction model generation step (S120).

Additionally, the information acquisition step (S110) may determine if there are missing values exceeding a preset time within the acquired information. If missing data exceeding the preset time is detected, the information acquisition step (S110) may reacquire data for the time period with missing values. For example, data for overlapping time periods may be calculated as an average, and information for the missing time intervals can be directly reflected to complete the acquired information. This approach enhances the prediction model's accuracy by compensating for missing data.

The information acquisition step (S110) can also analyze and verify location information for the acquired data. The data is acquired from IoT terminals installed within the building, and each IoT terminal may contain its own location information. This verification ensures that the data is indeed from IoT terminals within the building, preventing any data from external building IoT devices that could distort the accuracy of the air conditioning prediction model. If location information is absent or does not match predefined location settings, the information acquisition step (S110) may exclude such data from further processing.

The information acquisition step (S110) can also obtain environmental information by analyzing audio data within the building or social media (SNS) data. For instance, user conversations within the building about the indoor environment or social media posts can be processed as big data to derive environmental insights. Statements like "It's too humid indoors," "It's too hot," or "It's too dry" can indicate that humidity or temperature thresholds have been exceeded, enabling a more multidimensional understanding of indoor conditions beyond quantitative data.

Additionally, to monitor fluid flow within the building, the information acquisition step (S110) may utilize unmanned aerial vehicles (UAVs). These UAVs are passively propelled by airflow, moving naturally with wind currents. Equipped with communication chips, they

transmit their speed, coordinates, and other positional data back to the net zero type air conditioning management server (100). Multiple UAVs can be deployed in the air within the building, usually dropped from a set height, ideally near an air conditioning facility. These UAVs can be released at preset intervals or on command, enabling monitoring of the building's airflow patterns over time.

In the prediction model generation step (S120), an air conditioning prediction model for the building is created using at least one piece of data from the air conditioning information, control information, equipment information, and environmental information. For example, the air conditioning prediction model may be generated for a single-space or multi-space configuration within the building, relying on data-driven learning rather than fluid dynamics calculations. Initially, a prediction model is generated for single-space configurations. The prediction model generation step (S120) then calculates the energy consumption based on the air conditioning prediction model.

For this, a deep learning-based prediction model can be trained using a dataset containing more than one day's worth of air conditioning, control, equipment, and environmental data. Based on this prediction model, expected energy consumption is calculated and kept within a predefined range, serving as the baseline model for net-zero energy building management.

Additionally, the prediction model generation step (S120) can customize the air conditioning prediction model for various operating modes, such as energy-saving, comfort, hybrid, and fire-response modes. The prediction model can also be adapted by combining prediction models according to different times of day to create a final air conditioning prediction model, allowing active adaptation to the building's changing conditions.

Furthermore, the prediction model generation step (S120) can adjust the air conditioning prediction model based on changes in building space. By combining single-space prediction models, a multi-space prediction model can be generated, enabling adaptation to varying building layouts. This multi-space model may be used to calculate overall energy consumption based on different spatial configurations.

The carbon emission calculation step (S130) calculates carbon emissions using at least one piece of data from the air conditioning information, control information, equipment information, and environmental information obtained from the IoT terminal. Carbon

emissions are calculated by converting energy usage data into carbon monoxide and carbon dioxide emissions, and may vary depending on the chosen air conditioning prediction model. For instance, different prediction models, such as Model 1 and Model 2, may yield different carbon emissions depending on how they control facility operations.

Additionally, the carbon emission calculation step (S130) can calculate carbon emissions based on detected indoor carbon levels. This includes not only emissions derived from energy consumption but also carbon produced by occupants and equipment within the building. The carbon emission calculation step (S130) may acquire carbon dioxide or other carbon concentration data using multiple gas sensors installed in predefined zones within the building, enabling a comprehensive calculation of total carbon emissions.

The facility control step (S140) controls building facilities based on the air conditioning prediction model and carbon emission data to keep energy consumption below preset limits. Facilities controlled may include lighting, water heaters, inverters, air curtains, and direct drive fans, but are not limited to these. Facility control based on the air conditioning prediction model optimizes energy usage, allowing efficient air conditioning management within the building.

For instance, the facility control step (S140) may adjust lighting intensity to reduce energy usage by monitoring indoor brightness levels and dimming or turning off lights as needed. Additionally, this step monitors indoor temperature, lighting levels, and occupancy to optimize energy usage and maintain optimal conditions.

The facility control step (S140) can also manage renewable energy systems within the building, such as solar panels or wind turbines, though not limited to these. Electricity generated by solar panels on the building's exterior or interior may be used to power other facilities, and, when production exceeds a preset threshold, can be redirected to specified facility power supplies.

The facility control step (S140) may also utilize wind energy generation systems by harnessing airflow produced by the building's air conditioning system to rotate blades, thereby generating electricity to power other facilities. This eco-friendly energy generation

helps to reduce overall carbon emissions associated with facility energy use. By combining renewable energy systems in this way, the building can achieve a reduction in carbon emissions even when maintaining the same level of energy usage.

Additionally, the facility control step (S140) can use electricity generated by piezoelectric elements installed within the building. For example, piezoelectric elements may be embedded in the flooring of the building, generating electricity from the pressure exerted by people moving over them. This enables the building to sustainably generate power as the flow of people increases, contributing to energy savings in an environmentally friendly manner.

Furthermore, the air conditioning management method of the net zero type air conditioning management server in this invention can include a prediction model adjustment step. When carbon emissions exceed a predefined threshold, this step adjusts the air conditioning prediction model to ensure that total carbon emissions remain below the threshold. For instance, the prediction model adjustment step converts energy usage data from IoT terminals into carbon emissions and adds these values to the carbon levels detected in the building to calculate total emissions. Adjustments to the air conditioning prediction model can then be made to reduce carbon emissions, such as by decreasing energy usage. The adjusted prediction model serves as a foundation for facility control to keep overall carbon emissions within acceptable limits.

The prediction model adjustment step can also modify the air conditioning prediction model based on the flight path of unmanned aerial vehicles (UAVs) within the building. This approach ensures that the model is optimized for the building's interior layout, taking into account UAV flight paths. For example, in areas where structural elements or walls prevent UAV movement, the model may reduce air conditioning in those areas. In this way, the prediction model adjustment step can refine the air conditioning prediction model using the building's spatial layout and UAV flight data.

Referring to **Figure 6**, the air conditioning management method according to an embodiment of this invention may include a carbon reduction step. In this step, carbon emitted within the building is captured to lower overall emissions. For example, carbon capture filters (201) can be used to capture indoor carbon and reduce the amount of carbon released outside the building. The carbon capture filter (201) may use activated carbon to adsorb carbon dioxide,

although other methods, such as chemical reactions using amine solutions, may also be applied. By storing the captured carbon underground, emissions into the atmosphere can be minimized.

Additionally, the carbon reduction step can utilize air-purifying plants (202) to naturally reduce carbon. Examples of such plants include Areca Palm, Sansevieria, Spathiphyllum, Peperomia, and Ivy, though the selection is not limited to these species. These plants naturally absorb carbon within the building, thereby lowering overall emissions. The carbon reduction step manages factors like temperature, humidity, and sunlight to optimize the growth conditions for these air-purifying plants, enhancing their ability to reduce indoor carbon levels.

In this case, the facility control step can adjust watering systems, lighting systems, and heating/cooling systems to support the growth of air-purifying plants (202). By managing conditions such as temperature, humidity, and sunlight, the facility control step helps these plants thrive and fulfill their role in reducing carbon emissions. This approach not only improves indoor aesthetics by cultivating air-purifying plants within the building but also contributes to lower carbon emissions from both occupants and facilities.

Accordingly, the present invention of the net zero type air conditioning management server and air conditioning management method allows for a reduction in carbon emissions by creating an air conditioning prediction model for the building and efficiently controlling facilities based on this model.

Additionally, by combining single spaces within the building into multi-space configurations, air conditioning prediction models can be generated to suit various spatial configurations within the building.

Moreover, the invention can capture carbon generated within the building, thereby reducing the overall carbon emissions.

While the preferred embodiments of the present invention have been described with reference to the accompanying drawings, the invention is not limited to these examples. Thus, the invention should be interpreted in accordance with the appended claims, encompassing all obvious modifications derived from the described embodiments.

Explanation of Reference Numerals

100: Air Conditioning Management Server

110: Communication Unit

120: Processor

130: Database

140: Input/Output Unit

101: Unmanned Aerial Vehicle (UAV)

201: Carbon Capture Filter

502: Air-Purifying Plant

Claims

[Claim 1]

A method for air conditioning prediction in a net zero type air conditioning management server, comprising:

an information acquisition step for managing at least one piece of acquired data among air conditioning information, control information, equipment information, and environmental information from at least one IoT terminal installed within a building;

a prediction model generation step for generating an air conditioning prediction model for the building using the acquired data;

a carbon emission calculation step for calculating carbon emissions based on the acquired data; and

a facility control step for controlling the building's facilities so that energy consumption remains within a preset range by using the air conditioning prediction model and the carbon emission data.

[Claim 2]

The method of claim 1, further comprising a prediction model adjustment step for modifying the air conditioning prediction model if the carbon emissions exceed a preset threshold.

[Claim 3]

The method of claim 1, further comprising a carbon reduction step for capturing carbon monoxide or carbon dioxide within the building using a carbon capture filter.

[Claim 4]

The method of any one of claims 1 to 3, wherein the prediction model generation step adapts the air conditioning prediction model according to changes in building space, by combining

multiple single-space-based prediction models to create a multi-space-based air conditioning prediction model.

[Claim 5]

An air conditioning management server comprising a communication unit, a processor, a database, and an input/output unit, wherein the processor:

manages at least one piece of acquired data among air conditioning information, control information, equipment information, and environmental information from at least one IoT terminal installed within a building;

generates an air conditioning prediction model for the building using the acquired data;

controls the building's facilities based on the air conditioning prediction model;

calculates carbon emissions using the acquired data; and

modifies the air conditioning prediction model if the carbon emissions exceed a preset threshold.