DESCRIPTION

Title of Invention: Refrigerator

Technical Field

[0001]

The present invention relates to a refrigerator equipped with an interior monitor camera.

Background Art

[0002]

Conventionally, a household refrigerator is equipped with plural electrical components including a fan configured to send cold air from a cooler to a refrigerator interior and an electric damper configured to supply or shut off cold air to various compartments in the refrigerator interior (see, for example, Patent Literature 1). To reduce transformer capacity needed for a controller, the refrigerator of Patent Literature 1 prescribes operating sequence of plural electrical components and limits the number of electrical components operating simultaneously.

[0003]

Also, for food management in the refrigerator interior, some recent refrigerators are models equipped with an imaging unit including a camera configured to image a refrigerator interior (see, for example, Patent Literature 2). By detecting volume of stored items contained in a storage compartment using a light-emitting unit configured to emit light and light-receiving unit configured to receive the emitted light or a weight sensor configured to detect weight of shelfs, the refrigerator of Patent Literature 2 is configured such that the camera will image the refrigerator interior upon a change in the stored volume.

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 63-061868

Patent Literature 2: Japanese Unexamined Patent Application Publication No.

2015-65630

Summary of Invention

Technical Problem

[0005]

However, because the refrigerator of Patent Literature 2 does not have a limit on the number of electrical components allowed to operate simultaneously, in order to provide for overlaps among operation timings of plural electrical components, it is necessary to increase a current capacity of a power supply circuit of the controller, creating a problem of increased cost. Also, because the refrigerator of Patent Literature 1 gives priority to operation of the electric damper whose operating time is relatively short, when operation timings of plural electrical components overlap, it is necessary to make the other electrical components wait until the operation of the electric damper is completed.

[0006]

The present invention has been made to solve the above problems and has an object to provide a refrigerator that allows an imaging unit to operate on a priority basis and reduces cost.

Solution to Problem

[0007]

A refrigerator according to an embodiment of the present invention comprises a main body having at least one compartment to be cooled; a plurality of electrical components including a solenoid valve configured to adjust a flow rate of refrigerant used to cool the compartment and an automatic ice maker; an imaging unit configured to image the compartment; and a controller provided with a power supply circuit and configured to control operation of the plurality of electrical components and the imaging unit, wherein the controller has priority level information to interrupt operation of the electrical components, and when causing the imaging unit to image the compartment, if total amperage of the plurality of electrical components and the imaging unit exceeds a current capacity of the power supply circuit, the controller interrupts the operation of at least one of the plurality of electrical components, and

the controller selects at least one of the electrical components based on the priority level information, and interrupts the operation of the selected at least one of the electrical components, and in the priority level information, a lower priority is given to interrupting the operation of the solenoid valve than a priority of interrupting the operation of the automatic ice maker.

Advantageous Effects of Invention

[0008]

According to an embodiment of the present invention, if the total amperage of the plurality of electrical components and the imaging unit exceeds the current capacity of the power supply circuit, the controller interrupts the operation of at least one of the plurality of electrical components and then causes the imaging unit to image the compartment. Thus, when the imaging unit is caused to image the compartment, since the total amperage of the plurality of electrical components can be reduced, the imaging unit can be caused to operate on a priority basis. Consequently, the current capacity of the power supply circuit can be reduced, making it possible to cut cost.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a front view of a refrigerator according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a side view showing an air flow path structure of the refrigerator of Fig. 1.

[Fig. 3] Fig. 3 is a schematic diagram of a refrigeration cycle provided on the refrigerator of Fig. 1.

[Fig. 4] Fig. 4 is a schematic diagram illustrating operating states of a two-way valve of Fig. 3 by example.

[Fig. 5] Fig. 5 is a schematic diagram illustrating operating states of a three-way valve of Fig. 3 by example.

[Fig. 6] Fig. 6 is a front view of the refrigerator of Fig. 1 with doors open.

[Fig. 7] Fig. 7 is a block diagram showing a functional configuration of a controller of Fig. 2.

[Fig. 8] Fig. 8 is a table illustrating by example drive currents of electrical components provided on the refrigerator of Fig. 1 at maximum loads.

[Fig. 9] Fig. 9 is a diagram illustrating by example priority level information possessed by the controller of Fig. 7.

[Fig. 10] Fig. 10 is a time chart showing operating states of respective electrical components when a current capacity permitted for the controller of Fig. 4 is set to 2.5 A.

[Fig. 11] Fig. 11 is a time chart showing operating states of the respective electrical components when the current capacity permitted for the controller of Fig. 4 is set to 2.0 A.

[Fig. 12] Fig. 12 is a time chart showing operating states of the respective electrical components when the current capacity permitted for the controller of Fig. 4 is set to 1.5 A.

[Fig. 13] Fig. 13 is an explanatory diagram associating open/close state of a refrigerator compartment of Fig. 3 with operation timing of an imaging unit.

[Fig. 14] Fig. 14 is a flowchart showing overall operation related to an imaging process of the controller of Fig. 7.

[Fig. 15] Fig. 15 is an explanatory diagram showing a concrete operation example of an imaging process carried out by the controller of Fig. 7.

Description of Embodiments

[0010]

Embodiment.

Fig. 1 is a front view of a refrigerator according to an embodiment of the present invention. An overall configuration of the refrigerator according to the present embodiment will be described with reference to Fig. 1. As shown in Fig. 1, the refrigerator 100 includes a main body 1 having plural compartments to be cooled, a first door 2a, a second door 2b, a drawer door 3a, a drawer door 4a, a drawer door 5a, a drawer door 6a, and a water tank (not shown). The main body 1 includes a refrigerator compartment 2, an ice-making compartment 3, a versatile compartment 4, a freezer compartment 5, and a vegetable compartment 6.

[0011]

The refrigerator compartment 2 is set to a refrigeration temperature zone and provided on an uppermost level of the main body 1. The first door 2a and second door 2b are used to open and close the refrigerator compartment 2, and upper parts

and lower parts thereof are attached to the main body 1 via hinges (not shown). That is, the refrigerator 100 allows the refrigerator compartment 2 to be opened and closed by means of the first door 2a and second door 2b configured to pivot on the hinges. Note that to keep water stored in the water tank from freezing, the water tank is installed inside the refrigerator compartment 2 set to the refrigeration temperature zone.

[0012]

The ice-making compartment 3 is set to a freezing temperature zone and provided with an automatic ice maker 23 configured to make ice using the water stored in the water tank. That is, the refrigerator 100 is designed such that once the water tank provided in the refrigerator compartment 2 is filled with water, water will be fed into the automatic ice maker 23 in the ice-making compartment 3 from the water tank. The automatic ice maker 23 is designed to automatically make ice using the water fed from the water tank and store the made ice in an ice storage case (not shown) provided in the ice-making compartment 3. The drawer door 3a is a pull-out door used to open and close the ice-making compartment 3.

[0013]

The versatile compartment 4 allows its preset temperature to be changed in a wide range from the freezing temperature zone to the refrigeration temperature zone. The drawer door 4a is a pull-out door used to open and close the versatile compartment 4. The freezer compartment 5 is used for long-term storage of frozen food, precooked food, and other food. The drawer door 5a is a pull-out door used to open and close the freezer compartment 5. The vegetable compartment 6 is set to a temperature slightly higher than the refrigeration temperature zone and used to store vegetables and other foodstuffs. The drawer door 6a is a pull-out door used to open and close the vegetable compartment 6.

[0014]

Fig. 2 is a side view showing an air flow path structure of the refrigerator 100 of Fig. 1. Fig. 3 is a schematic diagram of a refrigeration cycle provided on the refrigerator 100 of Fig. 1. Fig. 4 is a schematic diagram illustrating operating states

of a two-way valve of Fig. 3 by example. Fig. 5 is a schematic diagram illustrating operating states of a three-way valve of Fig. 3 by example. Fig. 6 is a front view of the refrigerator 100 of Fig. 1 with doors open. A configuration of the refrigerator 100 will be described in more detail with reference to Figs. 2 to 6.

[0015]

As shown in Fig. 2, the main body 1 includes an evaporator chamber 20. In the evaporator chamber 20, the refrigerator 100 has a cooler 35 serving as an evaporator, a refrigerator fan 21, and an electric damper 22. Also, as shown in Fig. 3, the refrigerator 100 includes a compressor 31 configured to compress refrigerant, a radiator 32 configured to function as a condenser, a heat dissipation fan 32a configured to send air to a radiator 32, a solenoid valve 33 configured to adjust a flow rate of the refrigerant, and a capillary tube 34 configured to depressurize the refrigerant. That is, in the refrigerator 100, the compressor 31, radiator 32, solenoid valve 33, capillary tube 34, and cooler 35 are connected via refrigerant pipes, making up a refrigeration cycle for circulating the refrigerant used to cool the compartments.

[0016]

Furthermore, the refrigerator 100 includes temperature sensors (not shown) made up, for example, of thermistors configured to detect temperatures of respective compartments. Also, the refrigerator 100 includes a controller 40 provided on a ceiling on the back of the main body 1 and configured to control operation of various actuators.

[0017]

The refrigerator fan 21 is designed to send cold air cooled by the cooler 35 to the compartments in a refrigerator interior. The electric damper 22 is provided in an air flow path to the compartments and designed to supply or shut off cold air to the respective compartments. That is, the electric damper 22 is designed to adjust volumes of cold air flowing into the respective compartments in the refrigerator interior.

[0018]

The controller 40 is designed to control operation of plural electrical components provided in the refrigerator 100. The refrigerator 100 according to the

present embodiment includes the refrigerator fan 21, electric damper 22, automatic ice maker 23, and solenoid valve 33 as electrical components. More specifically, the controller 40 is designed to control the operation of the refrigerator fan 21 and thereby send cold air cooled by the cooler 35 to the respective compartments. Also, the controller 40 is designed to control operation of the electric damper 22 according to the temperatures of the respective compartments detected by the temperature sensors. That is, when the temperature of a compartment becomes higher than a target temperature, the controller 40 supplies cold air to the compartment by operating the electric damper 22 so as to open the air flow path. Also, when the temperature of the compartment is cooled to the target temperature, the controller 40 shuts off cold air supplied to the compartment by operating the electric damper 22 so as to close the air flow path.

[0019]

Furthermore, the controller 40 is designed to adjust flow paths of the refrigerant by controlling the solenoid valve 33. Here, the controller 40 includes a power supply circuit (not shown), and current capacity permitted for the controller 40, i.e., the current capacity of the power supply circuit is set beforehand. Hereinafter, the current capacity of the power supply circuit of the controller 40 will also be referred to as "allowable ampacity."

[0020]

The solenoid valve 33 is designed to adjust the flow rate of refrigerant flowing through refrigerant pipes laid along a front face, side faces, and a back face of the refrigerator 100. The solenoid valve 33 includes a two-way valve 33a and a three-way valve 33b. The two-way valve 33a has plural covers each provided with a hole, which differs in diameter among the covers. The two-way valve 33a is designed to adjust the flow rate of refrigerant by placing the covers in the flow path of the refrigerant. The three-way valve 33b has an outlet side of the refrigerant connected to two pipes differing in diameter. The three-way valve 33b is designed to adjust the flow rate of refrigerant by opening and closing the flow paths to the two pipes.

[0021]

More specifically, as shown in Fig. 4, the two-way valve 33a is designed to cause the refrigerant flowing in through Pipe A to flow out through Pipe B. In the example of Fig. 4, the two-way valve 33a has three covers 331 to 333 differing in hole diameter, the cover 331, cover 332, and cover 333 being reduced in hole diameter in this order. In State 1 shown in Part (a) of Fig. 4, the two-way valve 33a is fully open. In State 2 shown in Part (b) of Fig. 4, the cover 331 of the two-way valve 33a is placed in the refrigerant flow path. In State 3 shown in Part (c) of Fig. 4, the cover 332 of the two-way valve 33a is placed in the refrigerant flow path. In State 4 shown in Part (d) of Fig. 4, the cover 333 of the two-way valve 33a is placed in the refrigerant flow path. Therefore, the flow rate of refrigerant is reduced in the order: State 1, State 2, State 3, and State 4.

[0022]

Also, as shown in Fig. 5, the three-way valve 33b is designed to cause the refrigerant flowing in through Pipe C to flow out through at least one of Pipe D and Pipe E. In the example of Fig. 5, Pipe D is larger in diameter than Pipe E. In State 1 shown in Part (a) of Fig. 5, the three-way valve 33b is fully open. In State 2 shown in Part (b) of Fig. 5, the flow path to Pipe E is closed by the three-way valve 33b. In State 3 shown in Part (c) of Fig. 5, the flow path to Pipe D is closed by the three-way valve 33b. In State 4 shown in Part (d) of Fig. 5, the flow paths to both Pipe D and Pipe E are closed by the three-way valve 33b. Therefore, the flow rate of refrigerant is reduced in the order: State 1, State 2, State 3, and State 4.

[0023]

Also, as shown in Fig. 6, the refrigerator 100 includes a first door open/close sensor 50a configured to detect an open/close state of the first door 2a, a second door open/close sensor 50b configured to detect an open/close state of the second door 2b, and an imaging unit 60 provided inside the first door 2a. The first door open/close sensor 50a and second door open/close sensor 50b are made up, for example, of magnetic sensors. The first door open/close sensor 50a and second door open/close sensor 50b are designed to output detection information showing detection results to the controller 40. More specifically, when the first door 2a is

opened, the first door open/close sensor 50a outputs open state detection information to the controller 40, indicating that the first door 2a is open and when the first door 2a is closed, the first door open/close sensor 50a outputs closed state detection information to the controller 40, indicating that the first door 2a is closed. When the second door 2b is opened, the second door open/close sensor 50b outputs open state detection information to the controller 40, indicating that the second door 2b is open and when the second door 2b is closed, the second door open/close sensor 50b outputs closed state detection information to the controller 40, indicating that the second door 2b is closed.

[0024]

The imaging unit 60 is equipped with a camera containing (not shown) an image sensing device such as a CCD (Charge Coupled Device) or CMOS (Complementary Metal Oxide Semiconductor) and designed to image the refrigerator interior. According to the present embodiment, the imaging unit 60 is placed in central part of the refrigerator compartment 2 when the first door 2a is closed and designed to image an entire area of the refrigerator compartment 2.

[0025]

Fig. 7 is a block diagram showing a functional configuration of the controller 40 of Fig. 2. As shown in Fig. 7, the controller 40 includes an open/close state determination unit 41, a time-measuring unit 42, an imaging control unit 43, and a storage unit 44. The open/close state determination unit 41 is designed to determine whether the refrigerator compartment 2 is in an open state or closed state based on detection information outputted from the first door open/close sensor 50a and second door open/close sensor 50b. Here, the open state of the refrigerator compartment 2 means a state in which at least one of the first door 2a and second door 2b is open. Also, the closed state of the refrigerator compartment 2 means a state in which both the first door 2a and second door 2b are closed.

[0026]

That is, when at least one of the first door 2a and second door 2b is open, the open/close state determination unit 41 determines that the refrigerator compartment 2

is open. Also, when both the first door 2a and second door 2b are closed, the open/close state determination unit 41 determines that the refrigerator compartment 2 is closed. Hereinafter, the state in which the refrigerator compartment 2 is open will also be referred to as an open state and the state in which the refrigerator compartment 2 is closed will also be referred to as a closed state. Then, when the refrigerator compartment 2 changes from an open state to a closed state, the open/close state determination unit 41 outputs a measurement command signal to the time-measuring unit 42. After outputting the measurement command signal, when the refrigerator compartment 2 goes into an open state, the open/close state determination unit 41 outputs a reset command signal to the time-measuring unit 42.

[0027]

The time-measuring unit 42 is designed to measure a duration during which the refrigerator compartment 2 remains in a closed state after a change from an open state to the closed state, as a closed-state duration. That is, the time-measuring unit 42 is designed to start measuring the closed-state duration in response to a measurement command signal outputted from the open/close state determination unit 41. Also, when the closed-state duration reaches an imaging wait time set in advance, the time-measuring unit 42 outputs an imaging command signal to the imaging control unit 43. That is, if the refrigerator compartment 2 is opened before the closed-state duration reaches the imaging wait time, the time-measuring unit 42 resets the closed-state duration and starts measuring a closed-state duration anew after the refrigerator compartment 2 is closed again. That is, the time-measuring unit 42 is designed to reset the closed-state duration in response to a reset command signal outputted from the open/close state determination unit 41. Then, in response to a measurement command signal outputted from the open/close state determination unit 41 anew, the time-measuring unit 42 starts measuring a closed-state duration again.

[0028]

The storage unit 44 stores priority level information to interrupt operation of electrical components, i.e., priority level information as to in what order electrical

components are to be interrupted on a priority basis. The storage unit 44 stores amperage information, indicating values of respective maximum-load drive currents of plural electrical components provided on the refrigerator 100 and a value of a maximum-load drive current of the imaging unit 60. Also, the storage unit 44 stores imaging information, indicating status of the refrigerator compartment 2 imaged by the imaging control unit 43.

[0029]

The imaging control unit 43 is designed to cause the imaging unit 60 to image the refrigerator compartment 2 upon an output of an imaging command signal from the time-measuring unit 42. The imaging control unit 43 has a function to monitor operating states of the plural electrical components and find total amperage of the plural electrical components and the imaging unit 60 by referring to the amperage information stored in the storage unit 44. When causing the imaging unit 60 to image the refrigerator compartment 2, the imaging control unit 43 interrupts the operation of at least one of the plural electrical components if the total amperage exceeds the allowable ampacity.

[0030]

More specifically, upon an output of an imaging command signal from the time-measuring unit 42, the imaging control unit 43 finds the total amperage assumed to be used when the imaging unit 60 images the refrigerator compartment 2 and determines whether or not the found total amperage exceeds the allowable ampacity. Here, the total amperage assumed to be used when the imaging unit 60 images the refrigerator compartment 2 is the total amperage used when the imaging unit 60 is operated with the operating states of the plural electrical components maintained and will hereinafter be also referred to as "imaging-time total amperage." When it is determined that the found imaging-time total amperage exceeds the allowable ampacity, the imaging control unit 43 interrupts the operation of at least one of the plural electrical components such that the total amperage used when the imaging unit 60 images the refrigerator compartment 2 will not exceed the allowable ampacity.

[0031]

Furthermore, based on the priority level information in the storage unit 44, the imaging control unit 43 selects at least one of the electrical components to interrupt operation thereof when the imaging unit 60 images the refrigerator compartment 2. That is, the imaging control unit 43 is designed to select at least one of the electrical components based on the priority level information to reduce the imaging-time total amperage to or below the allowable ampacity. Then, the imaging control unit 43 interrupts the operation of the selected at least one of the electrical components when operating the imaging unit 60. Then, the imaging control unit 43 stores imaging information representing an image picked up by the imaging unit 60 in the storage unit 44.

[0032]

Here, the controller 40 can be implemented by hardware such as circuit devices that implement the respective functions described above or implemented as software run, for example, on a microcomputer such as a DSP (Digital Signal Processor) or on an arithmetic unit such as a CPU (Central Processing Unit). Also, the storage unit 44 of the controller 40 can be made up of a PROM (Programmable Read Only Memory), such as a flash memory, or an HDD (Hard Disk Drive).

[0033]

Fig. 8 is a table illustrating by example drive currents of the electrical components provided on the refrigerator 100 of Fig. 1 at maximum loads. That is, Fig. 8 is a table summarizing amperage needed to drive each of the refrigerator fan 21, electric damper 22, automatic ice maker 23, and solenoid valve 33. In the case of Fig. 8, the refrigerator 100 needs a current of 0.68 A to drive the refrigerator fan 21, and a current of 0.53 A to drive the solenoid valve 33. Also, the refrigerator 100 needs a current of 0.64 A to drive the automatic ice maker 23, and a current of 0.14 A to drive the electric damper 22.

[0034]

Fig. 9 is a diagram illustrating by example the priority level information possessed by the controller 40 of Fig. 7. As shown in Fig. 9, the priority level information is made up, for example, of table information associating interrupt

priorities, which represent the order in which operation is interrupted on a priority basis, with the electrical components. The priority level information is set by taking into consideration impacts of the electrical components on cooling capacity of the refrigerator 100 such that a user will not experience inconvenience in actual use environment.

[0035]

More specifically, in the priority level information, first priority is given to interrupting the automatic ice maker 23. Also, in the priority level information, a lower priority is given to interrupting the solenoid valve 33 than a priority of interrupting the automatic ice maker 23. Furthermore, in the priority level information, a lower priority is given to interrupting the electric damper 22 than a priority of interrupting the solenoid valve 33. Also, in the priority level information, a lower priority is given to interrupting the refrigerator fan 21 than a priority of interrupting the electric damper 22. Note that in the example of Fig. 9, the interrupt priority of the solenoid valve 33 is set to be the second highest, the interrupt priority of the electric damper 22 is set to be the third highest, and the interrupt priority of the refrigerator fan 21 is set to be the fourth highest.

[0036]

The automatic ice maker 23 and solenoid valve 33 ranked high in interrupt priority have smaller impacts on cooling performance of the refrigerator 100 than the refrigerator fan 21 configured to send cold air and the electric damper 22 configured to control a state of cold air supply. Thus, as the controller 40 performs interrupt handling for electrical components based on the priority level information with interrupt priorities established as described above the refrigerator 100 can avoid situations in which the user is inconvenienced in actual use environment.

[0037]

Fig. 10 is a time chart showing operating states of electrical components when the current capacity permitted for the controller 40 of Fig. 4 is set to 2.5 A. Fig. 11 is a time chart showing operating states of electrical components when the current capacity permitted for the controller 40 of Fig. 4 is set to 2.0 A. Fig. 12 is a time

chart showing operating states of electrical components when the current capacity permitted for the controller 40 of Fig. 4 is set to 1.5 A. The time charts shown in Figs. 10 to 12 will be described by relating the time charts to Figs. 8 and 9.

[0038]

As shown in the example of Fig. 10, when the allowable ampacity is 2.50 A, even if all of the refrigerator fan 21, electric damper 22, automatic ice maker 23, and solenoid valve 33 are operating, the current capacity has an allowance for driving the imaging unit 60. In this way, when maximum amperage needed to drive all of the electrical components and imaging unit 60 simultaneously is less than the allowable ampacity, the total amperage does not exceed the allowable ampacity. Consequently, there is no need for the controller 40 to temporarily interrupt the operation of electrical components when operating the imaging unit 60. However, to increase the allowable ampacity, a large-capacity power supply circuit has to be used as a power supply component of the controller 40, making it necessary to increase a product size of the controller 40 and resulting in increased cost.

[0039]

Thus, with the refrigerator 100 of the present embodiment, the allowable ampacity is set to be smaller than the maximum amperage. For example, in Fig. 11, which is an example in which the allowable ampacity is 2.00 A, at time t_4, which corresponds to imaging timing of the imaging unit 60, unless operation of any of the electrical components is interrupted, the total amperage will exceed the allowable ampacity when the imaging unit 60 carries out imaging. Therefore, at time t_4, which corresponds to drive timing of the imaging unit 60, the controller 40 temporarily interrupts operation of the automatic ice maker 23 with the highest interrupt priority such that the total amperage will not exceed the allowable ampacity. Then, at time t_5, at which operation of the imaging unit 60 is completed, the controller 40 resumes the operation of the automatic ice maker 23.

[0040]

Also, for example, in Fig. 12, which is an example in which the allowable ampacity is 1.50 A, operation of the solenoid valve 33 stops at time t_4 and remains in

the stopped state even at time t_6, which corresponds to imaging timing of the imaging unit 60. However, at time t_6, which corresponds to imaging timing of the imaging unit 60, since the imaging-time total amperage exceeds allowable amperage, unless operation of any of the electrical components is interrupted further, the total amperage will exceed the allowable ampacity when the imaging unit 60 carries out imaging. Therefore, at time t_6, the controller 40 temporarily interrupts operation of the automatic ice maker 23 based on the priority level information such that the total amperage will not exceed the allowable ampacity. Then, at time t_7, at which operation of the imaging unit 60 is completed, the controller 40 resumes the operation of the automatic ice maker 23.

[0041]

Fig. 13 is an explanatory diagram associating open/close state of the refrigerator compartment 2 of Fig. 3 with operation timing of the imaging unit 60. As shown in Fig. 13, when a door of the refrigerator compartment 2 changes from an open state to a closed state and the closed state does not continue during the imaging wait time, the refrigerator 100 resets the imaging wait time without making the imaging unit 60 carry out imaging. Then, after the refrigerator compartment 2 is closed, an imaging wait time starts to be measured again. Therefore, the refrigerator 100 can reduce unnecessary occasions to operate the imaging unit 60 under usage conditions in which food is taken in and out a lot of times by opening and closing the doors frequently. This makes it possible to reduce occasions to interrupt the operation of the electrical components other than the imaging unit 60 and thereby increase operating stability.

[0042]

On the other hand, as shown in Fig. 13, when a door of the refrigerator compartment 2 changes from an open state to a closed state and the closed state continues during the imaging wait time, the refrigerator 100 makes the imaging unit 60 carry out imaging. In so doing, based on the current capacity of the power supply circuit of the controller 40 and on the priority level information, the refrigerator 100 interrupts the operation of at least one of the plural electrical components. Therefore,

since the total amperage during operation of the imaging unit 60 can be kept down, the refrigerator 100 can reduce the current capacity of the power supply circuit of the controller 40 and make the imaging unit 60 operate on a priority basis.

[0043]

Fig. 14 is a flowchart showing overall operation related to an imaging process of the controller 40 of Fig. 7. Fig. 15 is an explanatory diagram showing a concrete operation example of an imaging process carried out by the controller 40 of Fig. 7. First, timing with which the controller 40 causes the imaging unit 60 to image the refrigerator interior will be described with reference to Fig. 14.

[0044]

The controller 40 waits until the refrigerator compartment 2 goes into an open state (No in step S101 of Fig. 14). When the refrigerator compartment 2 goes into an open state (Yes in step S101 of Fig. 14), the controller 40 waits until the refrigerator compartment 2 goes into a closed state (No in step S102 of Fig. 14).

[0045]

When the refrigerator compartment 2 goes into a closed state (Yes in step S102 of Fig. 14), the controller 40 starts measuring a closed-state duration and waits until the closed-state duration reaches the imaging wait time (No in step S103 of Fig. 14) unless the refrigerator compartment 2 goes into an open state (No in step S104 of Fig. 14). Then, when the closed-state duration reaches the imaging wait time (Yes in step S103 of Fig. 14), the controller 40 carries out an imaging process (step S105 of Fig. 14). On the other hand, when the refrigerator compartment 2 goes into an open state (Yes in step S104 of Fig. 14) without the closed-state duration reaching the imaging wait time (No in step S103 of Fig. 14), the controller 40 returns to step S102.

[0046]

The description of the imaging process carried out by the controller 40 will be continued with reference to Fig. 15. First, the controller 40 finds the imaging-time total amperage and determines whether or not the found imaging-time total amperage is higher than the allowable ampacity (step S201 of Fig. 15). When the imaging-time total amperage is higher than the allowable ampacity (Yes in step S201 of Fig. 15),

the controller 40 interrupts the operation of at least one of electrical components based on the priority level information (step S202 of Fig. 15).

[0047]

Next, the controller 40 causes the imaging unit 60 to image the refrigerator interior and stores imaging information acquired from the imaging unit 60 in the storage unit 44 (step S203 of Fig. 15). Next, the controller 40 resumes operation of the stopped electrical component (step S204 of Fig. 15).

[0048]

On the other hand, when the imaging-time total amperage is equal to or lower than the allowable ampacity (No in step S201 of Fig. 15), the controller 40 causes the imaging unit 60 to image the refrigerator interior without stopping the operating electrical components. Then, the controller 40 stores imaging information acquired from the imaging unit 60 in the storage unit 44 (step S205 of Fig. 15).

[0049]

As described above, the refrigerator 100 according to the present embodiment is configured such that when the imaging-time total amperage exceeds the allowable ampacity, the controller 40 will operate the imaging unit 60 after interrupting the operation of at least one of the plural electrical components. Thus, since the refrigerator 100 can reduce the total amperage of electrical components with the timing of operating the imaging unit 60, the imaging unit 60 can be operated on a priority basis. Then, by reducing the current capacity of the power supply circuit of the controller 40, the refrigerator 100 can cut cost.

[0050]

That is, when the operation of the imaging unit 60 overlap the operation of the plural electrical components, the refrigerator 100 determines whether the imaging-time total amperage exceeds the allowable ampacity. Then, if the imaging-time total amperage exceeds the allowable ampacity, the refrigerator 100 can acquire a captured image at an early stage by interrupting the operation of at least one of the operating electrical components. Then, when the imaging process is completed, the refrigerator 100 can shorten a temporary downtime of the electrical components to

resume the operation of the stopped electrical components.

[0051]

Also, when temporarily interrupting the operation of electrical components during operation of the imaging unit 60, the refrigerator 100 selects the electrical components whose operation is to be interrupted, by referring to the priority level information. In the example of Fig. 9, the order of the electrical components whose operation is to be interrupted is as follows: the automatic ice maker 23, solenoid valve 33, electric damper 22, and refrigerator fan 21. That is, the automatic ice maker 23, which requires high amperage to operate and does not affect cooling performance, ranks high in the list of the electrical components whose operation is to be interrupted. On the other hand, the refrigerator fan 21, which is designed to send cold air into the refrigerator, has a large impact on cooling performance. The electric damper 22, which is designed to adjust states of cold air supply to the compartments in the refrigerator, has the second largest impact on cooling performance next to the refrigerator fan 21. Note that the solenoid valve 33, which is not designed to directly control cold air, has a smaller impact on cooling performance than the refrigerator fan 21 and electric damper 22. That is, since electrical components that have a relatively small impact on cooling performance are ranked high in the interrupt priority while electrical components that have a relatively large impact on cooling performance are ranked low in the interrupt priority, the refrigerator 100 can restrain degradation in cooling performance during operation of the imaging unit 60.

[0052]

Here, for the refrigerator 100, desired timing of imaging by means of the imaging unit 60 occurs when food is taken in or out of the refrigerator 100, i.e., when a door is opened and closed. In this respect, as with the refrigerator of Patent Literature 2, use of a light-emitting unit and light-receiving unit or a weight sensor to detect a change in the stored volume serving as a trigger for the camera to carry out imaging results in high cost. In contrast, the refrigerator 100, which operates the imaging unit 60 by being triggered by opening and closing of a door, allows an interior monitor camera system to be built without using a light-emitting unit and light-

receiving unit, a weight sensor, or the like to detect the volume of stored food and thereby enables cost reductions.

[0053]

Also, the refrigerator 100, which images the refrigerator interior when a door-closed state continues for a predetermined period of time after a door is opened and closed, can restrain unnecessary imaging under usage conditions in which food is taken in and out a lot of times by opening and closing the doors frequently and reduce occasions to interrupt the operation of electrical components. That is, after the refrigerator compartment 2 changes from an open state to a closed state, if at least one of the first door 2a and second door 2b is opened before the imaging wait time lapses, the refrigerator 100 resets the imaging wait time without making the imaging unit 60 carry out imaging. Therefore, under conditions in which food is taken in and out a lot of times and imaging of the refrigerator interior is considered to be unnecessary such as when the doors are opened and closed frequently, the refrigerator 100 can maintain the operating states of the electrical components without operating the imaging unit 60. Consequently, the refrigerator 100 can increase operating stability and save energy.

[0054]

Note that the embodiment described above is a preferred concrete example of a refrigerator and the technical scope of the present invention is not limited to the above aspect. For example, in the example illustrated in Fig. 3, the imaging unit 60 is provided on the first door 2a, which is one of double doors, this is not restrictive, and the imaging unit 60 may be provided on the second door 2b. Alternatively, the imaging unit 60 may be provided on both the first door 2a and second door 2b. Then, it is recommended that the refrigerator 100 includes an imaging unit 60 configured to image the entire area of the refrigerator compartment 2 and an imaging unit 60 configured to image an interior of the refrigerator compartment 2. However, at least one of the imaging units 60 may be provided inside the refrigerator compartment 2.

[0055]

Also, although in the example illustrated in the above embodiment, the

refrigerator compartment 2 is imaged by the imaging unit 60, this is not restrictive, and at least one of the ice-making compartment 3, versatile compartment 4, freezer compartment 5, and vegetable compartment 6 may be imaged by the imaging unit 60. Furthermore, the refrigerator 100 may include an imaging unit 60 configured to image at least one of the ice-making compartment 3, versatile compartment 4, freezer compartment 5, and vegetable compartment 6 separately from the imaging unit 60 configured to image the refrigerator compartment 2. In addition, the refrigerator 100 may include at least one of an ice-making compartment door open/close sensor configured to detect an open/close state of the drawer door 3a, a versatile compartment door open/close sensor configured to detect an open/close state of the drawer door 4a, a freezer compartment door open/close sensor configured to detect an open/close state of the drawer door 5a, and a vegetable compartment door open/close sensor configured to detect an open/close state of the drawer door 6a. Then, the controller 40 may cause at least one of the ice-making compartment 3, versatile compartment 4, freezer compartment 5, and vegetable compartment 6 to be imaged based on detection information from these door open/close sensors.

[0056]

Furthermore, although in the example illustrated in the above embodiment, the controller 40 operates the imaging unit 60 when the imaging wait time lapses, this is not restrictive, and the controller 40 may operate the imaging unit 60 every predetermined period of time or every set period of time. In addition, the refrigerator 100 may include an input unit configured to accept input from the user and the input unit may have a function to accept a command to image the refrigerator interior. Then, the controller 40 may operate the imaging unit 60 when directed by the user via the input unit to image the refrigerator interior.

[0057]

Also, although in the example illustrated in the above embodiment, the imaging control unit 43 of the controller 40 stores imaging information in the storage unit 44, this is not restrictive. For example, the refrigerator 100 may be configured to have a storage device outside the controller 40 and the imaging control unit 43 may store

imaging information acquired from the imaging unit 60 in the storage device.

[0058]

Furthermore, the refrigerator 100 may be configured to include a communications unit configured to communicate with external communications devices and the communications unit may externally transmit imaging information stored in the storage unit 44 or storage device. However, a portable terminal may be allowed to acquire the imaging information stored in the storage unit 44 or storage device, via the communications unit.

[0059]

Also, although in the above embodiment, the refrigerator fan 21, electric damper 22, automatic ice maker 23, and solenoid valve 33 are shown as examples of plural electrical components, this is not restrictive, and the plural electrical components may include other electrical components such as an internal heater. However, the plural electrical components may be configured by excluding at least one of the refrigerator fan 21, electric damper 22, automatic ice maker 23, and solenoid valve 33 and including various other electrical components. Then, it is recommended to set the priority level information by taking impacts of the respective electrical components on the cooling performance of the refrigerator 100 into consideration.

[0060]

Furthermore, although in the example illustrated in Fig. 2, the refrigerator 100 has a single refrigerator fan 21, this is not restrictive, and the refrigerator 100 may have two or more refrigerator fans 21 in the evaporator chamber 20. Besides, although in the example illustrated in Fig. 2, the refrigerator 100 has a single electric damper 22, this is not restrictive, and the refrigerator 100 may have plural electric dampers 22 associated with the compartments or areas. Then, it is recommended to refine the priority level information according to the numbers of refrigerator fans 21 and electric dampers 22 in the refrigerator 100.

[0061]

Also, although in the example of Fig. 4 the two-way valve 33a configured to

adjust the flow rate of refrigerant in four levels is illustrated, this is not restrictive, and the two-way valve 33a may be designed to adjust the flow rate of refrigerant in two levels, three levels, or five or more levels. In addition, although in the example illustrated in the above embodiment, the solenoid valve 33 includes the two-way valve 33a and three-way valve 33b, this is not restrictive, and the solenoid valve 33 may be configured to include either of the two-way valve 33a and three-way valve 33b. However, when the solenoid valve 33 includes the two-way valve 33a and three-way valve 33b, in the priority level information, an interrupt priority may be set for each of the two-way valve 33a and three-way valve 33b.

[0062]

Furthermore, although in the example illustrated in the above embodiment, the imaging control unit 43 finds total amperage based on the amperage information stored in the storage unit 44, this is not restrictive. For example, the refrigerator 100 may be configured to include current sensors configured to detect respective drive currents of electrical components. Then, the imaging control unit 43 may find the total amperage of the plural electrical components based on actual measured values provided by the current sensors. In addition, although in the above embodiment, the refrigerator 100 having compartments in five temperature zones is illustrated as a representative example, this is not restrictive, and the number and shape of compartments may be changed as desired. For example, the refrigerator 100 may have less than or more than five compartments to be cooled.

Reference Signs List

[0063]

1 main body 2 refrigerator compartment 2a first door 2b second door 3 ice-making compartment 3a to 6a drawer door 4 versatile compartment 5 freezer compartment 6 vegetable compartment 20 evaporator chamber 21 refrigerator fan 22 electric damper 23 automatic ice maker 31 compressor 32 radiator 32a heat dissipation fan 33 solenoid valve 33a two-way valve 33b three-way valve 34 capillary tube 35 cooler 40 controller 41 open/close state determination unit 42

time-measuring unit 43 imaging control unit 44 storage unit 50a first door open/close sensor 50b second door open/close sensor 60 imaging unit 100 refrigerator 331 to 333 cover

CLAIMS

[Claim 1]

A refrigerator comprising:

a main body having at least one compartment to be cooled;

a plurality of electrical components including a solenoid valve configured to adjust a flow rate of refrigerant used to cool the compartment and an automatic ice maker;

an imaging unit configured to image the compartment; and

a controller provided with a power supply circuit and configured to control operation of the plurality of electrical components and the imaging unit, wherein

the controller has priority level information to interrupt operation of the electrical components, and is configured to,

when causing the imaging unit to image the compartment, if total amperage of the plurality of electrical components and the imaging unit exceeds a current capacity of the power supply circuit, interrupt the operation of at least one of the plurality of electrical components, and

select at least one of the electrical components based on the priority level information, and interrupt the operation of the selected at least one of the electrical components, and

in the priority level information, a lower priority is given to interrupting the operation of the solenoid valve than a priority of interrupting the operation of the automatic ice maker.

[Claim 2]

The refrigerator of claim 1, wherein

in the priority level information, first priority is given to interrupting the operation of the automatic ice maker.

[Claim 3]

The refrigerator of claim 1 or claim 2, wherein

the plurality of electrical components further includes an electric damper configured to control cold air supply to the compartment; and

in the priority level information, a lower priority is given to interrupting the operation of the electric damper than a priority of interrupting the operation of the solenoid valve.

[Claim 4]

The refrigerator of claim 3, wherein

the plurality of electrical components further includes a fan configured to send cold air into the compartment; and

in the priority level information, a lower priority is given to interrupting the operation of the fan than a priority of interrupting the operation of the electric damper.

[Claim 5]

The refrigerator of any one of claims 1 to 4, further comprising:

at least one door provided for the compartment; and

a door open/close sensor configured to detect opening and closing of the door, wherein

the controller is configured to, when the compartment changes from an open state to a closed state and an imaging wait time lapses while the compartment remains in the closed state, cause the imaging unit to image the compartment.