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(54) **SYSTEM AND METHOD FOR CONTROL OF FAN ROTATIONAL SPEED**

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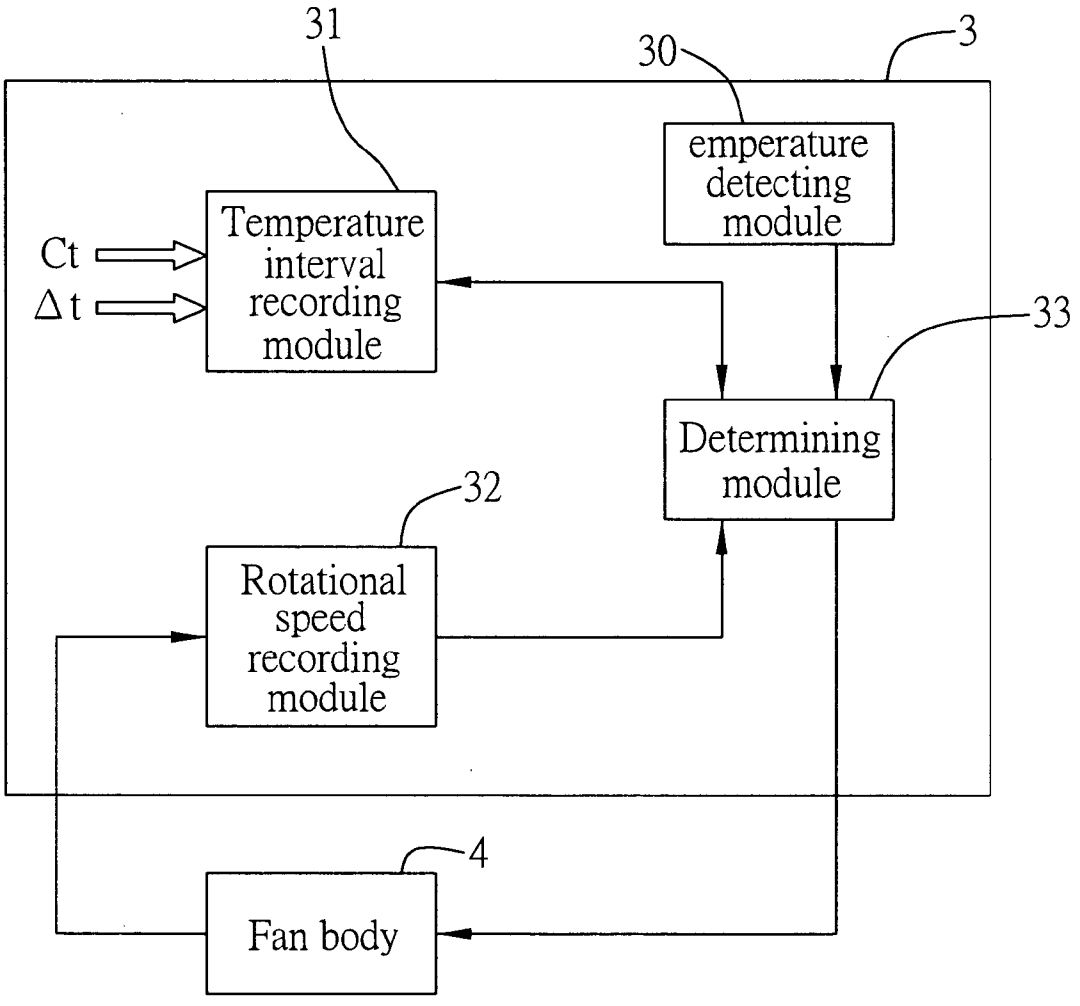
(57) **ABSTRACT**

A system and a method for control of fan rotational speed are applied in an electronic device with a fan for temperature adjustment. The electronic device at least records a first fan rotational speed of the fan when a temperature of the fan is higher than a predetermined temperature interval and a second fan rotational speed of the fan when the temperature of the fan is lower than the temperature interval. A fan rotational speed during operation of the fan is recorded. The electronic device detects a temperature of an exothermic object being adjusted by the fan, and outputs a temperature parameter. The electronic device determines whether the temperature parameter belongs to the temperature interval and accordingly adjusts the fan rotational speed of the fan. The system and method make change of the fan rotational speed less sensitive to oscillations in system temperature and prolong the lifetime of the fan.



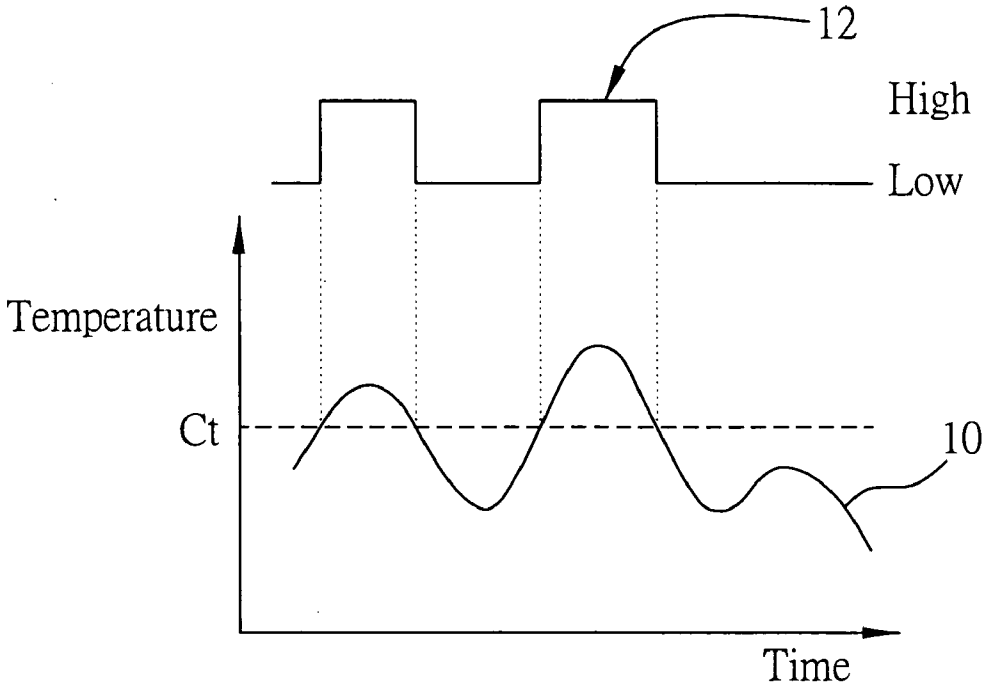


FIG. 1 (PRIOR ART)

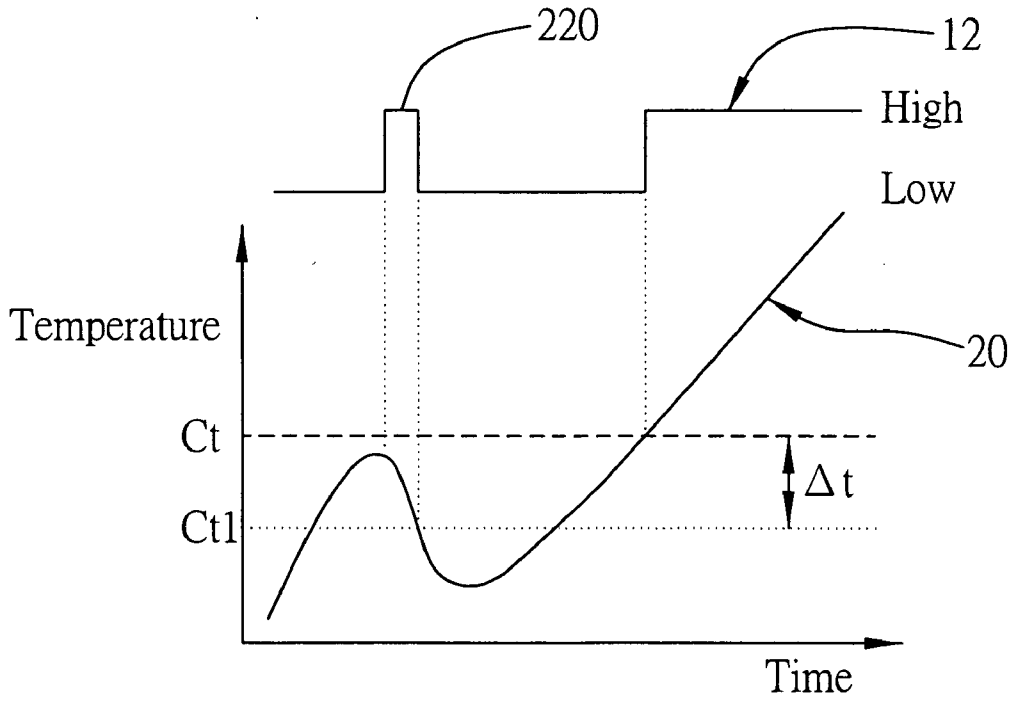


FIG. 2(PRIOR ART)

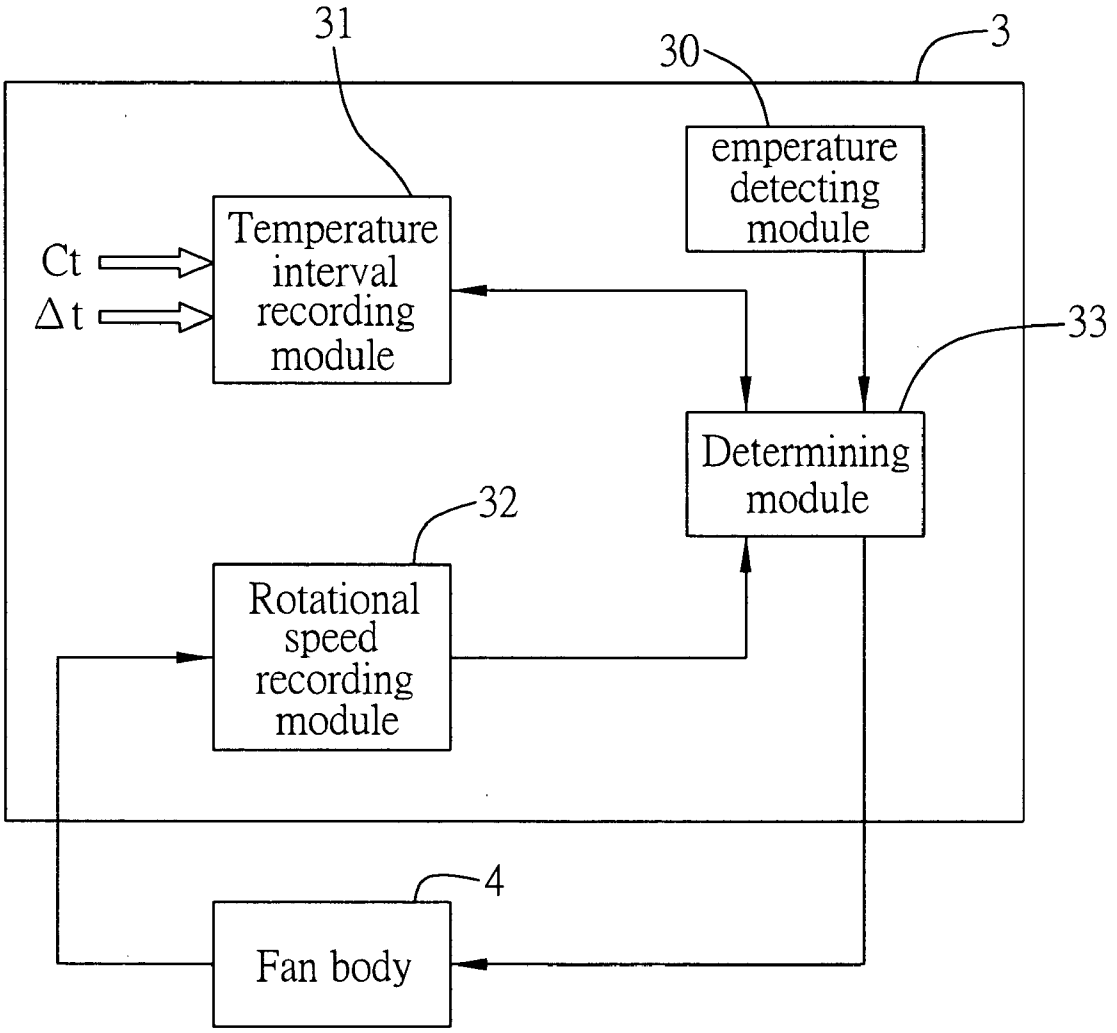

31
30
3
emperature detecting module
Ct
Δt
Temperature interval recording module
33
Determining module
32
Rotational speed recording module
4
Fan body

FIG. 3

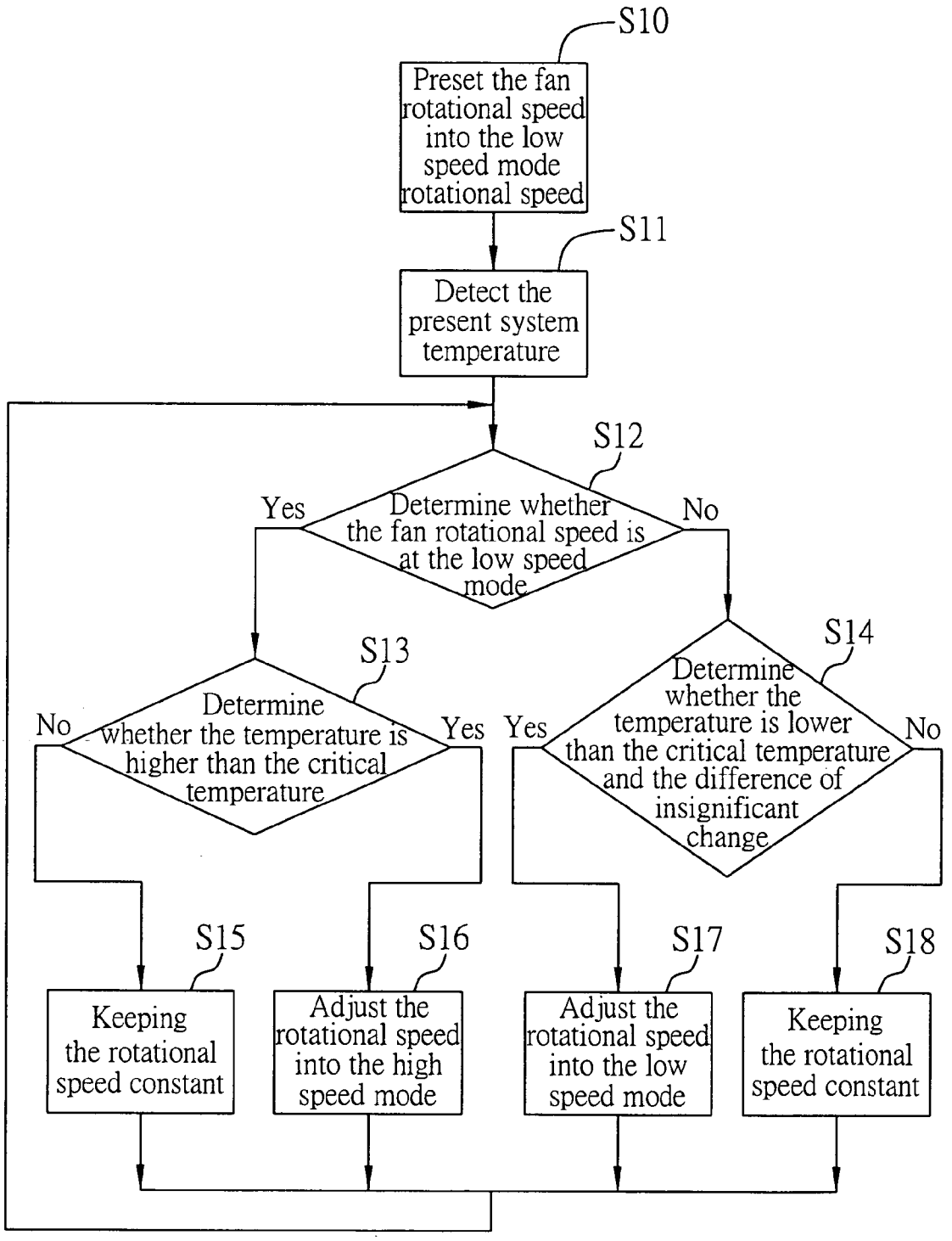

S10
Preset the fan rotational speed into the low speed mode rotational speed
S11
Detect the present system temperature
S12
Determine whether the fan rotational speed is at the low speed mode
Yes
No
S13
Determine whether the temperature is higher than the critical temperature
No
Yes
S14
Determine whether the temperature is lower than the critical temperature and the difference of insignificant change
Yes
No
S15
Keeping the rotational speed constant
S16
Adjust the rotational speed into the high speed mode
S17
Adjust the rotational speed into the low speed mode
S18
Keeping the rotational speed constant

FIG. 4

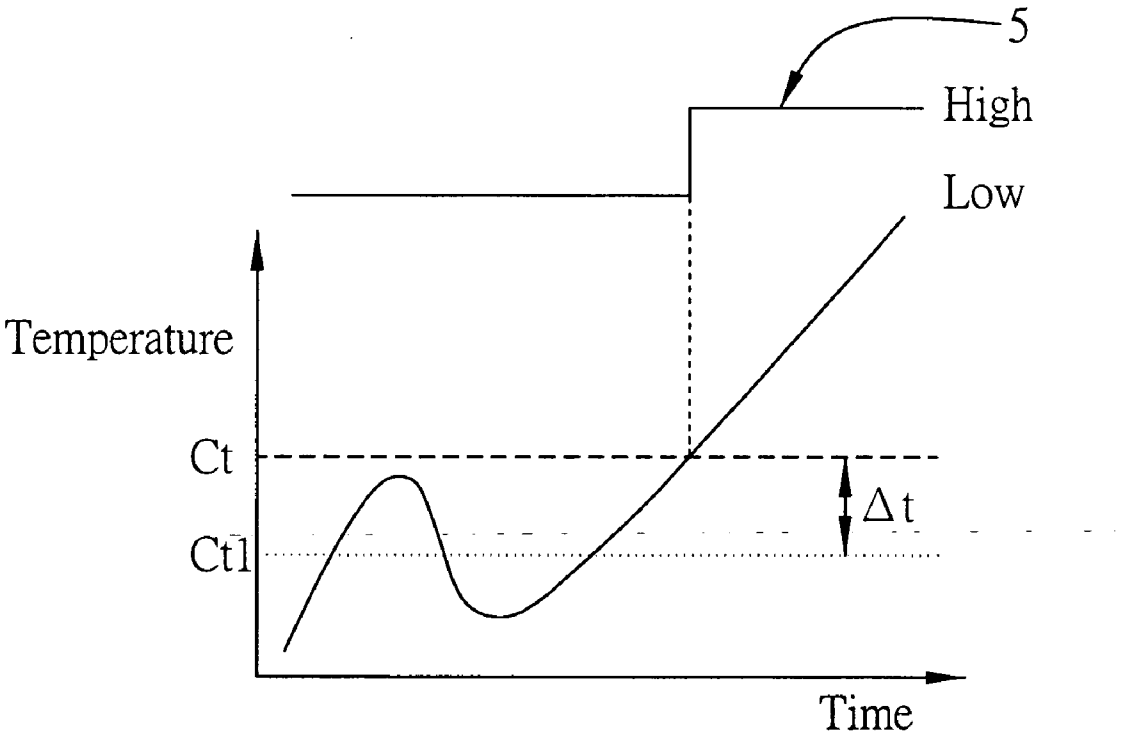


FIG. 5

SYSTEM AND METHOD FOR CONTROL OF FAN ROTATIONAL SPEED

FIELD OF THE INVENTION

[0001] The present invention relates to systems and methods for control of fan rotational speed, and more particularly, to a system and method for control of fan rotational speed of a fan according to a predetermined temperature interval.

BACKGROUND OF THE INVENTION

[0002] Computers have become indispensable tools during work and everyday life, and technological advances have brought about increases in the operational speed of the central processing unit (CPU) which allow the execution of more and more processor-intensive programs. However, a huge amount of heat energy is generated when a CPU is operated at high speed, which, in turn, has a considerable effect on the system. Minor effects include temporary system hangs, and major effects include unrecoverable disk or processor damage to the system. Thus, research into system heat-radiating ability is receiving more and more attention.

[0003] Cooling through the use of a fan is the most commonly used radiating method in the market. This kind of radiating device is constructed of a fan and a heat sink device equipped with fins. This device is broadly applied in computer systems and other electronic devices based on its advantages of simple structure, low cost, safety, reliability, technical maturity, and so on. In order to quickly radiate a large amount of heat energy generated by the system heat sources, the rotational speed of the system radiating fan has to be accelerated. However, additional noise is generated by higher rotational speeds. In addition, regularly rotating the fan at high speed reduces its lifespan.

[0004] In order to solve the problem mentioned above, a fan rotational speed control technique has appeared in the market. A temperature sensing device is utilized, wherein, according to the changes of system temperature, the fan rotational speed will also be altered. In this technique, the fan is operated in at least a low-speed rotation mode and a high-speed rotation mode. **FIG. 1** illustrates how the fan rotational speed is controlled based on a critical temperature value. As shown in the diagram, the temperature changing curve **10** illustrates an electronic device (e.g. computer main frame, laptop, etc) with an installed two-speed fan (in addition to off). The critical temperature value is denoted as Ct and shown by the dashed, horizontal line. System temperature varies above and below this critical temperature depending on system utilization and environmental factors. As illustrated by the fan rotational speed line **12** in the diagram, when the system temperature exceeds the critical temperature value, the fan rotational speed controller will adjust the fan rotational speed into the high-speed rotation mode. Conversely, when the temperature drops below the critical temperature value, the fan rotational speed controller will adjust the fan rotational speed into the low-speed rotation mode. However, the present fan rotational control speed technique is still lacking. In particular, when the system temperature oscillates around the critical temperature value, the fan rotational speed controller has to continually respond and adjust the fan rotational speed in order to meet the requirements. Such frequent changes of the fan rotational speed will result in a shorter fan life.

[0005] In order to solve the deficiency mentioned above, an improvement scheme is proposed. As shown in **FIG. 2**, the amount of a predetermined insignificant temperature change Δt is deducted from the critical temperature value Ct to form a second critical temperature value Ct_1. A critical temperature interval exists between the critical temperature value Ct and the critical temperature value Ct_1, that is the critical temperature value Ct is the upper limit and the other critical temperature value Ct_1 is the lower limit (the difference of Ct minus the insignificant temperature change Δt). When the system temperature exceeds the critical temperature value Ct, the fan rotational speed controller adjusts the fan into the high-speed rotation mode. When the temperature drops below the critical temperature value Ct minus the insignificant temperature change Δt to the critical temperature value Ct**1**, the fan rotational speed controller will adjust the fan into the low-speed rotation mode. Using this technique, the fan can be kept at a stable speed for a longer time. However, this method cannot fully solve the problem of frequent rotational speed changes caused by oscillating temperature. As shown in the diagram, when the system temperature change curve **20** oscillates around the critical temperature value Ct_1, sudden abrupt changes of the fan rotational speed will still occur. A sudden abrupt rotational speed change **220** can occur as shown by the fan rotational speed change line **220** at the relative points, and the lifespan of the fan will be degraded.

[0006] For this reason, a system and a method for control of fan rotational speed is needed to avoid the deficiency of the previously mentioned technique, thus making the change of the fan rotational speed less sensitive to temperature oscillations, and hence remarkably prolonging the life of the fan, as well as reducing system noise.

SUMMARY OF THE INVENTION

[0007] In order to solve the problems of the prior art, a primary objective of the present invention is to provide a system for control of fan rotational speed that avoids repetitive changes of the fan rotational speed in a short period of time due to system temperature oscillations.

[0008] Another objective of the present invention is to provide a method for control of fan rotational speed that achieves the objectives of saving power and prolonging the life of the fan.

[0009] In order to achieve the above objectives, the system for control of fan rotational speed is applied in the electronic device with a built-in fan for temperature adjusting purposes. The system includes at the very least: a temperature interval recording module for at least recording the relative first fan rotational speed when the temperature is at least higher than a temperature interval and the relative second fan rotational speed when the temperature is lower than the temperature interval; a rotational speed recording module for recording the fan rotational speed when the fan is operating; a temperature detecting module for detecting the temperature of an exothermic object being adjusted by the fan and for outputting temperature parameters; and a determining module for determining whether the temperature parameter outputted by the temperature detecting module belongs to the temperature interval recorded by the temperature interval recording module and sending control signals accordingly. For the determining module, if the

temperature parameter belongs to the temperature interval, the system keeps the same rotational speed for the fan operation, and, if the temperature parameter does not belong to the temperature interval, then according to the temperature parameters of the temperature interval recording module, it determines whether the relative fan rotational speed is the same as the fan rotational speed recorded in the rotational speed recording module. If the fan rotational speeds are not the same, according to the temperature parameter of the temperature interval recording module, it determines whether the temperature parameter is lower than the temperature interval. If the temperature parameter is lower, it slows down the fan rotational speed and then updates the fan rotational speed recorded in the rotational speed recording module with the latest fan rotational speed. On the contrary, if the temperature parameter is higher, it operates the fan with the rotational speed recorded in the rotational speed recording module. In contrast, if the fan rotational speeds are the same, then, according to the temperature parameter of the temperature interval recording module, it determines whether the temperature parameter is higher than the temperature interval. If the temperature parameter is higher, it speeds up the fan rotational speed and then updates the fan rotational speed recorded in the rotational speed recording module with the latest fan rotational speed. On the contrary, if the temperature parameter is lower, it operates the fan with the rotational speed recorded in the rotational speed recording module.

[0010] The method for control of fan rotational speed is applied in an electronic device with a built-in fan for temperature adjusting purposes. The method at the very least includes the following procedures: making the electronic device at least record the relative first fan rotational speed when the temperature is at least higher than a temperature interval and the relative second fan rotational speed when the temperature is lower than the temperature interval, and recording the fan rotational speed when the fan is operating; making the electronic device detect the temperature of an exothermic object being adjusted by the fan, and outputting the temperature parameters; and making the electronic device determine whether the output temperature parameter belongs to the temperature interval recorded by the temperature interval recording module. If the temperature parameter belongs to the temperature interval, the method keeps the same rotational speed for the fan operation. If the temperature parameter does not belong to the temperature interval, then, according to the temperature parameter, it determines whether the relative fan rotational speed is the same as the recorded fan rotational speed. If the fan rotational speeds are not the same, then, according to the temperature parameter, it determines whether the temperature parameter is lower than the temperature interval. If the temperature parameter is lower, it slows down the fan rotational speed and then updates the fan rotational speed recorded in the electronic device with the latest fan rotational speed. On the contrary, if the temperature parameter is higher, it operates the fan with the rotational speed recorded in the electronic device. In contrast, if the fan rotational speeds are the same, then, according to the temperature parameter, it determines whether the temperature parameter is higher than the temperature interval. If the temperature parameter is higher, it speeds up the fan rotational speed and then updates the fan rotational speed recorded in the electronic device with the latest fan rotational speed. On the contrary, if the temperature parameter is lower, it operates the fan with the rotational speed recorded in the electronic device.

[0011] Compared with the commonly used fan rotational speed control technique, sudden abrupt changes of fan rotational speed caused by the temperature oscillation can be avoided, according to the preset temperature interval of the system and the method for control of fan rotational speed of the present invention, so as to avoid the deficiency of the prior art, smooth the fan operational rotational speed, prolong the life of the fan, and reduce system noise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A better understanding of the present invention can be obtained when the forgoing detailed description is considered in conjunction with the following drawings, in which:

[0013] **FIG. 1** (PRIOR ART) is a diagram showing the commonly used critical temperature method for control of fan rotational speed;

[0014] **FIG. 2** (PRIOR ART) is a diagram showing the commonly used critical temperature method after compensating for insignificant temperature changes in the control of fan rotational speed;

[0015] **FIG. 3** is a block diagram showing the basic configuration of the system for control of fan rotational speed according to the present invention;

[0016] **FIG. 4** is a flow chart showing the operational procedures which focuses on the low and high speed mode of fan rotational speed according to the method for control of fan rotational speed of the present invention; and

[0017] **FIG. 5** is a relevant diagram of the method for control of fan rotational speed of the present invention, showing how the fan rotational speed varies with the critical temperature value, when progress the rotational speed control to the fan body.

DETAILED DESCRIPTION OF THE PREFFERED EMBODIMENTS

[0018] **FIG. 3** is a block diagram showing the basic configuration of the system for control of fan rotational speed according to the present invention. As shown in the diagram, the fan rotational speed control system **3** includes at very least: a temperature detecting module **30**, a temperature interval recording module **31**, a rotational speed recording module **32**, and a determining module **33**, wherein the system **3** is connected to a fan body **4**. The fan rotational speed control system **3** is implemented in the electronic device which adjusts the system temperature through the use of the fan. In the example, the electronic device is a server computer, and the fan of the fan body **4** is controlled at a low and a high rotational speed.

[0019] The temperature detecting module **30** is used to detect the temperature parameter of an exothermic object (e.g. a CPU, etc.) being adjusted by the fan. In the example, the temperature detecting model **30** can be temperature detector, which is used to detect the system temperature in real time when the server is operating and sends out the system temperature to the determining module **33**.

[0020] The temperature interval recording module **31** is used to record temperature intervals related to different fan rotational speeds. For example, a preset critical temperature value Ct of 50° C. and an insignificant temperature change Δt of 3° C. When the system temperature is higher than 50° C., the fan rotational speed control system **3** will control the fan body **4** to enter high speed operation, and when the system temperature is lower than 47° C. (i.e. the critical temperature value Ct minus the insignificant temperature change Δt), the fan rotational speed control system will control the fan body **4** to enter low speed operation. In more detailed description, if the present fan rotational speed is in low speed mode, the critical temperature interval should be merged into the low rotational speed interval, and if the present fan rotational speed is in high speed mode, the critical temperature interval should be merged into the high rotational speed interval.

[0021] The rotational speed recording module **32** is used to record the present rotational speed when the fan is operating; the record provides an important basis for the determining module **33** to make decisions.

[0022] The determining module **33** is used to determine the temperature interval related to the present temperature parameter detected by the temperature detecting module **30**. In the example, it executes the determination according to the result defined by the temperature interval recording module **31** previously mentioned. The decision of determining module **33** is based on whether the present temperature parameter belongs to the temperature interval recorded in the temperature interval recording module **31**. If yes, the fan body **4** will still operate with the present rotational speed, i.e. keep the present rotational speed.

[0023] However, when the determining module **33** determines that the temperature parameter does not belong to the temperature interval, then, according to the temperature parameter recorded in the temperature interval recording module **31**, it determines whether the fan rotational speed related to the temperature parameter is the same as the fan rotational speed recorded in the rotational speed recording module **32**. If, when the fan rotational speed is different, then, according to the temperature parameter recorded in the temperature interval recording module **31**, it determines whether the temperature parameter is lower than the temperature interval. If the parameter is lower than the temperature interval, it reduces the rotational speed of the fan body **4**, and, at the same time, it updates the rotational speed module **32** with the reduced rotational speed. In contrast, when the temperature parameter determined by the determining module is not lower than the temperature interval, it operates the fan body **4** with the present rotational speed (i.e. keeps the present rotational speed).

[0024] On contrary, when the determining module **33** determines the fan rotational speed related to the temperature parameter is the same as the fan rotational speed recorded in the rotational speed recording module **32**, then, according to the temperature parameter recorded in the temperature interval recording module **31**, it determines whether the temperature parameter is higher than the temperature interval. If the parameter is higher than the temperature interval, it increases the rotational speed of the fan body **4**, and, at the same time, it updates the rotational speed module **32** with the increased rotational speed. In contrast, when the temperature parameter determined by the determining module is lower than the temperature interval, it operates the fan body **4** with the present rotational speed (i.e. keeps the present rotational speed).

[0025] **FIG. 4** is a flow chart showing the operational procedures focusing on the low and high speed modes of fan rotational speed according to the method for control of fan rotational speed of the present invention. In order for the electronic equipment, such as a server, to apply the system and the method for control of fan rotational speed of the present invention, the previously mentioned temperature interval recording module **31** is created in advance in a memory unit, such as the BIOS ROM, for recording the relative first fan rotational speed (i.e. high speed mode) when the temperature is at least higher than a temperature interval (i.e. the interval between the critical temperature value Ct and the insignificant temperature change Δt), and the relative second fan rotational speed (i.e. low speed mode) when the temperature is lower than the temperature interval.

[0026] First, in step S**10**, activate the fan body **4** during the operational process of the server, and record the activated fan rotational speed into the rotational speed recording module **32**. In the example, the fan rotational speed is at the low rational speed. Next, execute step S**11**.

[0027] In step S**11**, make the temperature detecting module **30** detect the temperature of the server when operating, and output the present temperature T. Next, execute step S**12**.

[0028] In step S**12**, make the determining module **33** determine whether the present fan rotational speed is in low speed mode. If yes, execute step S**13**. If no, executes step S**14**.

[0029] In step S**13**, make the determining module **33** determine whether the present system temperature T is higher than the critical temperature value, i.e. the preset critical temperature value 50° C. previously described. If not, execute step S**15**. Otherwise, execute step S**16**.

[0030] In step S**14**, make the determining module **33** determine whether the present system temperature is lower than the critical temperature value minus the preset amount of insignificant temperature change (i.e. below the critical temperature value Ct of 50° C. minus the amount insignificant temperature change Δt of 3° C. previously described, for a lower limit of 47° C.). If yes (i.e., it is lower), execute step S**17**. Otherwise, execute step S**18**.

[0031] In step S**15**, keep the fan rotational speed the same and return to the previously described step S**11**. Repeat the execution of the step S**11** to the step **18**, so that the fan rotational speed will be changed timely according to the system temperature.

[0032] In step S**16**, make the determining module **33** adjust the rotational speed of the fan body **4** to the high rotational speed mode, and return to the previously described step S**11**. Repeat the execution of the step S**11** to the step **18**, so that the fan rotational speed will be changed timely according to the system temperature.

[0033] In the step S**17**, make the determining module **33** adjust the rotational speed of the fan body **4** to the low rotational speed mode, and return to the previously

described step S11. Repeat the execution of the step S11 to the step 18, so that the fan rotational speed will be changed timely according to the system temperature.

[0034] In the step S18, keep the fan rotational speed the same, and return to the step S11. Repeat the execution of the step S11 to the step 18, so that the fan rotational speed will be changed timely according to the system temperature.

[0035] FIG. 5 illustrates the result of the controlled rotational speed of the fan body 4 according to the method for control of fan rotational speed applied in the present invention. In contrast with the prior art where more frequent abrupt changes occur as shown in FIG. 2, in the present invention, the temperature intervals can be adjusted by the system and the method for control of fan rotational speed of the present invention according to the fan rotational speeds. With the present invention, numerous abrupt changes of fan rotational speed caused by temperature oscillations around can be avoided, the fan rotational speed can be smoothed, the life of the fan can be prolonged, and system noise can be reduced.

[0036] Moreover, the present invention is not only suitable for a two-speed fan, but also suits multiple critical temperature values. For instance, the temperature range of two critical temperature values Ct_1 and Ct_2 (Ct_1 is smaller than the Ct_2) and the relative fan rotational speeds are slow speed mode, medium speed mode, and high speed mode. The adjustments toward the case are:

[0037] 1. the fan rotational speed is kept unchanged when it is determined that the system temperature T is lower than the critical temperature value Ct_1 and the present fan rotational speed is in the low speed mode; the fan rotational speed is adjusted to the medium speed mode when it is determined that the system temperature T is higher than the critical temperature value Ct_1 and lower than the critical temperature value Ct_2; the fan rotational speed is adjusted to the high speed mode when it is determined that the system temperature T is higher than the critical value Ct_2.

[0038] 2. If the present fan rotational speed is at the medium speed mode, the fan rotational speed is adjusted to the low speed mode when the system temperature T is lower than the critical temperature value Ct_1 minus the amount of the insignificant temperature change Δt; the fan rotational speed is kept unchanged when the system temperature T is higher than the critical temperature value Ct_1 minus the amount of the insignificant temperature change Δt and, at the same time, lower than the critical temperature value Ct_2; the fan rotational speed is adjusted to the high speed mode when the system temperature T is higher than the critical value Ct_2.

[0039] 3. If the present fan rotational speed is at the high speed mode, the fan rotational speed is adjusted to the low speed mode when the system temperature T is lower than the critical temperature value Ct_1; the fan rotational speed is adjusted to the medium speed mode when the system temperature T is higher than the critical temperature value Ct_1 and lower than the critical temperature value Ct_2 minus the amount of the insignificant temperature change Δt; the fan rotational speed is kept unchanged when the system temperature T is higher than the critical temperature value Ct_2 minus the amount of the insignificant temperature change Δt.

[0040] A rotational speed control flow chart of relative multiple critical temperature values and more than three fan rotational speeds can be made according to the adjustment scheme mentioned above. The flow chart can be generated by making a few changes to the basic operational procedures shown in FIG. 4, thus the adjustment scheme will not be further described.

[0041] The embodiments described above are only to illustrate aspects of the present invention; they should not be construed as to limit the scope of the present invention in any way.

[0042] The invention has been described using exemplary preferred embodiments. However, it is to be understood that the scope of the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangement. The scope of the claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A system for control of fan rotational speed of a fan in an electronic device for temperature adjustment, comprising:

a temperature interval recording module for at least recording a first fan rotational speed of the fan when a temperature of the fan is higher than a predetermined temperature interval and a second fan rotational speed of the fan when the temperature of the fan is lower than the predetermined temperature interval;

a rotational speed recording module for recording a fan rotational speed of the fan during operation of the fan;

a temperature detecting module for detecting a temperature of an exothermic object being adjusted by the fan and outputting a temperature parameter; and

a determining module for determining whether the temperature parameter output by the temperature detecting module belongs to the temperature interval recorded by the temperature interval recording module, if yes, allowing the fan to operate at the same fan rotational speed, or if no, according to the temperature parameter determining from the temperature interval recording module whether a fan rotational speed corresponding to the temperature parameter is the same as the fan rotational speed recorded by the rotational speed recording module; if the fan rotational speeds are different, according to the temperature parameter determining from the temperature interval recording module whether the temperature parameter is lower than the temperature interval; if the temperature parameter is lower than the temperature interval, reducing the fan rotational speed of the fan and updating the fan rotational speed recorded by the rotational speed recording module with the reduced fan rotational speed, or if the temperature parameter is not lower than the temperature interval, allowing the fan to operate at the fan rotational speed recorded by the rotational speed recording module; or if the fan rotational speeds are the same, according to the temperature parameter determining from the temperature interval recording module whether the temperature parameter is higher than the temperature interval; if the temperature parameter is

higher than the temperature interval, increasing the fan rotational speed of the fan and updating the fan rotational speed recorded by the rotational speed recording module with the increased fan rotational speed, or if the temperature parameter is not higher than the temperature interval, allowing the fan to operate at the fan rotational speed recorded by the rotational speed recording module.

2. The system as claimed in claim 1, wherein the temperature interval recorded by the temperature interval recording module is formed by a critical temperature value and a small temperature difference from the critical temperature value.

3. The system as claimed in claim 2, wherein the critical temperature value serves as an upper limit of the temperature interval, and a lower limit of the temperature interval corresponds to a value of the critical temperature value minus the small temperature difference.

4. The system as claimed in claim 1, wherein the first rotational speed is greater than the second rotational speed.

5. The system as claimed in claim 1, wherein the temperature interval recording module is further for recording a plurality of temperature intervals corresponding to different fan rotational speeds.

6. A method for control of fan rotational speed of a fan in an electronic device for temperature adjustment, comprising the steps of:

having the electronic device at least record a first fan rotational speed of the fan when a temperature of the fan is higher than a predetermined temperature interval and a second fan rotational speed of the fan when the temperature of the fan is lower than the predetermined temperature interval, and record a fan rotational speed during operation of the fan;

having the electronic device detect a temperature of an exothermic object being adjusted by the fan and output a temperature parameter;

having the electronic device determine whether the output temperature parameter belongs to the recorded temperature interval, if yes, allowing the fan to operate at the same fan rotational speed, or if no, according to the temperature parameter determining whether a fan rotational speed corresponding to the temperature parameter is the same as the recorded fan rotational speed during operation of the fan; if the fan rotational speeds are different, according to the temperature parameter determining whether the temperature parameter is lower than the temperature interval; if the temperature parameter is lower than the temperature interval, reducing the fan rotational speed of the fan and updating the fan rotational speed recorded in the electronic device with the reduced fan rotational speed, or if the temperature parameter is not lower than the temperature interval, allowing the fan to operate at the fan rotational speed recorded in the electronic device; if the fan rotational speeds are the same, according to the temperature parameter determining whether the temperature parameter is higher than the temperature interval; if the temperature parameter is higher than the temperature interval, increasing the fan rotational speed of the fan and updating the fan rotational speed recorded in the electronic device with the increased fan rotational speed, or if the temperature parameter is not higher than the temperature interval, allowing the fan to operate at the fan rotational speed recorded in the electronic device.

7. The method as claimed in claim 6, wherein the temperature interval recorded by the electronic device is formed by a critical temperature value and a small temperature difference from the critical temperature value.

8. The method as claimed in claim 7, wherein the critical temperature value serves as an upper limit of the temperature interval, and a lower limit of the temperature interval corresponds to a value of the critical temperature value minus the small temperature difference.

9. The method as claimed in claim 6, wherein the first rotational speed is greater than the second rotational speed.

10. The method as claimed in claim 6, wherein the electronic device further records a plurality of temperature intervals corresponding to different fan rotational speeds.

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