

DEVICE AND METHOD FOR CONTROLLING OUTPUT OF LOAD

Field of the Invention

5 [0001] The present invention generally relates to a device and method for controlling an output of a load. Specifically, the invention relates to a device and method for controlling an output of an electrical device, such as light emission intensity of a light emitting device, a speed of a fan and heating or refrigerating intensity of an air conditioner.

10 Background of the Invention

[0002] A dimmer circuit generally controls output light intensity of the light emitting device by selectively changing a conduction angle of an input AC voltage applied to the light emitting device. Typically the conduction angle of the voltage is varied by chopping or blocking a portion of the positive and negative cycles of the input AC
15 voltage applied to the light emitting device. The amount of dimming which is achieved is variable depending upon the extent to which the conduction angle is chopped or blocked.

[0003] Dimmer circuits are generally designed for linear operation and are therefore relatively easily interfaced with and functionally operable with traditional light emitting
20 devices such as incandescent lamps and low voltage halogen lamps which happen to be linear in nature.

[0004] However, as existing dimmer circuits tend to exhibit generally poor compatibility with non-linear light emitting devices such as compact fluorescent lamps (CFLs), fluorescent tube lamps and Light Emitting Diodes (LEDs), various problems
25 such as flickering, service cycle reduction, and light emission failure tend to arise. Moreover, in order for an existing dimmer circuit to be rendered suitably compatible with a non-linear dimmable light emitting device, adaptations of the existing dimmer circuit have to be made, but each individual adaptation for one type or brand of non-linear light emitting device may not be applicable to another type or brand of
30 non-linear light emitting device.

[0005] As it is perceived that the market for energy-saving light emitting devices (which are generally non-linear in nature) is rapidly growing, the problems associated with poor compatibility of existing dimmers with such light emitting devices is

commercially undesirable. For example, a dimmer device and method which is capable of relieving the above problems is disclosed in a PCT patent application No. PCT/CN2010/080529 titled "DEVICE AND METHOD FOR CONTROLLABLY DIMMING THE OUTPUT OF A LOAD", filed on December 30, 2010, in which the
5 device and method are able to detect a type of a load when the load is initially installed so as to apply suitable dimming modes.

[0006] However, characteristics of non-linear light emitting devices may be affected by external environment, such as voltage and temperature, which may lead to wrong operations of a dimmer with an automatic load recognition function due to differences
10 between load characteristics of a current operating period and an initial recognition period. Further, if a user replaces a load with different characteristics, for example from an incandescent lamp to a CFL and from a dimmable CFL to a non-dimmable CFL, wrong operations will also be incurred.

15 **Summary of the Invention**

[0007] The brief summary of the invention will be given below to provide basic understanding of some aspects of the invention. However, it shall be appreciated that this summary is neither exhaustively descriptive of the invention nor intended to define essential or important components or the scope of the invention but is merely for the
20 purpose of presenting some concepts of the invention in a simplified form and hereby acts as a preamble of more detailed descriptions which will be presented later.

[0008] In view of the aforementioned circumstances, an object of the invention is thus to provide a device and method for controlling an output of a load which can overcome or relieve the forgoing problems and can provide abilities to monitor, recognize and
25 control the load in real time without affecting the user, thus improving intelligibility of a product.

[0009] To achieve the above object, according to a first aspect of the invention, there is provided a device for controlling an output of a load, the device including: a conduction angle changing circuit adapted to change a conduction angle of an input AC voltage applied to the load; a current scanner adapted to scan at least one form of a current
30 flowing through the load in response to changing the conduction angle of the input AC voltage applied to the load; and a digital signal processing unit connected with the current scanner and the conduction angle changing circuit and adapted to control the output of the load by referring to a current pattern representing relationship between the
35 at least one form of the current scanned by the current scanner and a varying conduction

angle of the input AC voltage, wherein the digital signal processing unit comprises: a preset load type acquiring module adapted to acquire a preset load type of the load; and a continuous template matching module adapted to perform continuous template matching at a predetermined timing in an event that the preset load type acquired by the
5 preset load type acquiring module is a non-linear dimmable load, wherein the continuous template matching module comprises: a conduction angle range determining sub-module adapted to determine a conduction angle range in accordance with a current conduction angle and a minimum conduction angle associated with the load; a local
10 pattern acquiring sub-module adapted to acquire, in response to changing the conduction angle within the conduction angle range determined by the conduction angle range determining sub-module, a local pattern within the conduction angle range in accordance with the at least one form of the current flowing through the load scanned by the current scanner; a matching sub-module adapted to match the local pattern
15 acquired by the local pattern acquiring sub-module and a local pattern within the conduction angle range in a pre-stored current pattern template; and an updating sub-module adapted to update a control parameter for the load in accordance with a matching result of the matching sub-module.

[0010] According to a second aspect of the invention, there is further provided a method for controlling an output of a load, the method including: a preset load type
20 acquiring step of acquiring a preset load type of the load; a continuous template matching step of performing continuous template matching in an event that the preset load type acquired in the preset load type acquiring step is a non-linear dimmable load, wherein the continuous template matching comprises: a conduction angle range
25 determining step of determining a conduction angle range in accordance with a current conduction angle and a minimum conduction angle associated with the load; a local pattern acquiring step of scanning at least one form of a current flowing through the load in response to changing a conduction angle of an input AC voltage within the conduction angle range determined in the conduction angle range determining step, thus
30 acquiring a local pattern within the conduction angle range, the local pattern representing relationship between the scanned at least one form of the current and a varying conduction angle of the input AC voltage; a matching step of matching the local pattern acquired in the local pattern acquiring step with a local pattern within the conduction angle range in a pre-stored current pattern template; and an updating step of
35 updating a control parameter for the load in accordance with a matching result in the matching step.

[0011] The present invention can perform online scanning on the load without

disturbing the user, effectively avoiding wrong operations caused by reasons such as load replacement or variations in load characteristics due to aging or external influences, thus it is possible to apply most appropriate control to the load so as to obtain better performance.

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Brief Description of the Drawings

[0012] The invention can be better understood with reference to the detailed description given below in conjunction with the accompanying drawings, throughout which identical or like reference signs denote identical or like components and together
10 with which the following detailed description is incorporated into and forms a part of the specification and serves to further illustrate the preferred embodiments of the invention and to explain the principle and advantages of the invention. In the drawings Fig.1 is a flow chart illustrating a method according to an embodiment of the invention;

15 [0013] Fig.1 illustrates a block diagram of a dimming device according to an embodiment of the invention;

[0014] Fig.2A illustrates a schematic view of the dimming device connected to a light emitting device and an AC power source in an exemplary two-wire serial configuration according to the embodiment of the invention;

20 [0015] Fig.2B illustrates a schematic view of the dimming device connected to the light emitting device and the AC power source in an exemplary three-wire configuration according to the embodiment of the invention;

[0016] Fig.3 illustrates a block diagram of functional configuration of a digital signal processing unit as shown in Fig.1 according to the embodiment of the invention;

25 [0017] Fig.4 illustrates a schematic view of creation of a local pattern in a current pattern template;

[0018] Fig.5 illustrates a block diagram of functional configuration of a matching sub-module as shown in Fig.3 according to the embodiment of the invention;

30 [0019] Fig.6 illustrates a block diagram of functional configuration of an updating sub-module as shown in Fig.3 according to the embodiment of the invention;

[0020] Fig.7 illustrates a flow chart of a method for controlling an output of a load according to an embodiment of the invention;

[0021] Fig.8 illustrates a flow chart of a continuous template matching step as shown

in Fig.7 according to the embodiment of the invention;

[0022] Fig.9 illustrates a flow chart of specific processing of a matching step as shown in Fig.8 according to the embodiment of the invention;

5 [0023] Fig.10 illustrates a flow chart of specific processing of an updating step as shown in Fig. 8 according to the embodiment of the invention; and

[0024] Fig. 11 illustrates a flow chart of a discrete template matching step as shown in Fig.7 according to the embodiment of the invention.

Detailed Description of the Invention

10 [0025] Exemplary embodiments of the present invention will be described below in conjunction with the accompanying drawings. For the sake of clarity and conciseness, not all the features of practical implementations are described in the specification. However, it is to be appreciated that numerous implementation-specific decisions shall be made during developing any of such practical implementations so as to achieve the
15 developer's specific goals, for example, to comply with system- and business-related constraining conditions which will vary from one implementation to another. Moreover, it shall also be appreciated that such a development effort might be very complex and time-consuming but may simply be a routine task for those skilled in the art benefiting from this disclosure.

20 [0026] It shall further be noted that only those device structures and/or process steps closely relevant to the solutions of the invention are illustrated in the drawings while other details less relevant to the invention are omitted so as not to obscure the invention due to those unnecessary details.

[0027] Preferred embodiments of the invention will be described with reference to
25 Figs. 1-11 now. For purpose of exemplary, embodiments of the invention will be described only with regard to controllable dimming for the light emitting device 6. Then, those skilled in the art will appreciate that alternative embodiments which are not explicitly described herein may apply to controllably regulate the output of other types of devices (such as the speed of the fan, heating or refrigerating output of the air
30 conditioner or the like).

[0028] Figs. 1, 2A and 2B illustrate a dimming device 1 according to the embodiment of the invention, which can be configured in a two-wire or three-wire electrical connection. In Fig.2A, conductive terminals 4 of the dimming device 1 are connected to an AC power source 5 of 50/60 Hz and a linear or non-linear light emitting device 6 in a

two-wire serial configuration. Alternatively, Fig.2B illustrates that the dimming device 1, the AC power source 5 and the light emitting device 6 are connected together in a three-wire configuration. In the three-wire configuration, the dimming device 1 includes an additional conductive terminal 4' for connecting to the AC power source 5 and the light emitting device 6.

[0029] As shown in Fig.1, the dimming device 1 further includes a circuit for changing a conduction angle of an input AC voltage applied to the lighting emitting device 6 (not shown), a current scanner 3 and a digital signal processing unit 2 coupled to the current scanner 3 and the circuit. The digital signal processing unit 2 may be for example a microcomputer which can perform one or more functions described herein by executing computer programs or may be for example a specialized hardware device incorporating one or more hardware modules, in which these hardware modules are used for implementing one or more functional modules described herein.

[0030] The digital signal processing unit 2 and the current scanner 3 may automatically scan at least one form of a current flowing through the light emitting device 6 in response to changing the conduction angle of the voltage applied to the lighting emitting device 6. The digital signal processing unit 2 in combination with an appropriate switching circuit may automatically change the conduction angle of the input AC voltage during scanning of the current form. This circuit is known and understandable to those skilled in the art, and thus will not be described in detail herein.

[0031] The current form scanned by the digital signal processing unit 2 and the current scanner 3 in response to changing the conduction angle of the voltage may include but not limited to an absolute current average, a half-cycle current average, a root mean square current and/or a current integration.

[0032] The digital signal processing unit 2 may control the light emission output of the light emitting device 6 by referring to a current pattern representing relationship between at least one current form scanned by the current scanner 3 and a varying conduction angle of the input AC voltage.

[0033] As understood by those skilled in the art, the conduction angle of the voltage refers to a portion for powering the light emitting device 6 in a operation cycle (for example, a sinusoidal voltage of 360°), while the minimum conduction angle refers to a conduction angle for enabling the light emitting device 6 to operate in a lowest brightness state. In this embodiment, since only half an operation cycle is considered during the dimming, for the half operation cycle, a relative minimum conduction angle is 0° and a relative maximum conduction angle is 180°. In an alternative embodiment,

the scanned conduction angle range may be changed as required. As an example, in this embodiment, for the positive half cycle, the minimum conduction angle may be larger than or equal to 0° and the maximum conduction angle may be smaller than or equal to 180° ; and for the negative half cycle, the minimum conduction angle may be larger than or equal to 180° and the maximum conduction angle may be smaller than or equal to 360° .

[0034] Next, a functional configuration of the digital signal processing unit 2 as shown in Fig.1 according to the embodiment of the invention will be described in detail with reference to Fig.3.

10 [0035] As shown in Fig.3, the digital signal processing unit 2 may include one or more of a preset load type acquiring module 21, a continuous template matching module 22 and a discrete template matching module 23.

[0036] The preset load type acquiring module 21 may be configured to acquire the preset load type of the light emitting device 6. The preset load type may be set in advance by detecting the load type utilizing the method such as that disclosed in the foregoing PCT patent application No. PCT/CN2010/080529 or by inputting the load type through user's manual input, when the load is initially installed or the load is replaced, for example.

20 [0037] First, a functional configuration of the continuous template matching module 22 will be described in detail.

[0038] The continuous template matching module 22 may perform continuous template matching at a predetermined timing (such as when turning off or dimming the light emitting device 6) in an event that the preset load type acquired by the preset load type acquiring module 21 is a non-linear dimmable load, thus identifying whether the type or characteristics of the light emitting device 6 has varied, without affecting normal use for the user.

25 [0039] Specifically, as shown in Fig.3, the continuous template matching module 22 may include a conduction angle range determining sub-module 221, a local pattern acquiring sub-module 222, a noise filtering sub-module 223, a matching sub-module 224 and an updating sub-module 225.

[0040] Functional configurations of respective sub-modules described above will be described in detail below.

[0041] The conduction angle range determining sub-module 221 may be configured to determine a regulating range of the conduction range in accordance with a conduction

angle at which the light emitting device 6 operates currently and a minimum conduction angle associated with the light emitting device 6.

[0042] The local pattern acquiring sub-module 222 may be configured to acquire, in response to changing the conduction angle of the input AC voltage within the conduction angle range determined by the conduction angle range determining sub-module 221, a local pattern representing relationship between the varying conduction angle and an average load current within the determined conduction angle range in accordance with at least one form of the current (for example, the average load current) flowing through the light emitting device 6 scanned by the current scanner 3.

Moreover, the local pattern within the determined conduction angle range can be acquired from a pre-stored current pattern template in accordance with the determined conduction angle range for use in the subsequent matching processing. For example, Fig. 4 schematically illustrates a creation process of the local pattern in the current pattern template of the non-linear dimmable load.

[0043] The noise filtering sub-module 223 may be configured to filter a noise in the acquired local pattern of the light emitting device 6 so as to smooth out relatively large waveform deformation for use in the subsequent processing. It is to be noted that the noise filtering sub-module 223 is optional.

[0044] The matching sub-module 224 may be configured to match the local pattern acquired by the local pattern acquiring sub-module 222 with the local pattern within the determined conduction angle range in the pre-stored current pattern template.

[0045] The updating sub-module 227 may be configured to update a control parameter for light emission output of the light emitting device 6, such as a minimum startup conduction angle for enabling an appropriate startup illumination of the light emitting device 6 and/or a minimum conduction angle for enabling the light emitting device 6 to operate in a lowest brightness state, in accordance with the result of the matching performed by the matching sub-module 224, thereby achieving control for the light emission output of the light emitting device 6.

[0046] According to one specific embodiment of the invention, as shown in Fig.5, the matching sub-module 224 may further include a first normalization section 2241, a first matching section 2242, a second normalization section 2243 and a second matching section 2244.

[0047] Specifically, the first normalization section 2241 may be configured to normalize the acquired local pattern at a first ratio, the first ratio being a ratio of a start point of the acquired local pattern to a start point of the local pattern in a pre-stored

current pattern template of the linear load, for example.

5 [0048] The first matching section 2242 may be configured to match the local pattern normalized by the first normalization section 2241 with the local pattern within the determined conduction angle range in the pre-stored current pattern template of the linear load.

[0049] The second normalization section 2243 may be configured to normalize the acquired local pattern at a second ratio, the second ratio being a ratio of the start point of the acquired local pattern to a start point of the local pattern in the pre-stored current pattern template of the non-linear dimmable load, for example.

10 [0050] The second matching section 2244 may be configured to match the local pattern normalized by the second normalization section 2243 with the local pattern within the determined conduction angle range in the pre-stored current pattern template of the non-linear dimmable load.

15 [0051] In this case, the updating sub-module 225 may be configured to update the control parameter for the light emission output of the light emitting device 6 in an event that the matching results of both the first matching section 2242 and the second matching section 2244 each indicate an unsuccessful matching.

20 [0052] Further, according to one specific embodiment of the invention, as shown in Fig.6, the updating sub-module 225 may further include a control parameter identifying section 2251 and a control parameter updating section 2252. Specifically, the control parameter identifying section 2251 may be configured to identify the control parameter for the light emission output of the light emitting device 6 by referring to a feature extracted from the local pattern acquired by the local pattern acquiring sub-module 222. The control parameter updating section 2252 may be configured to update the control
25 parameter for the light emitting device 6 with the control parameter identified by the control parameter identifying section 2251.

[0053] Preferably, the feature of the local pattern includes at least one of a turning point in the local pattern, a maximum and a minimum slope, a monotonic decrease and monotonic increase characteristics, a local valley and a local peak.

30 [0054] Preferably, the control parameter includes at least one of the following: the minimum startup conduction angle for enabling the appropriate startup illumination of the light emitting device 6; and the minimum conduction angle for enabling the light emitting device 6 to operate in the lowest brightness state. As an example, in this embodiment, the minimum startup conduction angle may be set in such a way that no

less than 20% of each of the voltages in the positive half cycle and in the negative half cycle is applied to the load when starting up, and the minimum conduction angle may be set to be no less than 20% of each of the voltages in the positive half cycle and in the negative half cycle.

5 [0055] Next, the functional configuration of the discrete template matching module 23 will be described in detail.

[0056] The discrete template matching module 23 may be configured to automatically perform discrete template matching when the light emitting device 6 operates normally, so as to identify whether the characteristics of the light emitting device 6 have varied
10 (such as being dimmed off, flickering, the dimmability being varied) without affecting the normal use for the user. Specifically, as shown in Fig.3, the discrete template matching module 23 may include one or more of a dimming-off judging sub-module 231, a flickering judging module 232 and a dimmability judging sub-module 233.

[0057] Functional configurations of respective sub-modules of the discrete template
15 matching module 23 will be described in detail below.

[0058] Specifically, the dimming-off judging sub-module 231 may be configured to judge, in an event that the preset load type acquired by the preset load type acquiring module 21 is the non-linear dimmable load, whether the light emitting device 6 is dimmed off in accordance with the value of the current (for example, the average load
20 current) flowing through the light emitting device 6 scanned by the current scanner 3 at the current conduction angle and the current value at the minimum conduction angle in the pre-stored current pattern template of the non-linear dimmable load. Specifically, if the difference value by which the scanned current value at the current conduction angle is smaller than the current value at the minimum conduction angle in the pre-stored
25 current pattern template of the non-linear dimmable load is larger than a predetermined threshold, then it can be determined that the light emitting device 6 is dimmed off.

[0059] Moreover, the dimming-off judging sub-module 231 may be further configured to judge, in an event that the preset load type acquired by the preset load type acquiring module 21 is the linear load, whether the light emitting device 6 is dimmed off in
30 accordance with the value of the current (for example, the average load current) flowing through the light emitting device 6 scanned by the current scanner 3 at the current conduction angle and a predetermined current threshold, the predetermined current threshold being a current value associated with the load which is well-known to those skilled in the art and which makes the brightness of the linear light emitting device be
35 lowest. Specifically, if the difference value by which the scanned current value at the

current conduction angle is smaller than the predetermined current threshold is larger than a predetermined threshold, then it can be determined that the light emitting device 6 is dimmed off.

5 [0060] The flickering judging sub-module 232 may be configured to judge, in an event that the preset load type acquired by the preset load type acquiring module 21 is the non-linear dimmable load or the linear load, whether the light emitting device 6 is flickering by comparing values of current (for example, the average load current) flowing through the light emitting device 6 scanned by the current scanner 3 at the same current conduction angle in several operation cycles. If the current values in these
10 operation cycles are different, the light emitting device 6 is judged to be flickering. Moreover, if at least one of the cases that the light emitting device 6 is dimmed off or is flickering is judged to occur, then the type of the light emitting device 6 can be re-set. For example, the type of the light emitting device 6 can be automatically detected with the method such as that disclosed in the foregoing PCT patent application No.
15 PCT/CN2010/080529 or the type of the light emitting device 6 may be input manually, so as to apply suitable operating modes to the light emitting device 6, thereby enabling the light emitting device 6 to operate in a better state.

[0061] The dimmability judging sub-module 233 may be configured to judge, in an event that the preset load type acquired by the preset load type acquiring module 21 is
20 non-linear non-dimmable load, whether the dimmability of the light emitting device 6 has varied by comparing values of the current (for example, the average load current) flowing through the light emitting device 6 scanned by the current scanner 3 at two predetermined conduction angles. Preferably, the two predetermined conduction angles are a full conduction angle and any conduction angle between 36° and 90° respectively.
25 If the difference between the current values scanned at the two predetermined conduction values exceeds a predetermined threshold, the dimmability of the light emitting device 6 is judged to have varied, thus the type of the light emitting device 6 is re-set.

30 [0062] The device for controlling the output of the load, i.e., the dimming device 1, according to the embodiments of the invention has been described in detail in combination with the drawings above. The method for controlling the output of the load according to the embodiment of the invention will be described with reference to Figs. 7-11 below. This method may be performed by the device for controlling the output of the load described above.

35 [0063] First, the method for controlling the output of the load performed by the

dimming device 1 according to the embodiment of the invention will be described with reference to the flow chart as shown in Fig. 7. As shown in Fig.7, the method may include one or more of a preset load type acquiring step S710, a continuous template matching step S730 and a discrete template matching step S740.

5 [0064] Firstly, in the preset load type acquiring step S710, the preset load type of the light emitting device 6 is acquired. Particularly, the preset load type may be set in advance by automatically detecting the load type with the method such as that disclosed in the foregoing PCT patent application No. PCT/CN2010/080529 or by inputting the load type through user's manual input, when the load is initially installed or the load is
10 replaced, for example.

[0065] Next, if the preset load type acquired in the preset load type acquiring step S710 is non-linear dimmable load (i.e., YES in step S720), the processing proceeds to the continuous template matching step S730 and subsequently proceeds to the discrete template matching step S740.

15 [0066] On the contrary, if the preset load type acquired in the preset load type acquiring step S710 is linear or non-linear non-dimmable load (i.e., NO in step S720), then the processing directly proceeds to the discrete template matching step S740.

[0067] Next, the continuous template matching step performed by the continuous template matching module 22 in the dimming device 1 according to the embodiment of
20 the invention will be described with reference to the flow chart as shown in Fig. 8. Preferably, this processing is performed at a predetermined timing such as when turning off the light emitting device 6 or dimming the light emitting device 6 in an event that the preset load type acquired in the preset load type acquiring step S710 is the non-linear dimmable light emitting device, without affecting the normal use for the user.

25 [0068] Firstly, in the conduction angle range determining step S731, the range of the conduction angle is determined in accordance with the current angle at which the light emitting device 6 operates currently and the minimum conduction angle associated with the light emitting device 6.

[0069] Then, after determining the conduction angle range, in the local pattern
30 acquiring step S732, the local pattern within the determined conduction angle range is acquired by scanning at least one form of the current (for example, the average load current) flowing through the light emitting device 6 in response to changing the conduction angle of the input AC voltage within the determined conduction angle range, the local pattern representing the relationship between the scanned at least one current
35 form and the varying conduction angle of the input AC voltage.

[0070] Then, in the noise filtering step S733, the noise of the local pattern acquired in the local pattern acquiring step S732 is filtered so as to filter out the relatively large waveform deformation. It is to be noted that the noise filtering step S733 is optional.

5 [0071] Next, in the matching step S734, the local pattern acquired in the local pattern acquiring step S732 is matched with the local pattern within the determined conduction angle range in the pre-stored current pattern template.

10 [0072] After that, in the updating step S735, the control parameter for the light emission output of the light emitting device 6, such as the minimum startup conduction angle for enabling the appropriate startup illumination of the light emitting device 6 and/or the minimum conduction angle for enabling the light emitting device 6 to operate in the lowest brightness state, is updated in accordance with the result of the matching performed in the matching step S734.

15 [0073] According to one specific embodiment of the invention, as shown in Fig.9, the matching step S734 may further include a first normalization sub-step S7341, a first matching sub-step S7342, a second normalization sub-step S7344 and a second matching sub-step S7345.

20 [0074] Specifically, firstly in the first normalization sub-step S7341, the local pattern acquired in the local pattern acquiring step S732 is normalized at a first ratio, the first ratio being a ratio of a start point of the acquired local pattern to a start point of the local pattern within the determined conduction angle range in the pre-stored current pattern template of the linear load.

[0075] Then, in the first matching sub-step S7342, the local pattern normalized in the first normalization sub-step S7341 is matched with the local pattern within the determined conduction angle range in the current pattern template of the linear load.

25 [0076] Next, if the matching does not succeed (NO in step S7343), the processing proceeds to the second normalization sub-step S7344, in which the local pattern acquired in the local pattern acquiring step S732 is normalized at a second ratio, the second ratio being a ratio of a start point of the acquired local pattern to a start point of the local pattern within the determined conduction angle range in the pre-stored current pattern template of the non-linear dimmable load. Furthermore, if the matching
30 succeeds (YES in step S7343), that is, the type of the load has varied, then the type of the load is re-set.

[0077] Next, in the second matching sub-step S7345, the local pattern normalized in the second normalization sub-step S7344 is matched with the local pattern within the

determined conduction angle range in the current pattern template of the non-linear dimmable load.

[0078] If the matching does not succeed (NO in step S7346), it indicates that the characteristics of the type have varied, then in the updating step S735, the control parameter for the light emitting device 6 is automatically updated by referring to the feature (such as a turning point in the local pattern, a maximum and a minimum slope, a monotonic decrease and monotonic increase characteristics, a local valley and a local peak) extracted from the scanned local pattern, so as to automatically compensate the non-linearity of the operation characteristics of the light emitting device 6. Additionally, if the matching succeeds (YES in step S7346), the original control parameter is maintained.

[0079] As can be seen from the above, the control parameter for the light emission output of the light emitting device 6 is updated in the updating step S735 only in the event that the matching results both in the first matching sub-step S7342 and in the second matching sub-step S7345 each indicate an unsuccessful matching (i.e., NO in steps S7343 and S7346).

[0080] According to one specific embodiment of the invention, as shown in Fig.10, the updating step S735 may further include a control parameter identifying sub-step S7351 and a control parameter updating sub-step S7352.

[0081] Specifically, first, in the control parameter identifying sub-step S7351, the control parameter for the light emission output of the light emitting device 6 is identified by referring to the feature of the acquired local pattern. Next, in the control parameter updating sub-step S7352, the control parameter for the light emitting device 6 is updated with the control parameter identified in the control parameter identifying sub-step S7351.

[0082] Next, the discrete template matching step performed by the discrete template matching module 23 in the dimming device 1 according to the embodiment of the invention will be described in detail with reference to the flow chart in Fig.11. This processing may be performed when the light emitting device 6 operates normally, without affecting the normal use for the user.

[0083] Typically, in the event that the preset load type acquired in the preset load type acquiring step S710 is the non-linear dimmable load or linear load, whether the characteristics of the light emitting device 6 have varied, e.g. being dimmed off or flickering, is judged by performing single-point matching.

[0084] Specifically, in the dimming-off judging step S741, in the event that the preset load type acquired in the preset load type acquiring step S710 is the non-linear dimmable load, whether the light emitting device 6 is dimmed off is judged in accordance with the value of the current (for example, the average load current) flowing through the light emitting device 6 scanned at the current conduction angle and the current value at the minimum conduction angle in the pre-stored current pattern template of the non-linear dimmable load. Specifically, if the difference value by which the current value scanned at the current conduction angle is smaller than the current value at the minimum conduction angle in the pre-stored current pattern template of the non-linear dimmable load is larger than a predetermined threshold, then the light emitting device 6 is judged to be dimmed off.

[0085] Moreover, in the dimming-off judging step S741, in the event that the preset load type acquired in the preset load type acquiring step S710 is the linear load, whether the light emitting device 6 is dimmed off is judged in accordance with the value of the current (for example, the average load current) flowing through the light emitting device 6 scanned at the current conduction angle and a predetermined current threshold, the predetermined current threshold being a current value associated with the load which is well-known to those skilled in the art and makes the brightness of the linear light emitting device be lowest. Specifically, if the difference value by which the current value scanned at the current conduction angle is smaller than the predetermined current threshold is larger than a predetermined threshold, then the light emitting device 6 is judged to be dimmed off.

[0086] If it is judged in the above dimming-off judging step S741 that the light emitting device 6 is dimmed off (YES in step S744), the type of the light emitting device 6 is re-set (step S747).

[0087] In the flickering judging step S742, whether the light emitting device 6 is flickering is judged by comparing values of the current (for example, the average load current) flowing through the light emitting device 6 scanned at the same current conduction angle in several operation cycles. If it is judged that the light emitting device 6 is flickering (YES in step S745), the load type is re-set (step S747).

[0088] It is possible to avoid the circumstances in which the light emitting device 6 is flickering or dimmed off due to applying of inappropriate operation modes by performing the judgment for characteristics of the non-linear dimmable load or the linear load described above, thereby improving the dimming performance of the device and enabling the user to obtain better dimming effects.

[0089] Further, if the preset load type acquired in the preset load type acquiring step S710 is the non-linear non-dimmable load, whether the characteristics of the light emitting device 6 (for example, the dimmability) have varied is generally judged by performing two-point matching.

5 [0090] Specifically, in the dimmability judging step S743, whether the dimmability of the light emitting device 6 has varied is judged by comparing values of current (for example, the average load current) flowing through the light emitting device 6 scanned at two predetermined conduction angles. Preferably, the two predetermined conduction angles may be a full conduction angle and any conduction angle between 36° and 90°
10 respectively. For example, when the difference between the average load currents scanned at the two conduction angles exceeds a predetermined threshold, it is judged that the dimmability of the light emitting device 6 has varied (YES in step S746), and thus the load type is re-set (step S747) to apply an appropriate operation mode.

15 [0091] It is to be noted that the method described according to the embodiment of the invention corresponds to the foregoing device embodiment, thus portions which are not described in detail in the method embodiment can be seen from the corresponding description in the device embodiment, and no repeated description will be made herein.

[0092] As can be seen from the above description of the preferred embodiments of the invention, wrong operations due to variation in load type, variation in load
20 characteristics caused by aging or variation in temperature and voltage for example and wrong load type in the initial recognition can be avoided by scanning, monitoring and updating the load characteristics in real time, thus improving intelligibility of the dimming device 1 and better dimming performance can be obtained.

[0093] It is to be noted that the above described current pattern templates of the linear
25 load, the non-linear dimmable load and the non-linear non-dimmable load may be preferably stored in a memory in advance through manual input. Alternatively, the foregoing templates may also be current pattern templates which are identified when initially connecting the dimming device 1 with the light emitting device 6.

[0094] Further, it is to be noted that the above series of processing and devices may
30 also be implemented through software and/or firmware. In case of being implemented through software and/or firmware, a program constituting the software is installed from storage medium or network into a computer having specialized hardware structures which is capable of executing various functions when installed with various programs.

[0095] It shall further be noted that the steps of the foregoing series of processing may
35 naturally but not necessarily be sequentially performed in the order as described. Some

of the steps may be performed concurrently or independently from each other.

[0096] Those skilled in the art should understand that changes and modifications may be made to the invention in addition to the specific description set forth herein without departing from the scope of the invention. All such changes and modifications obvious
5 to those skilled in the art are considered to fall within the spirit and scope of the invention. It is to be understood that all these changes and modifications are included in the invention. The invention also individually or collectively includes all the steps and features recited or indicated in the specification as well as any and all combinations of any two or more of the steps or features.

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CLAIMS

1. A device for controlling an output of a load, the device comprising:

a conduction angle changing circuit adapted to change a conduction angle of an input AC voltage applied to the load;

5 a current scanner adapted to scan at least one form of a current flowing through the load in response to changing the conduction angle of the input AC voltage applied to the load; and

a digital signal processing unit connected with the current scanner and the conduction angle changing circuit and adapted to control the output of the load by referring to a current pattern representing relationship between the at least one form of the current scanned by the current scanner and a varying conduction angle of the input AC voltage,

wherein the digital signal processing unit comprises:

15 a preset load type acquiring module adapted to acquire a preset load type of the load; and

a continuous template matching module adapted to perform continuous template matching at a predetermined timing in an event that the preset load type acquired by the preset load type acquiring module is a non-linear dimmable load, wherein the continuous template matching module comprises:

20 a conduction angle range determining sub-module adapted to determine a conduction angle range in accordance with a current conduction angle and a minimum conduction angle associated with the load;

25 a local pattern acquiring sub-module adapted to acquire, in response to changing the conduction angle within the conduction angle range determined by the conduction angle range determining sub-module, a local pattern within the conduction angle range in accordance with the at least one form of the current flowing through the load scanned by the current scanner;

30 a matching sub-module adapted to match the local pattern acquired by the local pattern acquiring sub-module and a local pattern within the conduction angle range in a pre-stored current pattern template; and

an updating sub-module adapted to update a control parameter for the load in accordance with a matching result of the matching sub-module.

2. The device according to claim 1, wherein the continuous template matching module further comprises:

5 a noise filtering sub-module adapted to filter a noise of the local pattern acquired by the local pattern acquiring sub-module.

3. The device according to claim 1, wherein the matching sub-module further comprises:

10 a first normalization section adapted to normalize the acquired local pattern at a first ratio, the first ratio being a ratio of a start point of the acquired local pattern to a start point of the local pattern in a current pattern template of a linear load;

a first matching section adapted to match the local pattern normalized by the first normalization section with the local pattern within the conduction angle range in the current pattern template of the linear load;

15 a second normalization section adapted to normalize the acquired local pattern at a second ratio, the second ratio being a ratio of the start point of the acquired local pattern to a start point of the local pattern in a current pattern template of a non-linear dimmable load; and

20 a second matching section adapted to match the local pattern normalized by the second normalization section with the local pattern within the conduction angle range in the current pattern template of the non-linear dimmable load.

4. The device according to claim 3, wherein the updating sub-module is adapted to update the control parameter for the load in an event that matching results of
25 both the first matching section and the second matching section each indicate an unsuccessful matching.

5. The device according to claim 1, wherein the updating sub-module further comprises:

30 a control parameter identifying section adapted to identify a control parameter by referring to a feature of the local pattern; and

a control parameter updating section adapted to update the control parameter

for the load with the control parameter identified by the control parameter identifying section.

5 6. The device according to claim 5, wherein the feature comprises at least one of: a turning point in the local pattern; a maximum slope in the local pattern; a minimum slope in the local pattern; a monotonic decrease characteristics in the local pattern; a monotonic increase characteristics in the local pattern; a local valley in the local pattern; and a local peak in the local pattern.

10 7. The device according to claim 1, wherein the preset timing is a timing when turning off the load or regulating the load.

15 8. The device according to claim 1, wherein the digital signal processing unit further comprises a discrete template matching module adapted to perform discrete template matching, wherein the discrete template matching module comprises one or more of the following sub-modules:

20 a dimming-off judging sub-module adapted to judge, in an event that the preset load type acquired by the preset load type acquiring module is a non-linear dimmable load, whether the load is dimmed off in accordance with a value of the current flowing through the load scanned by the current scanner at the current conduction angle and a current value at a minimum conduction angle in the pre-stored current pattern template of the non-linear dimmable load; and to judge, in an event that the preset load type acquired by the preset load type acquiring module is a linear load, whether the load is dimmed off in accordance with the value of the current flowing through the load scanned by the current scanner at the current conduction angle and a predetermined current threshold;

30 a flickering judging sub-module adapted to judge, in an event that the preset load type acquired by the preset load type acquiring module is the non-linear dimmable load or the linear load, whether the load is flickering by comparing values of current flowing through the load scanned by the current scanner at the same current conduction angle in a plurality of operation cycles; and

 a dimmability judging sub-module adapted to judge, in an event that the preset load type acquired by the preset load type acquiring module is a non-linear non-dimmable load, whether the dimmability of the load has varied by comparing

values of current flowing through the load scanned by the current scanner at two predetermined conduction angles.

5 9. The device according to claim 8, wherein the two predetermined conduction angles are a full conduction angle and any conduction angle between 36° and 90° respectively.

10 10. The device according to claim 1, wherein the load comprises at least one of a light emitting device, a fan and an air conditioner.

11. The device according to claim 1, wherein the form of the current comprises but is not limited to one of an absolute current average, a half-cycle current average, a root mean square current and a current integration.

15 12. The device according to claim 1, wherein the control parameter comprises at least one of a minimum startup conduction angle enabling an appropriate startup output of the load and the minimum conduction angle enabling the load to operate in a critical lowest state.

20 13. A method for controlling an output of a load, the method comprising:
a preset load type acquiring step of acquiring a preset load type of the load;
a continuous template matching step of performing continuous template matching in an event that the preset load type acquired in the preset load type acquiring step is a non-linear dimmable load,

25 wherein the continuous template matching comprises:

a conduction angle range determining step of determining a conduction angle range in accordance with a current conduction angle and a minimum conduction angle associated with the load;

30 a local pattern acquiring step of scanning at least one form of a current flowing through the load in response to changing a conduction angle of an input AC voltage within the conduction angle range determined in the conduction angle range determining step, thus acquiring a local pattern within the conduction angle range, the

local pattern representing relationship between the scanned at least one form of the current and a varying conduction angle of the input AC voltage;

5 a matching step of matching the local pattern acquired in the local pattern acquiring step with a local pattern within the conduction angle range in a pre-stored current pattern template; and

an updating step of updating a control parameter for the load in accordance with a matching result in the matching step.

14. The method according to claim 13, wherein the method further comprises:

10 a noise filtering step of filtering a noise of the local pattern acquired in the local pattern acquiring step.

15. The method according to claim 13, wherein the matching step further comprises:

15 a first normalization sub-step of normalizing the acquired local pattern at a first ratio, the first ratio being a ratio of a start point of the acquired local pattern to a start point of the local pattern in a current pattern template of a linear load;

20 a first matching sub-step of matching the local pattern normalized in the first normalization sub-step with the local pattern within the conduction angle range in the current pattern template of the linear load;

a second normalization sub-step of normalizing the acquired local pattern at a second ratio, the second ratio being a ratio of the start point of the acquired local pattern to a start point of the local pattern in a current pattern template of a non-linear dimmable load; and

25 a second matching sub-step of matching the local pattern normalized in the second normalization sub-step with the local pattern within the conduction angle range in the current pattern template of the non-linear dimmable load.

30 16. The method according to claim 15, wherein the control parameter for the load is updated in the updating step in an event that matching results of both in the first matching sub-step and in the second matching sub-step each indicate an unsuccessful matching.

17. The method according to claim 13, wherein the updating step further comprises:

5 a control parameter identifying sub-step of identifying a control parameter by referring to a feature of the local pattern; and

a control parameter updating sub-step of updating the control parameter for the load with the control parameter identified in the control parameter identifying sub-step.

10 18. The method according to claim 17, wherein the feature comprises at least one of: a turning point in the local pattern; a maximum slope in the local pattern; a minimum slope in the local pattern; a monotonic decrease characteristics in the local pattern; a monotonic increase characteristics in the local pattern; a local valley in the local pattern; and a local peak in the local pattern.

15 19. The method according to claim 13, wherein the method is performed at a preset timing which is a timing when turning off the load or regulating the load.

20 20. The method according to claim 13, further comprising a discrete template matching step of performing discrete template matching, wherein the discrete template matching comprises one or more of the following steps:

25 a dimming-off judging step of judging, in an event that the preset load type acquired in the preset load type acquiring step is a non-linear dimmable load, whether the load is dimmed off in accordance with a value of the current flowing through the load scanned at the current conduction angle and a current value at a minimum conduction angle in the pre-stored current pattern template of the non-linear dimmable load; and judging, in an event that the preset load type acquired in the preset load type acquiring step is a linear load, whether the load is dimmed off in accordance with the value of the current flowing through the load scanned at the current conduction angle and a predetermined current threshold;

30 a flickering judging step of judging, in an event that the preset load type acquired in the preset load type acquiring step is the non-linear dimmable load or the linear load, whether the load is flickering by comparing values of current flowing through the load scanned at the same current conduction angle in a plurality of operation

cycles; and

5 a dimmability judging step of judging, in an event that the preset load type acquired in the preset load type acquiring step is a non-linear non-dimmable load, whether the dimmability of the load has varied by comparing values of current flowing through the load scanned at two predetermined conduction angles.

10 21. The method according to claim 20, wherein the two predetermined conduction angles are a full conduction angle and any conduction angle between 36° and 90° respectively.

22. The method according to claim 13, wherein the load comprises at least one of a light emitting device, a fan and an air conditioner.

15 23. The method according to claim 13, wherein the form of the current comprises but is not limited to one of an absolute current average, a half-cycle current average, a root mean square current and a current integration.

20 24. The method according to claim 13, wherein the control parameter comprises at least one of a minimum startup conduction angle enabling an appropriate startup output of the load and the minimum conduction angle enabling the load to operate in a critical lowest state.

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