

SELF-LEARNING LIGHTING GROUP CONTROL SYSTEM AND METHOD

Technical Field

The present invention relates to the field of intelligent lighting, in particular to a self-learning lighting group control system and method.

Background Art

For public area lighting of buildings, lighting of typical scenes such as halls, corridors, and underground parking lots, the number of lighting nodes is large, the traditional manual switch control mode usually does not control each lamp individually, and it is difficult to achieve a special kind of dynamic lighting requirements-concomitant lighting following the movement of a moving body and farther safe lighting in the direction of travel. Such dynamic lighting can provide users with better and more advanced lighting experience for exhibition halls, shopping malls and hotels; for health care centers and underground parking lot, this kind of dynamic lighting can not only provide a wider field of lighting, but also better protect the safety of people or vehicles. In order to realize the dynamic lighting, in the prior art, one type of control method is implemented as follows: by providing a sensing device, a moving body passing the sensing device will trigger a lighting node around the sensing device to achieve a range of lighting. Although this kind of control method can realize induction lighting in a certain range around the moving body with the moving body as the center, it cannot provide a farther lighting field of view, and there is a lot to optimize to balance energy saving and experience.

Another type of control method is implemented as follows: it is necessary to manually adjust and mark the types of lighting nodes (such as distinguishing channel lamps from location lamps), and realize the dynamic control of different types of lighting nodes by means of a central controller. However, this kind of control method needs manual debugging of the system according to the lighting requirements when the system is deployed, and needs to complete the listing of lighting nodes, networking, compilation and testing of control logic. Once the lighting requirements are changed, manual debugging needs to be performed again, and the system has high complexity, low intelligence and high operation and maintenance costs.

Summary of the Invention

The present invention provides a self-learning lighting group control system and method aimed at achieving concomitant lighting following the movement of a moving body and farther safe lighting in the direction of travel.

In a first aspect, an embodiment of the present application provides a self-learning lighting group control system including a plurality of intelligent lighting nodes, where each of the intelligent lighting nodes includes a sensing module, a storage module, a calculation module, a communication module, a control module and a lighting module; where

the sensing module is configured to collect trigger data when a moving body passes through a lighting area;

the storage module is coupled to the sensing module, and the storage module is configured to receive and store the trigger data;

the communication module is configured to receive a communication instruction generated by the calculation module, and perform communication and data exchange with the other intelligent lighting nodes according to the communication instruction to obtain communication data;

the calculation module is coupled to the storage module and the communication module, and the calculation module is configured to adaptively generate a lighting group control scheme according to the trigger data and the communication data, and control the intelligent lighting nodes on the adjacent and pre-determined traveling routes according to the lighting group control scheme, so that the control module in the intelligent lighting nodes on the adjacent and pre-determined traveling routes controls the lighting modules thereof to operate; and

the control module is coupled to the calculation module and the lighting module, and the control module is configured to receive a lighting control instruction generated by the calculation module and control the lighting module to operate according to the lighting control instruction.

In order to achieve the above object, in another aspect, an embodiment of the present application also provides a self-learning lighting group control method including:

collecting, by the triggered intelligent lighting node, trigger data when the moving body passes in a lighting area, and saving and transmitting the trigger data to a neighborhood intelligent lighting node;

receiving and forwarding, by the neighborhood intelligent lighting node, the trigger data;

generating, by the neighborhood intelligent lighting node, a response message according to the trigger data to transmit the response message to the triggered intelligent lighting node;

updating, by the triggered intelligent lighting node, a first neighborhood node list, a second neighborhood node list and a neighborhood primary channel node list stored therein according to the response message;

performing, by the triggered intelligent lighting node, self-learning according to the first neighborhood node list, the second neighborhood node list and the neighborhood primary channel node list stored therein and the trigger data to generate a lighting group control scheme; and

if the triggered intelligent lighting node completing self-learning senses the moving body again, reading the lighting group control scheme stored therein to generate a corresponding lighting control message, and transmitting the lighting control message to the neighborhood intelligent lighting node, so that the neighborhood intelligent lighting node executes a group control action corresponding to the lighting control message.

Embodiments of the present application provide a self-learning lighting group control system and method. The system includes a plurality of intelligent lighting nodes, where the intelligent lighting node collects trigger data by a sensing module when a moving body passes through a lighting area; the communication module transmits the trigger data to other intelligent lighting nodes and receives communication data responded by the other intelligent lighting nodes; and the calculation module adaptively generates a lighting group control scheme according to the trigger data and the communication data, and the control module controls the intelligent lighting nodes on the adjacent and pre-determined traveling routes to control its own lighting module to achieve a lighting effect corresponding to the lighting group control scheme. The system of the present application self-adaptively generates a lighting group control scheme of intelligent lighting nodes on adjacent and pre-determined traveling routes by self-learning the trigger data of a moving body when passing through a lighting area, and can realize the concomitant lighting following the movement of a moving body and farther safe lighting in the direction of travel, and can better guarantee the lighting experience and safety under the premise of ensuring dynamic energy saving.

Brief Description of the Drawings

In order to more clearly illustrate the technical solutions of the embodiments of the

present application, the drawings required to be used in the description of the embodiments are briefly introduced below, and it is obvious that the drawings in the description below are some embodiments of the present application, and it is obvious for a person skilled in the art to obtain other drawings based on the drawings without creative efforts.

FIG. 1 is a schematic structural diagram showing a self-learning lighting group control system according to an embodiment of the present application;

FIG. 2 is a schematic diagram showing distribution of intelligent lighting nodes in a self-learning lighting group control system according to an embodiment of the present application;

FIG. 3 is a schematic flow diagram showing a self-learning lighting group control method according to an embodiment of the present application;

FIG. 4 is a sub-schematic flow diagram showing a self-learning lighting group control method according to an embodiment of the present application;

FIG. 5 is a sub-schematic flow diagram showing a self-learning lighting group control method according to an embodiment of the present application; and

FIG. 6 is a sub-schematic flow diagram showing a self-learning lighting group control method according to an embodiment of the present application.

Detailed Description of the Invention

The embodiments of the present application will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the present application are shown. It is to be appreciated that the embodiments described are a few, but not all embodiments of the present application. Based on the embodiments of the present application, all other embodiments obtained by a person skill in the art without inventive effort fall within the scope of the present application.

It will be appreciated that the terms “include” and “include”, when used in this description and the appended claims, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

It is also to be appreciated that the terminology used in the description of the present application herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present application. As used in the description of the present application and the appended claims, the singular forms “a”, “an”, and “the”

are intended to include the plural forms as well, unless the context clearly indicates otherwise.

It should be further appreciated that the term “and/or” as used in the description and the appended claims refers to and includes any and all possible combinations of one or more of the associated listed items.

As used in this specification and the appended claims, the term “if” may be interpreted contextually as “when” or “upon” or “in response to determining” or “in response to detecting”. Similarly, the phrase “if it is determined that” or “if a [described condition or event] is detected” can be interpreted, depending on the context, to mean “upon determination” or “in response to determination” or “upon detection of a [described condition or event]” or “in response to detection of a [described condition or event]”.

Referring to FIG. 1, FIG. 1 is a schematic diagram showing a self-learning lighting group control system according to an embodiment of the present application. The system can be applied to intelligent lighting scene of underground parking lot. As shown in FIG. 1, the self-learning lighting group control system is composed of a plurality of distributed intelligent lighting nodes, and each intelligent lighting node includes a sensing module, a storage module, a calculation module, a communication module, a control module and a lighting module, where the sensing module is configured to collect trigger data when a moving body passes through a lighting area; the trigger data is data collected by a sensing module triggered when a moving body passes through a certain intelligent lighting node. The trigger data collected by the sensing module will be written into the storage module of the node where it is located for storage, to provide basic data for self-learning. Preferably, the sensing module is installed with a microwave radar to sense movement of a moving body within a specific distance range and collect related data. Alternatively, the sensing module may add a sensor such as light sensation, sound sensation, etc. to enhance the sensitivity of the system to the sensing of the moving body by collecting sensing data such as light, sound, etc. In the present embodiment, the moving body is a traveling vehicle.

The storage module is coupled to the sensing module, and the storage module is configured to receive and store the trigger data. Further, the storage module may be operable to store record a plurality of types of data, including, for example: trigger data of an intelligent lighting node (hereinafter referred to as a node) where a storage module is located; triggering response data of a node where a storage module is located and a neighborhood node; relaying communication data of a node where a storage module is located; a neighborhood node generated by self-learning of a node where a storage

module is located and control scheme data of a lighting node on a pre-determined traveling route.

The communication module is configured to receive a communication instruction generated by the calculation module, and perform communication and data exchange with the other intelligent lighting nodes according to the communication instruction to obtain communication data; where a network connection can be established between each intelligent lighting node via the communication module to transmit and receive communication instructions between nodes. Preferably, wireless networking and data transmission between nodes can be implemented using wireless technologies such as radio, bluetooth, WiFi, ZigBee, Lora, etc.

The calculation module is coupled to the storage module and the communication module, and the calculation module is configured to adaptively generate a lighting group control scheme according to the trigger data and the communication data, and control the intelligent lighting nodes on the adjacent and pre-determined traveling routes according to the lighting group control scheme, so that the control module in the intelligent lighting nodes on the adjacent and pre-determined traveling routes controls the lighting modules thereof to operate. The calculation module has a built-in MCU, and the functions thereof include generating a communication instruction, extracting data in the communication instruction, executing a self-learning program, reading a self-learning result and generating a lighting control instruction. In particular, the calculation module plays a role of reading the trigger data thereof recorded by the storage module to generate a communication instruction to broadcast the trigger data to a neighborhood node; extracting trigger data, response data and relay data in a communication instruction received by a communication module, and generating a lighting group control scheme of a node by executing a self-learning program; when the node is triggered again, the self-learning result recorded by the storage module is read and a lighting control instruction is generated so that the control module performs a corresponding action to control the lighting module.

The control module is coupled to the calculation module and the lighting module, and the control module is configured to receive a lighting control instruction generated by the calculation module and control the lighting module to operate according to the lighting control instruction. For example, the control module may receive control and configuration instructions output by the calculation module, and realize control effects of on/off, dimming, toning, gradual change, etc. of a light source in a lighting module of a corresponding node by adjusting the current or switching period of a controller

thereof.

The lighting module is coupled to the control module and is composed of a power source and a light source, and is an important part for realizing the lighting of the intelligent lighting node. Preferably, an LED light fixture may be formed using an LED power supply and an LED light source for public area lighting of buildings or underground parking lots.

Referring to FIG. 2, FIG. 2 is a schematic diagram showing the distribution of intelligent lighting nodes according to an embodiment of the present application. In FIG. 2, the embodiment self-learning lighting group control system consists of 24 distributed intelligent lighting nodes. Moreover, the embodiment has two main lanes, and intelligent lighting nodes 0, 3, 6, 5, 11, 15, 20, 21, 22, 23 and 24 are successively arranged above the main lane 1; intelligent lighting nodes 0, 3, 6, 7, 8, 13, 18, 23, 24 are sequentially arranged above the main lane 2. The intelligent lighting nodes on adjacent and pre-determined traveling routes controlled by the lighting group control scheme include a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node. The intelligent lighting node of which the number of communication hops with the triggered intelligent lighting node is not greater than an upper limit value of the number of communication hops of the first neighborhood is referred to as a first neighborhood intelligent lighting node; an intelligent lighting node of which the number of communication hops with a triggered node is greater than an upper limit value of the number of the communication hops of the first neighborhood and not greater than an upper limit value of the number of the communication hops of the second neighborhood is referred to as a second neighborhood intelligent lighting node. In the present embodiment, the nodes communicate wirelessly with the nodes that are far away in a multi-hop manner. An upper limit value of the number of the communication hops of the first neighborhood set in the present embodiment is 1, and an upper limit value of the number of the communication hops of the second neighborhood is 2. Taking the intelligent lighting node 6 (hereinafter referred to as node 6) in FIG. 2 as an example, intelligent lighting nodes 3, 5, 7 and 12 with a communication hop number of 1 from node 6 are first neighborhood intelligent lighting nodes of the triggered node 6, and nodes 0, 4, 8, 11 and 16 with a communication hop number of 2 from node 6 are second neighborhood intelligent lighting nodes of the triggered node 6.

Moreover, it can be seen from FIG. 2 that the neighborhood of each of the intelligent lighting nodes includes the at least one first neighborhood intelligent lighting node, and

the distance to the intelligent lighting node does not exceed a wireless communication single hop maximum distance, to ensure that each of the intelligent lighting nodes and the surrounding intelligent lighting nodes can achieve networking in a wireless single hop or multi-hop manner. For example, there are the first neighborhood intelligent lighting nodes 3, 5, 7 and 12 with the distance from the node 6 not exceeding the maximum distance of a wireless communication single hop, and there is at least one first neighborhood intelligent lighting node with the distance from any one of the nodes 3, 5, 7 and 12 not exceeding the maximum distance of a wireless communication single hop, so that the wireless networking requirements of the node 6 and surrounding nodes can be guaranteed.

Referring to FIG. 3, FIG. 3 is a schematic flow diagram showing a self-learning lighting group control method according to an embodiment of the present application is shown. The self-learning lighting group control method is applied to the above-mentioned self-learning lighting group control system, and by the self-learning lighting group control method of the present application, concomitant lighting following movement and safe lighting at a longer distance in a traveling direction can be provided to a moving body. The self-learning lighting group control method is described in detail below. As shown in FIG. 3, the method includes the following steps S100-S130.

S100 Collect, by the triggered intelligent lighting node, trigger data when the moving body passes in a lighting area, and save and transmit the trigger data to a neighborhood intelligent lighting node.

In an embodiment of the present application, a moving body (i.e., a vehicle) passes multiple times along a travel channel in an area where a plurality of intelligent lighting nodes are distributed, the intelligent lighting nodes which are no more than the sensing distance from the moving body to the sensing module are triggered, and trigger data is recorded and written into a storage module of the triggered intelligent lighting nodes. The trigger data includes triggered intelligent lighting node id, cumulative trigger times, and recent trigger times. It should be noted that in the present embodiment, the travel channel includes a primary channel and a branch channel, the lane is the primary channel, the route from the parking space to the lane is the branch channel, and the number of passes of the moving body on the primary channel is generally greater than the number of passes of the branch channel. It should also be noted that the number of travel channels in the embodiments of the present application is not limited to a particular number. Other typical scenes except for the present embodiment are: floor public area lighting scenes, where a public corridor is a primary channel, and a route

from a station to the public corridor is a branch channel.

S110 Receive and forward, by the neighborhood intelligent lighting node, the trigger data.

In an embodiment of the present application, the neighborhood intelligent lighting node includes a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node. Preferably, in the present embodiment, the basis for determination of the first neighborhood intelligent lighting node is: an adjacent intelligent lighting node of which the number of communication hops with the triggered intelligent lighting node is not greater than the upper limit value of the number of communication hops of the first neighborhood is a first neighborhood intelligent lighting node of the triggered intelligent lighting node. The basis for determination of the second neighborhood intelligent lighting node is: the adjacent intelligent lighting node with which the number of communication hops with the triggered intelligent lighting node is greater than the upper limit value of the number of the communication hops of the first neighborhood and is not greater than the upper limit value of the number of the communication hops of the second neighborhood is a second neighborhood intelligent lighting node of the triggered intelligent lighting node. In the present embodiment, the upper limit value of the number of the communication hops of the first neighborhood is 1, and the upper limit value of the number of the communication hops of the second neighborhood is 2. Alternatively, in other embodiments, the basis for determination of the first neighborhood and second neighborhood intelligent lighting nodes may also be: the linear distance between the triggered lighting node and the adjacent intelligent lighting node satisfies a specific threshold condition; or the triggered lighting node receives a feedback communication time of an adjacent intelligent lighting node satisfying a specific duration condition. Therefore, the first neighborhood intelligent lighting node and the second neighborhood intelligent lighting node receive and forward trigger data, generate a corresponding response message according to the trigger data, and transmit the response message to the triggered intelligent lighting node.

Referring to FIG. 4, in one embodiment, for example, in an embodiment of the present application, the step S110 includes the following steps S111-S116.

S111 Receive, by the first neighborhood intelligent lighting node, the trigger data and check whether a triggered intelligent lighting node id is recorded in the first neighborhood node list stored therein according to the trigger data;

S112 If the triggered intelligent lighting node id does not exist in the first neighborhood

node list, record the triggered intelligent lighting node id to the first neighborhood node list thereof;

S113 Check, by the first neighborhood intelligent lighting node, the number of trigger data jumping to determine whether the number of jumping is smaller than an upper limit value of the number of the communication hops of the first neighborhood;

S114 If the number of jumping is smaller than the upper limit value of the number of the communication hops of the first neighborhood, take the first neighborhood intelligent lighting node as the relay node to forward the trigger data to the next first neighborhood intelligent lighting node;

S115 Return the next first neighborhood intelligent lighting node to execute the step of receiving, by the first neighborhood intelligent lighting node, the trigger data and checking whether a triggered intelligent lighting node id is recorded in the first neighborhood node list stored therein according to the trigger data, until the number of jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood; and

S116 If the number of jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood, take the first neighborhood intelligent lighting node as the relay node to forward the trigger data to the second neighborhood intelligent lighting node.

In an embodiment of the present application, when a first neighborhood intelligent lighting node receives trigger data broadcast by a triggered lighting node, the first neighborhood intelligent lighting node checks whether the triggered intelligent lighting node id is recorded in the first neighborhood node list stored therein, and if not, the triggered intelligent lighting node id is recorded in the first neighborhood node list thereof. At the same time, the first neighborhood intelligent lighting node checks the number of trigger data jumping, and compares the number of jumping with an upper limit value of the number of the communication hops of the first neighborhood (in the present embodiment, the set upper limit value of the first neighborhood communication is 1); if the number of jumping is smaller than the upper limit value of the number of the communication hops of the first neighborhood, the first neighborhood intelligent lighting node will serve as a relay node to forward the trigger data to the next first neighborhood intelligent lighting node; and the next first neighborhood intelligent lighting node returns to execute steps S111-114 cyclically until the number of jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood. In addition, when the number of trigger data jumping is not

smaller than the upper limit value of the number of the communication hops of the first neighborhood, the first neighborhood intelligent lighting node (i.e., a node in the first neighborhood intelligent lighting node which receives the trigger data last) serves as a relay node to forward the trigger data to the second neighborhood intelligent lighting node. It should be noted that in other embodiments, an upper limit value of the first neighborhood communication may be set to other numerical values. It may be appreciated that when the number of trigger data jumping is smaller than the upper limit value of the number of the communication hops of the first neighborhood, the trigger data is forwarded within the first neighborhood range of the triggered intelligent lighting node, and the first neighborhood intelligent lighting node within the first neighborhood range forwards same to the next first neighborhood intelligent lighting node; and when the number of trigger data jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood, the trigger data is forwarded as a relay node to a node in the second neighborhood (i.e., a second neighborhood intelligent lighting node) by a node in the first neighborhood that last receives the trigger data.

Referring to FIG. 5, in one embodiment, for example, in an embodiment of the present application, the step S110 further includes the following steps S211-S217.

S211 Receive, by the second neighborhood intelligent lighting node, the trigger data forwarded by the relay node and check whether a first neighborhood node list stored therein records the relay node id.

S212 If the relay node id does not exist in the first neighborhood node list of the second neighborhood intelligent lighting node, record the relay node id to the first neighborhood node list thereof.

S213 Check, by the second neighborhood intelligent lighting node, whether a triggered node list stored therein records the triggered intelligent lighting node id;

S214 If the triggered intelligent lighting node id does not exist in the triggered node list, record the triggered intelligent lighting node id to the triggered node list;

S215 Check, by the second neighborhood intelligent lighting node, the number of trigger data jumping to determine whether the number of jumping is smaller than an upper limit value of the number of the communication hops of the second neighborhood;

S216 If the number of jumping is smaller than the upper limit value of the number of the communication hops of the second neighborhood, take the second neighborhood intelligent lighting node as a next-level relay node to forward the trigger data to the next second neighborhood intelligent lighting node; and

S217 Return the next second neighborhood intelligent lighting node to execute the step of receiving, by the second neighborhood intelligent lighting node, the trigger data forwarded by the relay node and checking whether a first neighborhood node list stored therein records the relay node id, until the number of jumping is not smaller than the upper limit value of the number of the communication hops of the second neighborhood. In an embodiment of the present application, the second neighborhood intelligent lighting node receives the trigger data forwarded by the relay node and checks whether the first neighborhood node list stored therein records the relay node id, and if not, records the relay node id to the first neighborhood node list therein. It should be noted that in the present embodiment, the relay node id is a first neighborhood intelligent lighting node id. Moreover, the second neighborhood intelligent lighting node receives the trigger data forwarded by the relay node, and also checks whether the self-stored triggered node list records the triggered intelligent lighting node id, and if not, records the triggered intelligent lighting node id to its own triggered node list. The source node information of the trigger data can be obtained from the triggered intelligent lighting node id recorded by the triggered node list.

Alternatively, after the second neighborhood intelligent lighting node receives the trigger data, further including: the second neighborhood intelligent lighting node checks the number of trigger data jumping to determine whether the number of jumping is smaller than an upper limit value of the number of the communication hops of the second neighborhood; and if the number of jumping is smaller than the upper limit value of the number of the communication hops of the second neighborhood, the second neighborhood intelligent lighting node continues to forward the trigger data to the next second neighborhood intelligent lighting node as a next-level relay node. The next second neighborhood intelligent lighting node executes the above-mentioned steps S211-216 cyclically until the number of jumping is not smaller than an upper limit value of the number of the communication hops of the second neighborhood, then the forwarding of the trigger data is discontinued.

S120 Generate, by the neighborhood intelligent lighting node, a response message according to the trigger data to transmit the response message to the triggered intelligent lighting node.

In one embodiment, for example, in an embodiment of the present application, a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node of a triggered intelligent lighting node generate a response message according to the trigger data to transmit the response message to the triggered intelligent lighting

node. Specifically, referring to FIG. 6, step S120 includes the following steps S121 to S125.

S121 After receiving the trigger data, generate, by the first neighborhood intelligent lighting node, the first response message and transmitting the first response message to the triggered intelligent lighting node;

S122 After receiving the trigger data, generate, by the second neighborhood intelligent lighting node, the second response message and transmitting the second response message to the first neighborhood intelligent lighting node;

S123 After receiving the second response message, check, by the first neighborhood intelligent lighting node, whether a first neighborhood node list stored therein records a second neighborhood intelligent lighting node id;

S124 If the second neighborhood intelligent lighting node id does not exist in the first neighborhood node list of the first neighborhood intelligent lighting node, record, by the first neighborhood intelligent lighting node, the second neighborhood intelligent lighting node id to the first neighborhood node list; and

S125 After receiving the second response message, forward, by the first neighborhood intelligent lighting node, the second response message to the triggered intelligent lighting node.

In an embodiment of the present application, after receiving the trigger data, the neighborhood intelligent lighting node generates a response message to respond to a transmitter of the trigger data. In particular, the response message includes a first response message and a second response message, where the first response message is generated by a first neighborhood intelligent lighting node and the second response message is generated by a second neighborhood intelligent lighting node. The second response message generated by the second neighborhood intelligent lighting node is transmitted to the first neighborhood intelligent lighting node (or relay node), so that the first neighborhood intelligent lighting node (or relay node) learns that it is an adjacent intelligent lighting node. However, since the second neighborhood intelligent lighting node is far away from the triggered intelligent lighting node, it needs to respond to the message in a multi-hop manner. Therefore, after receiving the second response message, the first neighborhood intelligent lighting node needs to forward the second response message to the triggered intelligent lighting node, so that the triggered intelligent lighting node learns the second neighborhood intelligent lighting node id. Meanwhile, the first neighborhood intelligent lighting node checks whether the first neighborhood node list stored therein records the second neighborhood intelligent

lighting node id, and if not, records the second neighborhood intelligent lighting node id to the first neighborhood node list therein. By the same reasoning, after receiving the trigger data, the first neighborhood intelligent lighting node will generate a first response message and transmit same to the triggered intelligent lighting node, so that the triggered intelligent lighting node learns information about the first neighborhood intelligent lighting node thereof. It may be appreciated that in the present embodiment, the object that the generated response message needs to be transmitted is determined according to the node id in the first neighborhood node list and the second neighborhood node list stored by each intelligent lighting node itself.

S130 Update, by the triggered intelligent lighting node, a first neighborhood node list, a second neighborhood node list and a neighborhood primary channel node list stored therein according to the response message.

In an embodiment of the present application, after the triggered intelligent lighting node receives the first response message, it is checked whether a first neighborhood node list stored therein records a first neighborhood intelligent lighting node id; if the first neighborhood intelligent lighting node id does not exist in the first neighborhood node list, the first neighborhood intelligent lighting node id is recorded to a first neighborhood node list thereof; moreover, after receiving the second response message, the triggered intelligent lighting node checks whether a second neighborhood node list stored therein records the second neighborhood intelligent lighting node id; if the second neighborhood intelligent lighting node id does not exist in the second neighborhood node list, the second neighborhood intelligent lighting node id is recorded to a second neighborhood node list thereof.

Further, in an embodiment of the present application, a triggered intelligent lighting node determines whether it is a primary channel node by comparing accumulated trigger times thereof and a neighborhood intelligent lighting node, and records or updates a determined result in a neighborhood primary channel node list of a first neighborhood node and a second neighborhood node of the triggered intelligent lighting node. The determined result of whether the triggered intelligent lighting node is a primary channel node is recorded in a binary group form; <triggered intelligent lighting node id, a numerical value of 1 or 0>, 1 indicating that the triggered intelligent lighting node is a primary channel node, and 0 indicating that the triggered intelligent lighting node is a non-primary channel node. Alternatively, in the present embodiment, the method for determining whether the triggered intelligent lighting node is a primary channel node is implemented as follows: the triggered intelligent lighting node acquires

the accumulated triggering times of the intelligent lighting nodes in the first neighborhood and the second neighborhood thereof, and orders same according to the magnitude of a numerical value from large to small to obtain a row of sequence tables; then respectively calculates the absolute deviation between the accumulated triggering times thereof and the average value of the first 50% of the order items in the sequence table, and the absolute deviation between the accumulated triggering times thereof and the average value of the last 50% of the order items in the sequence table, and the two are compared; if the numerical result of the former is smaller, it indicates that the trigger data feature of the triggered intelligent lighting node is closer to the node with a larger accumulated triggering times, and thus determining that the triggered intelligent lighting node is a primary channel node; otherwise, it is a non-primary channel node. Alternatively, in the present embodiment, the method for storing the determined result in the neighborhood primary channel node list of the first neighborhood node and the second neighborhood node of the triggered intelligent lighting node is implemented as follows: the triggered intelligent lighting node sequentially extracts each neighborhood node from a first neighborhood node list and a second neighborhood node list stored therein as a target node, transmits a message of a determined result of whether the triggered intelligent lighting node is a primary channel node to the target node, and after receiving the message, the target node checks the determined result; and if the numerical value in the binary group $<$ the triggered intelligent lighting node id, the numerical value in the numerical value 1 or 0 $>$ is 1, the triggered intelligent lighting node id in the binary group is added to the neighborhood primary channel node list of the target node.

S140 Perform, by the triggered intelligent lighting node, self-learning according to the first neighborhood node list, the second neighborhood node list and the neighborhood primary channel node list stored therein and the trigger data to generate a lighting group control scheme.

In an embodiment of the present application, first, the triggered intelligent lighting node extracts the first neighborhood intelligent lighting node id from a first neighborhood node list stored therein, and generates the lighting group control scheme of the first neighborhood intelligent lighting node according to the first neighborhood intelligent lighting node id and the trigger data. For example, taking the triggered node 6 in FIG. 2 as an example, the neighborhood intelligent lighting nodes within the 2-hop communication range of the node 6 include nodes 3, 5, 7, 12, 0, 2, 4, 11, 16, 8, where the nodes 3, 5, 7, 12 with the number of communication hops of 1 constitutes a first

neighborhood intelligent lighting node list of the node 6, and the remaining nodes 0, 2, 4, 11, 16, 8 constitute a second neighborhood node list of the node 6. Therefore, each node in the node list [3, 5, 7, 12] is an adjacent intelligent lighting node (first neighborhood intelligent lighting node) controlled by the lighting group control scheme when node 6 is triggered.

Secondly, the triggered intelligent lighting node reads the stored second neighborhood node list and neighborhood primary channel node list, and calculates the intersection of the two lists to obtain a lighting group control scheme with a farther range on the pre-determined traveling route of the triggered intelligent lighting node. Continuing to take the node 6 in FIG. 2 as an example, the second neighborhood node list stored by the node 6 is [0, 2, 4, 11, 16, 8], and the neighborhood primary channel node list stored by the node 6 is [0, 3, 5, 11, 7, 8], and the intersection of the two lists is taken to obtain the list [0, 11, 8], i.e., the node list which needs to light farther on the pre-determined traveling route when the node 6 is triggered. Alternatively, if the node 6 also stores the last trigger time of each node in the neighborhood primary channel node list, the travel direction of the vehicle along the primary channel can be determined, thereby optimizing the control scheme for the intelligent lighting nodes ahead and behind the pre-determined traveling route. For example, continuing to take the above-mentioned node 6 as an example, the node list which needs to light farther on the pre-determined traveling route when the node 6 is triggered is [0, 11, 8]; if the last triggering time of the node 0 is closer to the last triggering time of the node 6 than the nodes 11 and 8, it can be determined that the vehicle travel direction is from the node 0 to the node 6, and at this time, the list of nodes needing to light farther on the pre-determined traveling route can be optimized as [11, 8], to further save energy without affecting the driving experience.

Finally, the triggered intelligent lighting node completes self-learning and marks the learning state as completed. Alternatively, a method for determining that a node self-learning reaches a steady state is implemented by determining whether the ratio of the accumulated trigger times of a node to the sum of the accumulated trigger times of all neighborhood nodes including a first neighborhood and a second neighborhood is relatively stable, i.e., whether the ratio is smaller than a specific threshold value, and if the ratio is smaller than the specific threshold value, indicating that node learning reaches a steady state.

S150 If the triggered intelligent lighting node completing self-learning senses the moving body again, read the lighting group control scheme stored therein to generate a

corresponding lighting control message, and transmit the lighting control message to the neighborhood intelligent lighting node, so that the neighborhood intelligent lighting node executes a group control action corresponding to the lighting control message.

In an embodiment of the present application, if the triggered intelligent lighting node completing self-learning senses the moving body again, the lighting group control scheme stored therein is read to generate a corresponding lighting control message, and the lighting control message is transmitted to a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node via a communication module, so that the first neighborhood intelligent lighting node and the second neighborhood intelligent lighting node light on and/or light off. Specifically, first, the performed group control action includes performing a lighting control, where the lighting control parameter includes the brightness, color temperature, color, gradual change duration and lighting state duration of lighting target state, etc.; secondly, a light off control is performed, where the light off control parameter includes the brightness, color temperature, color, gradual change duration and the light off state duration of the light off target state. Continuing to take the node 6 as an example, when the node 6 which has completed self-learning is triggered again by a running vehicle, the first neighborhood intelligent lighting nodes 3, 5, 7 and 12 with the number of communication hops of 1 instantaneously light on to provide dynamic concomitant lighting, and the farther second neighborhood intelligent lighting nodes [0, 11, 8] on the pre-determined traveling route also synchronously light on to provide the safety lighting required for driving. Moreover, if it is further determined that the driving direction is from the node 0 to the node 6, it is ensured that the lighting duration of the nodes [11, 8] is longer and the lighting duration of the node 0 is shorter.

In summary, the embodiments of the present application provide a self-learning lighting group control system and method, where an intelligent lighting node adaptively generates a lighting control scheme on its neighborhood and a pre-determined traveling route by autonomously learning trigger data passed by a moving body in a lighting area. The self-learning lighting group control system provided by the embodiments of the present application does not need to use a central controller, does not need to manually compile or debug the control logic, and the intelligent lighting node only needs to be powered on, to realize the concomitant lighting following the movement of a moving body, and the farther safe lighting in the direction of travel, and can better ensure the lighting experience and safety under the premise of ensuring dynamic energy saving. In the above-mentioned embodiments, the description of each embodiment has its own

emphasis, and reference can be made to the description of described in detail can be referred to the description of other embodiments.

It will be apparent to a person skilled in the art that various modifications and variations can be made in the present application without departing from the spirit or scope of the inventions. Thus, it is intended that the present application cover the modifications and variations of the present application provided they come within the scope of the appended claims and their equivalents.

While the present application has been described with reference to specific embodiments, it will be appreciated by a person skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present application. Therefore, the protection scope of the present application shall be subject to the protection scope of the claims.

Claims

1. A self-learning lighting group control system, comprising a plurality of intelligent lighting nodes, wherein each of the intelligent lighting nodes comprises: a sensing module, a storage module, a calculation module, a communication module, a control module and a lighting module; wherein
the sensing module is configured to collect trigger data when a moving body passes through a lighting area;
the storage module is coupled to the sensing module, and the storage module is configured to receive and store the trigger data;
the communication module is configured to receive a communication instruction generated by the calculation module, and perform communication and data exchange with the other intelligent lighting nodes according to the communication instruction to obtain communication data;
the calculation module is coupled to the storage module and the communication module, and the calculation module is configured to adaptively generate a lighting group control scheme according to the trigger data and the communication data, and control the intelligent lighting nodes on the adjacent and pre-determined traveling routes according to the lighting group control scheme, so that the control module in the intelligent lighting nodes on the adjacent and pre-determined traveling routes controls the lighting modules thereof to operate; and
the control module is coupled to the calculation module and the lighting module, and the control module is configured to receive a lighting control instruction generated by the calculation module and control the lighting module to operate according to the lighting control instruction.
2. The self-learning lighting group control system according to claim 1, wherein the intelligent lighting nodes on the adjacent and pre-determined traveling routes of the triggered intelligent lighting nodes controlled by the lighting group control scheme comprise a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node, wherein the number of communication hops between the first neighborhood intelligent lighting node and the triggered intelligent lighting node is not greater than an upper limit value of the number of communication hops of the first neighborhood intelligent lighting node; the number of communication hops between the second neighborhood intelligent lighting node and the triggered intelligent lighting node is greater than an upper limit value of the number of the communication hops of

the first neighborhood, and is not greater than an upper limit value of the number of the communication hops of the second neighborhood.

3. The self-learning lighting group control system according to claim 2, wherein the neighborhood of each of the triggered intelligent lighting nodes comprises at least one of the first neighborhood intelligent lighting nodes, and the distance between the triggered intelligent lighting node and the first neighborhood intelligent lighting node does not exceed the maximum distance of a wireless communication single hop.

4. A self-learning lighting group control method applied to the self-learning lighting group control system according to any one of claims 1-3, wherein the method comprises: collecting, by the triggered intelligent lighting node, trigger data when the moving body passes in a lighting area, and saving and transmitting the trigger data to a neighborhood intelligent lighting node;

receiving and forwarding, by the neighborhood intelligent lighting node, the trigger data;

generating, by the neighborhood intelligent lighting node, a response message according to the trigger data to transmit the response message to the triggered intelligent lighting node;

updating, by the triggered intelligent lighting node, a first neighborhood node list, a second neighborhood node list and a neighborhood primary channel node list stored therein according to the response message;

performing, by the triggered intelligent lighting node, self-learning according to the first neighborhood node list, the second neighborhood node list and the neighborhood primary channel node list stored therein and the trigger data to generate a lighting group control scheme; and

if the triggered intelligent lighting node completing self-learning senses the moving body again, reading the lighting group control scheme stored therein to generate a corresponding lighting control message, and transmitting the lighting control message to the neighborhood intelligent lighting node, so that the neighborhood intelligent lighting node executes a group control action corresponding to the lighting control message.

5. The self-learning lighting group control method according to claim 4, wherein the neighborhood intelligent lighting node comprises a first neighborhood intelligent lighting node and a second neighborhood intelligent lighting node, and the neighborhood intelligent lighting node receives and forwards the trigger data, comprising:

receiving, by the first neighborhood intelligent lighting node, the trigger data and checking whether a triggered intelligent lighting node id is recorded in the first neighborhood node list stored therein according to the trigger data;

if the triggered intelligent lighting node id does not exist in the first neighborhood node list, recording the triggered intelligent lighting node id to the first neighborhood node list thereof;

checking, by the first neighborhood intelligent lighting node, the number of trigger data jumping to determine whether the number of jumping is smaller than an upper limit value of the number of the communication hops of the first neighborhood;

if the number of jumping is smaller than the upper limit value of the number of the communication hops of the first neighborhood, taking the first neighborhood intelligent lighting node as the relay node to forward the trigger data to the next first neighborhood intelligent lighting node;

returning the next first neighborhood intelligent lighting node to execute the step of receiving, by the first neighborhood intelligent lighting node, the trigger data and checking whether a triggered intelligent lighting node id is recorded in the first neighborhood node list stored therein according to the trigger data, until the number of jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood; and

if the number of jumping is not smaller than the upper limit value of the number of the communication hops of the first neighborhood, taking the first neighborhood intelligent lighting node as the relay node to forward the trigger data to the second neighborhood intelligent lighting node.

6. The self-learning lighting group control method according to claim 5, wherein the neighborhood intelligent lighting node receives and forwards the trigger data, further comprising:

receiving, by the second neighborhood intelligent lighting node, the trigger data forwarded by the relay node and checking whether a first neighborhood node list stored therein records the relay node id;

if the relay node id does not exist in the first neighborhood node list of the second neighborhood intelligent lighting node, recording the relay node id to the first neighborhood node list thereof;

checking, by the second neighborhood intelligent lighting node, whether a triggered node list stored therein records the triggered intelligent lighting node id;

if the triggered intelligent lighting node id does not exist in the triggered node list,

recording the triggered intelligent lighting node id to the triggered node list;
 checking, by the second neighborhood intelligent lighting node, the number of trigger data jumping to determine whether the number of jumping is smaller than an upper limit value of the number of the communication hops of the second neighborhood;
 if the number of jumping is smaller than the upper limit value of the number of the communication hops of the second neighborhood, taking the second neighborhood intelligent lighting node as a next-level relay node to forward the trigger data to the next second neighborhood intelligent lighting node; and
 returning the next second neighborhood intelligent lighting node to execute the step of receiving, by the second neighborhood intelligent lighting node, the trigger data forwarded by the relay node and checking whether a first neighborhood node list stored therein records the relay node id, until the number of jumping is not smaller than the upper limit value of the number of the communication hops of the second neighborhood.

7. The self-learning lighting group control method according to claim 6, wherein the response message comprises a first response message and a second response message, and the neighborhood intelligent lighting node generates a response message according to the trigger data to be transmitted to the triggered intelligent lighting node, comprising: after receiving the trigger data, generating, by the first neighborhood intelligent lighting node, the first response message and transmitting the first response message to the triggered intelligent lighting node;

after receiving the trigger data, generating, by the second neighborhood intelligent lighting node, the second response message and transmitting the second response message to the first neighborhood intelligent lighting node;

after receiving the second response message, checking, by the first neighborhood intelligent lighting node, whether a first neighborhood node list stored therein records a second neighborhood intelligent lighting node id;

if the second neighborhood intelligent lighting node id does not exist in the first neighborhood node list of the first neighborhood intelligent lighting node, recording, by the first neighborhood intelligent lighting node, the second neighborhood intelligent lighting node id to the first neighborhood node list; and

after receiving the second response message, forwarding, by the first neighborhood intelligent lighting node, the second response message to the triggered intelligent lighting node.

8. The self-learning lighting group control method according to claim 7, wherein the updating, by the triggered intelligent lighting node, a first neighborhood node list, a

second neighborhood node list and a neighborhood primary channel node list stored therein according to the response message comprises:

after receiving the first response message, checking, by the triggered intelligent lighting node, whether the first neighborhood node list stored therein records a first neighborhood intelligent lighting node id;

if the first neighborhood intelligent lighting node id does not exist in the first neighborhood node list, recording the first neighborhood intelligent lighting node id to the first neighborhood node list;

after receiving the second response message, checking, by the triggered intelligent lighting node, whether the second neighborhood node list stored therein records the second neighborhood intelligent lighting node id;

if the second neighborhood intelligent lighting node id does not exist in the second neighborhood node list, recording the second neighborhood intelligent lighting node id to the second neighborhood node list; and

determining, by the triggered intelligent lighting node, whether the triggered intelligent lighting node itself is a primary channel node by comparing accumulated triggering times of the triggered intelligent lighting node itself and the neighborhood intelligent lighting node, and recording or updating a determined result in a neighborhood primary channel node list of the first neighborhood node and the second neighborhood node of the triggered intelligent lighting node.

9. The self-learning lighting group control method according to claim 8, wherein the performing, by the triggered intelligent lighting node, self-learning according to the first neighborhood node list, the second neighborhood node list and the neighborhood primary channel node list stored therein and the trigger data to generate a lighting group control scheme comprises:

extracting, by the triggered intelligent lighting node, the first neighborhood intelligent lighting node id from the first neighborhood node list stored therein, and generating a lighting group control scheme of the first neighborhood intelligent lighting node according to the first neighborhood intelligent lighting node id and the trigger data; and reading, by the triggered intelligent lighting node, the second neighborhood node list and the neighborhood primary channel node list stored therein, and calculating an intersection between the second neighborhood node list and the neighborhood primary channel node list to obtain a lighting group control scheme with a farther range on a pre-determined traveling route of the triggered intelligent lighting node.

10. The self-learning lighting group control method according to claim 6, wherein the

transmitting the lighting control message to the neighborhood intelligent lighting node, so that the neighborhood intelligent lighting node executes a group control action corresponding to the lighting control message comprises:

transmitting the lighting control message to the first neighborhood intelligent lighting node and the second neighborhood intelligent lighting node to control the first neighborhood intelligent lighting node and the second neighborhood intelligent lighting node to light on and/or light off.