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(73) Octrooihouder(s):
Tvilight B.V. te Groningen.

(72) Uitvinder(s):
Henri Eskonen te Groningen.
Amit Gudadhe te Groningen.
Jayakrishnan Harikumaran te Groningen.
Chintan Shah te Groningen.
Ralph Hogenbirk te Groningen.

(74) Gemachtigde:
Ir. A.A.G. Land c.s. te DEN HAAG.

(54) **Lighting control system and method for association of nodes in a multi-node network.**

(57) The invention relates to a lighting control system and method for association of nodes in a multi-node network. The system comprises a number of lighting nodes forming a multi-node network, each lighting node comprising:
- a light source;
- a controller connected to the light source; and
- communication means connected to the controller, wherein the lighting control system further comprises:
- a memory component adapted to store information relating to at least one group of interrelated coordinates defined in a geographical coordinate system; and
- a processing component in communication with the lighting nodes and adapted to automatically associate at least one lighting node with the at least one group on the basis of the geographical location of said at least one lighting node.

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Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

LIGHTING CONTROL SYSTEM AND METHOD FOR ASSOCIATION OF NODES IN A MULTI-NODE NETWORK

The invention relates to lighting control systems. Such systems include a number of light sources and at least one controller connected to the light sources for controlling them, e.g. switching them on or off. Lighting control systems are typically used in street lighting, wherein a number of lampposts illuminate a road, walkway or a square for example. This improves visibility and increases safety.

However, continuously illuminating the streets of an area, such as a city or municipality, requires a large amount of energy. Furthermore, street lighting contributes to a phenomenon called light pollution, which relates to artificial light forming a disturbing factor in the environment for humans and animals, e.g. causing sleep deprivation or animal migration.

In practice, lighting control systems are known wherein each street light is equipped with a daylight sensor, a motion detector and a transmitter and receiver to allow the street lights to communicate with each other. If the daylight sensor of a particular street light determines that the ambient light is below a certain threshold and the motion detector of that streetlight also detects motion, the streetlight switches on and broadcasts a message to other street lights within its range to switch on as well. Although this approach partially addresses the problems stated above by reducing the time the street lights are switched on, this solution is unsatisfactory. For example, when two roads are close together, the movement of a car in the first road may unnecessarily activate the street lights on the second road. The same problem occurs for curvy roads.

In other words, there is no relation between the activation pattern of the street lights and the actual lay-out of the streetlights along the road. This leads to unnecessary activation of street lights and corresponding energy consumption and light pollution.

An object of the invention is to overcome or at least reduce the problems of the conventional systems and to provide a lighting control system which takes into account the actual lay-out of the lighting network for its activation pattern.

The object is achieved with the lighting control system according to the invention, the system comprising a number of lighting nodes forming a multi-node network, wherein each lighting node comprises:

- a light source;
- a controller connected to the light source; and
- communication means connected to the controller,

and wherein the lighting control system further comprises:

- a memory component adapted to store information relating to at least one group of interrelated coordinates defined in a geographical coordinate system; and
- a processing component in communication with the lighting nodes and adapted to automatically associate at least one lighting node with the at least one group on the basis of the geographical location of said at least one lighting node.

Possible light sources include any dimmable lamp, such as sodium-vapor lamps, incandescent light bulbs, halogen lamps and LEDs. The invention will be explained mainly in reference to a street lighting application. Other application areas may include lighting in a parking lot, parking garage or indoors.

For example, a group of interrelated coordinates may correspond to a geographical path, route and/or area, defined in a geographical coordinate system. A geographical coordinate system is a spatial coordinate system for defining a spatial location. For example, such a coordinate system includes coordinates for defining a location in a plane, e.g. latitude and longitude. Optionally, the coordinate system additionally or alternatively includes coordinates defining the vertical position of the location, e.g. the elevation.

The lighting control system according to the invention enables establishing the spatial relationships between the lighting nodes. On the basis of the geographical location of a given node, e.g. a GPS coordinate, the processing component determines to which group or groups as defined in the memory this node belongs. For example, the group of interrelated geographical coordinates may correspond to a road, a part or side of a road, or to a square or roundabout. For example, the group may represent a straight or curved path, or a path containing several turns. Therefore, the control system can activate the light sources of selected lighting nodes on the basis of the geographical path or region to which they belong. This leads to activation of the light sources in a manner which corresponds to the physical lay-out of the lighting network, e.g. along a road, a square, or intersection which they are supposed to illuminate. Furthermore, unnecessary activation of light sources is avoided, as only the light sources sharing a common geographical path, area or other predefined spatial relationship, will be activated. Moreover, it is not the communication range which determines the relationship between lighting nodes. According to the invention a path-wise or area-wise association of the nodes can be obtained.

Therefore, even if two lighting nodes are within each other’s communication range, they will only be associated to each other if they belong to the same group, e.g. they share a path or belong to the same geographical area.

Preferably, the communication means of each lighting node is further adapted for communication with other lighting nodes in the network. Preferably, the multi-node network of lighting nodes is a wireless network. Preferably, the network is an ad-hoc network, more preferably a network having a mesh topology, more preferably a wireless network having a mesh topology.

Preferably, the memory component and/or processing component are provided on a server, preferably a remote server, adapted to communicate with the network of lighting nodes. For example, the multi-node network is provided with a gateway connected to the server, e.g. via the internet. The nodes can communicate with the server via the gateway. Alternatively, each node has its own memory component and processing component. The advantage of using a server is that less components per node are required, reducing the costs and complexity of the system, thereby also reducing the risk of failure. Furthermore, performing calculations centrally on a server leads to faster operation of the lighting nodes, as no calculations have to be performed by the lighting nodes.

The communication means enable communication between the nodes and the processing component.

Preferably, communication between the nodes and the processing component is wireless.

Preferably, the processing component is adapted to send to the nodes information relating to the at least one group associated with the respective nodes. This enables a decentralized control wherein the lighting nodes “know” to which group they belong.

In a preferred embodiment, the processing component is further adapted to automatically associate at least one first lighting node with at least one second lighting node being associated with the same group of interrelated geographical coordinates, e.g. a geographical path or area.

Preferably, the processing component is adapted to send information related to the association of the at least one first node with the at least one second node to the first and second node. For example, the processing component is adapted to send each node associated to a certain group a list of the other nodes which are associated to the same group. Preferably, the processing component is adapted to send to each node information on a selected number (one or more) of the other nodes associated to the same group. For example, the processing component sends a node information indicating its direct neighbors along a path, e.g. the lighting nodes directly to the right and left of the node.

In the context of the application, a direct or first order neighbor of a first node is a second node which is directly next to the first node on the respective path or within the respective area. The second order neighbor of a first node is a second node which is separated from the first node by exactly one other node. Generally, an n-th order neighbor of a first node is a second node which is separated from the first node by exactly (n-1) other nodes. For example, for nodes A, B, C, D and E arranged in that order along a common path, node C has first order neighbors B and D and second order neighbors A and E, and node E has first order neighbor D, second order neighbor C, third order neighbor B and fourth order neighbor A.

In a further preferred embodiment, the processing component is further adapted to automatically determine the separation between said at least one first lighting node and said at least one second lighting node in the same group, e.g. along the same path.

The separation between the nodes may be expressed as a distance, e.g. a distance expressed in meters. Preferably, the separation between the nodes is expressed as a discrete number n representing the separation in terms of nodes . For example, first order neighbors are assigned $n = 1$, whereas the second order neighbors are assigned $n = 2$, and so on.

The separation information can be used in controlling the lights. For example, the lighting control system is configured such that only a fixed number of consecutive neighbors on the same path are activated, e.g. 3-10 consecutive nodes. In another example, all nodes of a group within a distance of 50 m from the point of detection are activated.

Preferably, the processing component is adapted to communicate the separation information to the nodes, preferably using wireless communication.

In a preferred embodiment, at least one lighting node comprises:

- an object detector connected to the controller; and
- a memory adapted to store information identifying at least one other lighting node which is associated by the processing component to the same group,

wherein this at least one lighting node is adapted to send a control signal to one or more of the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector for controlling the light source of said one or more of the at least one other lighting node.

One or more of the lighting nodes may be equipped with an object detector, such as a motion detector. Examples of motion detectors include passive infrared (PIR) motion detectors, radar and cameras. In the following text, lighting nodes comprising an object detector are referred to as detector nodes.

A detector node stores in its memory information about the nodes which belong to the same group of interrelated geographical coordinates as the detector node. This information is obtained from the processing component. For example, the memory comprises a list of all nodes on the same predefined path, or all nodes within the same predefined area. In another example, the memory comprises a list of a selected number (one or more) of nodes in the same group. The nodes may be referred to using a unique identification number (ID). In another example, the memory of the detector node stores a database which includes entries for each group to which the detector node belongs, each entry comprising a list of the other nodes belonging to that group.

For example, the processing component determines that nodes A, B and C belong to group Z, which may for example correspond to (a part of) a road, a square, a parking garage level or a tunnel. Node A is a detector node, e.g. equipped with a PIR motion sensor. The processing component determines the nodes which belong to the same group as node A, i.e. B and C, and communicates this information to node A. For example, node A stores this information in its memory, e.g. as a tuple variable (“group Z”; “B, C”) or alternatively as a single variable (“B, C”).

When detector node A subsequently detects motion, e.g. when a car, bicycle or pedestrian passes by, it switches its light source to a high output level and sends a control signal, e.g. a wireless message, to nodes B and C, as they are associated with the same group as node A. Upon receiving the control signal, the nodes B and C also switch their respective light sources to a higher level.

The detector node sends a control signal only to the at least one other lighting node identified by the information in the memory. This avoids sending a message to every node in the network. Therefore, overloading of the network is avoided. Furthermore, redundant or unnecessary network traffic is avoided. In the preferred case of wireless communication, interference with other applications, e.g. wifi internet, may be reduced.

Preferably, the processing component sends to each detector node information on a selected number (one or more) of the other nodes in the same group . For example, the processing component sends to each detector node information identifying the neighbors of that node up to a predefined order, e.g. its first order neighbors or its first and second order neighbors. The detector node stores this information and upon detection of an object sends a control signal only to the nodes in its memory .

A further advantage of this embodiment is that the detector nodes can comprise a simple logic for sending the control signals, whereas the more complicated determination of the geographical interrelationship between different nodes is performed automatically by the processing component, preferably on a server.

All nodes or only some nodes may be equipped with an object detector.

Optionally, a detector node comprises a daylight sensor and the controller is adapted to only send a control signal if the daylight sensor detects ambient light below a certain threshold, such that the lighting nodes only activate their light sources when it is dark. Another option is to include a timer such that control signals are only generated between certain times of the day, e.g. between 20:00 and 7:00. The starting and ending times may be made dependent on the date, e.g. according to a sunrise / sunset time table. Preferably, the processing component sends to the nodes a time table for switching on/off.

Optionally, the controller is adapted to gradually ramp up the light intensity at sunset and/or gradually ramp down the light intensity at sunrise, e.g. ramping up / down within 20 min from low / high intensity to high / low intensity respectively.

Preferably, the lighting nodes are configured to switch their light sources off or to a low light level after a predetermined time.

Preferably, this embodiment includes that the processing component is adapted to determine the separation between the detector node and the at least one other node within the same group. As explained above, separation information can be used in controlling the lights. For example, the lighting control system is configured such that only the lighting nodes up to a predefined separation from a detector node are activated, e.g. only its first order neighbors or only its first and second order neighbors.

For example, nodes A, B, C, D and E are associated to the same group of interrelated geographical coordinates, in this case a path. Node C is a detector node. Initially the light sources are operating at a low light level, e.g. switched off or switched on at a low light level such as 40%

of the maximum intensity. When node C detects an object, it switches its light source to a higher light level, for example 90-100% of maximum intensity. Furthermore, it sends a message to its first order neighbors only, i.e. B and D. On receiving the message, node B and D switch their light source to a higher light level as well. At a predetermined time after their activation, e.g. 10 s – 10 minutes, the light nodes B, C, D switch their light back to the low light level. Preferably, switching back to a low light level is executed gradually, e.g. a drop from 100% to 40% in 10 s – 2 minutes time.

Sending control signals to a selected number (one or more) of the at least one other nodes on the basis of the separation between said nodes further reduces the number of messages communicated between nodes in the network. Therefore, overloading of the network is avoided. Furthermore, redundant or unnecessary network traffic is avoided. In the preferred case of wireless communication, interference with other applications, e.g. wifi internet, may be reduced.

In a further preferred embodiment, the control signal comprises light level information for controlling the intensity of the light source of said at least one other lighting node, the light level information being based on information about the separation between the at least one lighting node and said at least one other lighting node.

This enables even more elaborate lighting patterns. For example, the control system can establish a gradient light level around the moving object, as it moves with respect to the lighting nodes.

For example - returning to the example above with nodes A, B, C, D and E associated with the same path - when C detects an object, it switches its light source to a 100 %

level and sends a message to B and D to switch their light source to an 80 % level and to A and E to switch their light source to a 50 % level. Therefore, a light envelope is created around the moving object.

Preferably, the detector node stores information about the separation in its memory. For example, the processing component determines the separation between a detector node and its neighboring nodes, e.g. first order neighbor, second order neighbor, etc. The processing component sends this information to the detector node. The detector node stores the information and upon detection of an object sends a control signal to each of the neighboring nodes contained in its memory, wherein the control signal comprises light level information based on the separation between the detector node and the respective neighboring node.

Instead of storing information about the separation, the detector node may be configured to store light level information associated with its neighboring nodes. In this case, the processing component determines the appropriate light levels on the basis of the separation and sends this light level information to the detector node. For example, the memory of the detector node stores a table comprising the nodes to which it is to send a control signal upon detecting an object and for each node a light level to include in the control signal. This simplifies the logic to be implemented on the detector nodes.

In another example, the control signal includes information identifying the detector node. Furthermore, each of the at least one other nodes is adapted to set their light levels based on the separation between the respective other node and the detector node upon receiving the control signal.

In a further preferred embodiment, the object detector is a motion detector adapted to detect the speed of the detected object and the detector node is adapted to send a control signal to a selected at least one other lighting node based upon the speed detection by the motion detector.

For example, the motion detector comprises a radar, camera or PIR motion sensor. Preferably, the motion detector is able to distinguish between at least two speed ranges. For example, the motion detector distinguishes objects moving with a speed from 3-7 km/h, objects with a speed of 7-25 km/h and object with a speed exceeding 25 km/h, corresponding to typical speeds of pedestrians, bicycles and cars.

The control signal generated by the detector node may depend on the detected speed. Furthermore, the group of nodes to which the detector node sends a control signal may depend on the detected speed. For example, if a high speed object is detected, a control signal will be sent to more of the other lighting nodes, such that a larger part of the path or area to which the detector node belongs is illuminated than would be the case for a lower detected speed.

For example, a node A detects an object at a speed of 5 km/h. Detector node A switches its light source to a 100% level and sends a message to its first order neighbors on the same path to switch their light source to an 80 % level, thereby creating a light gradient along the path which is sufficient for this speed. In another example, node A detects an object at a speed of 20 km/h. Detector node A again switches its light source to a 100% level. Instead of only sending a control signal to its first order neighbors, it now also sends a control signal to its second order neighbors, to increase their light output to a 100% level as well. Furthermore, it sends a control signal to its third order neighbors to switch their light source to a 80 % level. Therefore, a larger light envelope is created for this higher speed.

For example, the memory of the detector node stores different lists of neighboring nodes corresponding to different speeds. In the example above, detector A stores a first list comprising its first order neighbors, to which it sends a control signal upon detection of a relatively slow object. Detector A further stores a second list comprising its first, second and third order neighbors, to which it sends a control signal upon detection of a faster moving object. In another example, the memory of the detector node stores a single table of neighboring nodes, wherein the table comprises for each node a definition for which speed the detector node sends a control signal to that node, and preferably also corresponding light level information.

In a preferred embodiment, the detector node is arranged to send a control signal to a selection of the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector, the selection being based on a control signal previously received by the detector node.

Therefore, the number of control signals which the detector node will send may depend on one or more control signals which the detector received prior to the detection of an object by the detector node.

For example, the detector node is adapted to send a control signal to the at least one other nodes in its memory, except those other nodes which have sent a control signal to the detector node within a predetermined interval prior to detection of an object by the detector node. For example, the interval spans the last 2 minutes, the last minute or the last 30 s. As the nodes which recently sent a control signal to the detector node have recently detected an object, they will already be switched on. Not sending a control signal to those nodes will decrease network traffic in the node network. Therefore, overloading of the network is avoided. Furthermore, redundant or unnecessary network traffic is avoided. In the preferred case of wireless communication, interference with other applications, e.g. wifi internet, is reduced significantly.

Furthermore, incorporating previously received control signals in the logic of the at least one detector node enables detecting a direction of an object passing multiple nodes. Preferably, the information identifying other nodes stored in the memory of the detector node is distinguished in a first and second group of nodes, wherein the detector node is adapted to, upon detection of an object:

- send a control signal to the nodes belonging to the first group of nodes if it previously received a control signal from a node belonging to a third group of nodes; and
- send a control signal to the nodes belonging to the second group of nodes if it previously received a control signal from a node belonging to a fourth group of nodes.

For example, the first group of nodes corresponds to nodes on one side of the detector node, e.g. left. The second group of nodes in this example corresponds to nodes on the other side of the detector node, e.g. right. Depending on which control signals were recently, e.g. within the last 2 minutes, received by the detector node, it sends a control signal to the nodes on its left or its right. This enables an asymmetric lighting pattern which follows the moving object. In this example, the third and fourth groups of nodes correspond to groups of nodes on the right and left of the detector node respectively. If the detector node previously received a control signal from a node on its right (third group), it sends control signals upon detection of an object to its left (first group). If the detector node previously received a control signal from a node on its left (fourth group), it sends control signals upon detection of an object to its right (second group). The first and fourth group of nodes may be the same, or may comprise a different set of nodes. The same holds with respect to the second and third group of nodes.

It is noted that no strict separation between left and right is required. For example, the detector node may send control signals to three nodes on the left and one on the right if it previously received a control signal from a node on its right.

Moreover, incorporating the previously received control signals into the logic of the detector node enables detecting a speed or at least a speed range of an object moving past the lighting nodes.

In a preferred embodiment, each lighting node is adapted to communicate its location to the processing component.

For example, the nodes include a GPS device to determine its location.

Preferably however, each node comprises an internal memory in which its location can be programmed. As the nodes will have fixed locations in most applications, this obviates the need for a GPS device, which is cost-effective. For example, the internal memory can be programmed upon installation of the lighting node, wherein an external GPS device, e.g. a smartphone, laptop or dedicated device, is temporarily connected to the lighting node via a communication port to store the GPS coordinates obtained by the external device in the internal memory of the lighting node. Alternatively, a user can manually input the geographical coordinate, e.g. by means of connecting a keyboard. In other words, the node is configured such that the memory can be programmed manually or by using a disconnectable external device, i.e. a device external to the node which can be connected temporarily to the node, such that the memory stores the coordinate of the node without the node performing a measurement, i.e. a measurementless programming of the memory is obtained.

In a currently preferred embodiment, the system comprises a database component connected to the processing component, the database component comprising a database which relates information identifying the lighting nodes to the geographical location of the nodes.

This has the advantage that the geographical coordinates of the nodes are stored centrally. This obviates the need for storing the location on the node or determining the location by the node itself. Preferably, the database is editable. This enables fast and easy correction of the location of the nodes of the system, e.g. when the position of the lighting nodes is changed or when an error has been made in programming the node location.

In a preferred embodiment, the nodes comprise an identifier for identifying the nodes, preferably the identifier being a unique identifier.

For example, during installation the identifier of the node is read out by the installer. The installer also determines the GPS location of the node, e.g. by using a smartphone. The node identifier and corresponding GPS position are added to the database, e.g. by accessing the database over the internet.

For example, the identifier comprises a bar code, QR code, RFID tag or NFC tag.

In one embodiment, the processing component is adapted to obtain the geographical location of a lighting node from the database upon receiving information identifying said lighting node from said lighting node. In other words, the lighting nodes send an identifier (ID) to the processing component, which the processing component can link with the correct location by using the database.

In a preferred embodiment, the system further comprises a visualization component connected to the processing component and is adapted to show the locations of the lighting nodes in the network and/or the groups of interrelated coordinates, e.g. paths or areas, on a map on an electronic display.

For example, the locations of the nodes of the network and/or the groups as defined in the memory, e.g. paths or areas, are displayed as an overlay on digital mapping tools, such as Google Maps TM or Bing Maps TM. This enables an administrator of the system to get an overview of the system. Furthermore, errors in the node location information are easily spotted, e.g. when a certain node clearly falls outside the working area of the system. Preferably, the visualization component is adapted to indicate for each node to which group of interrelated coordinates they are linked.

Preferably, the visualization component is included on a server, e.g. the same server which comprises the processing component and the memory component. Preferably, the server comprises a login component for remote access to the visualization component. For example, the server comprises a web-application accessible over the internet, which shows authorized users the map comprising the nodes and/or stored groups.

In a further preferred embodiment, the system further comprises a configuration component connected to the memory component of the lighting control system and adapted to edit the information related to the at least one group of interrelated coordinates stored in said memory component on the basis of user input.

Preferably, the configuration component is also included on a server, e.g. the same server which comprises the visualization component. Preferably, the server comprises a login component for remote access to the configuration component. For example, the server comprises a web-application accessible over the internet, which enables users to edit the defined groups.

Preferably, the system is adapted such that the visualization component provides a graphical user interface for editing the defined groups. For example, the user can edit existing groups by selecting them on the map and/or create new groups by drawing a path or selecting an area on the map. Alternatively or additionally, the system provides a text based user interface for editing groups.

In a preferred embodiment, at least one of the at least one group of interrelated coordinates represents a path defined in the geographical coordinate system.

In a further preferred embodiment according to the invention, the processing component is further adapted to automatically determine intersections of said paths and to associate at least one lighting node with at least one intersection on the basis of the location of the respective lightning node.

In addition to using areas or paths to identify groups of lighting nodes which belong together, intersections can be used to group lighting nodes. When paths are defined in the memory component, the processing component can preferably automatically calculate if intersections of the defined paths exists.

For example, in a 2D Cartesian coordinate system, path Z is defined by the points (0,0), (10,0), (10,20) and (20,20), path Y is defined by the points (15,30), (15, 15) and (0,15). The processing component determines that path Y and path Z intersect at point (10,15) and (15,20). It stores these intersections in the memory component, e.g. ("intersection 1", "path Y", "path Z", (10,15)) and ("intersection 2", "path Y", "path Z", (15,20)). The nodes which are close to these intersections are determined. A message is sent to each of the nodes of the intersections. For example, node A receives a message that it shares an intersection with nodes B, C and D.

This information can be used to formulate rules for illuminating an intersection. Intersections on a road are places where one should be particularly alert of other traffic, therefore programming an additional or alternative activation protocol for light sources near intersections is particularly advantageous.

It is noted that the above can be implemented in a similar way as described with respect to association of nodes to groups. Preferably, the processing component is adapted to automatically determine the relationships between the nodes, e.g. to which path and/or intersection they belong, and to send to each detector node a list of other nodes to which to send a control signal upon detection of an object. In such a configuration of the system, the nodes do not "know" about paths or intersections, they only know what control signal to send to which other nodes. This simplifies the logic implemented in the individual nodes.

As described above, the group of nodes to which the detector sends a control signal and light level information in the control signal may depend on the speed of the detected objected and/or the separation between the detector node and the respective other node.

In a preferred embodiment, the processing component is further adapted to automatically generate groups of interrelated coordinates, e.g. paths or areas, on the basis of geographical data.

By automatically generating the groups of interrelated coordinates, the system according to the invention is easily configurable, as paths, areas or other geographical relations do not need to be defined manually.

For example, geographical data can be obtained from web-based mapping services, such as Google Maps TM or Bing Maps TM.

For example, the processing component loads geographical data comprising a map image and associated coordinates. The processing component then extracts the groups of interrelated coordinates on the basis of the colors used in the map image and determines the corresponding coordinates. For example, if the map image uses gray to indicate roads, the processing component determines the coordinates corresponding to the gray areas on the map image to obtain a description of a path.

The invention further relates to a lighting control system comprising a number of lighting nodes forming a multi-node network, each lighting node comprising:

- a light source;
- a controller connected to the light source; and
- communication means connected to the controller,

wherein at least one lighting node comprises:

- an object detector connected to the controller; and

- a memory adapted to store information identifying at least one other lighting node which is associated to said at least one lighting node,

wherein this at least one lighting node is adapted to send a control signal to the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector for controlling the light source of said at least one other lighting node. In other words, this further lighting control system according to the invention does not comprise a memory component and processing component as described above.

Preferably, the control signal comprises light level information for controlling the intensity of the light source of said at least one other lighting node, the light level information being based on information of the separation between the at least one lighting node and said at least one other lighting node.

Preferably, the object detector is a motion detector adapted to detect the speed of the detected object and the at least one lighting node is adapted to send a control signal to a selected at least one other lighting node based on the speed detected by the motion detector.

Preferably, the lighting node which comprises the object detector is arranged to send a control signal to a selection of the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector, the selection being based on a control signal previously received by said lighting node.

The invention further relates to a method for associating a node of a multi-node network with at least one other node of the network. The method comprises:

- storing information relating to groups of interrelated coordinates defined in a geographical coordinate system;
- determining the location of said node in the geographical coordinate system;
- automatically associating said node to at least one of the groups of interrelated coordinates on the basis of the location of the node; and
- automatically associating said node to at least one other node being associated with the same group.

The same effects and advantages as described above in relation to the lighting control system apply to the method according to the invention. Furthermore, the features of the system and the method according to the invention can be combined as desired. Preferably, the method according to the invention is performed using the lighting control system according to the invention.

In a preferred embodiment, the method further comprises automatically determining the separation between said node and said at least one other node being associated with the same group.

In a further preferred embodiment, the method further comprises:

- storing the information relating to groups on a server connected to the multi-node network; and
- sending information from the server to the node on the basis of the associated group.

In an embodiment, determining the location of the node comprises:

- providing the node with a memory for storing its GPS coordinate;
- determining the GPS coordinate of the node using an external GPS device; and

- storing the GPS coordinate of the node in the memory.

In a further preferred embodiment, determining the location of the node comprises providing a database which associates nodes with locations.

In a currently preferred embodiment, determining the location of the node comprises:

- providing the node with an identifier;
- determining the identifier associated with the node;
- determining the geographical location of the node; and
- storing the identifier and corresponding geographical location in the database.

Preferably, the identifier is a unique identifier.

For example, the geographical location is determined using an external GPS device.

For example, the identifier includes a barcode, QR code, RFID tag or NFC tag. Preferably, the method comprises providing a handheld device, such as a smartphone or laptop, comprising a GPS device and means for obtaining the identifier of a node. For example, the device includes a barcode scanner, QR code scanner, RFID reader or NFC reader. The method further comprises using the handheld device to obtain the identifier of the node and the GPS position of the node, and subsequently storing the obtained identifier and corresponding position in the database, e.g. via a wireless internet connection with the processing component.

In a further preferred embodiment, the method further comprises showing the location of at least one of the nodes and/or at least one of the groups of interrelated coordinates on a map on a electronic display.

In a further preferred embodiment, the method further comprises automatically determining groups of interrelated coordinates, such as paths and intersections, on the basis of geographical data.

The invention further relates to a system for performing the method according to the invention, the system comprising a multi-node network, a memory component adapted to store information relating to groups of interrelated coordinates defined in a geographical coordinate system, a processing component adapted to determine the location of the node in the geographical coordinate system, to associate a first node of the multi-network to at least one of the groups of interrelated coordinates on the basis of the location of the node and to associate said first node to at least one other node being associated with the same group of interrelated coordinates. For such a system the same effects and advantages apply as described above for the method according to the invention.

Further details, effects and advantages of the invention will be elucidated on the basis of exemplary embodiments thereof, wherein reference is made to the accompanying drawings.

- Figure 1 shows a schematic of a road with a light control system according to an embodiment of the invention;
- Figure 2 shows the groups of interrelated coordinates for the system of figure 1, in this case these groups correspond to paths;
- Figure 3 shows the association of one of the nodes to one of the paths in the system of figure 1;
- Figure 4 shows the system of figure 1, wherein groups of nodes belonging to the same path have been indicated;
- Figure 5 shows the system of figure 1, wherein groups of nodes belonging to intersections have been indicated; and

- Figure 6 shows a schematic drawing of the components of the system according to figure 1.

A network of roads 2 (figure 1) has been provided with a system according to the invention. The system comprises lighting nodes (a-w) provided next to the road. Each lighting node comprises a light source for illuminating part of the road. Each lighting node is equipped with a wireless communication device for communicating with other nodes. Furthermore, each node is equipped with a motion detector capable of detecting moving objects and determining their speed or at least determine in which speed range the detected object falls. The nodes communicate using the ZigBee standard for wireless mesh network communication. Alternatively, a different standard is used.

Five paths 4a-e are defined (figure 2). Path 4a passes nodes a-f, path 4b passes nodes i-n, path 4c passes nodes c, g, h, k, o, p, q, r, path 4d passes nodes s-u and path 4e passes node u-w. The paths are defined automatically by the system on the basis of geographical data, e.g. using Google Maps TM.

To associate the nodes to the defined paths, the system determines for each node, which paths are within a certain distance, called the linking radius 8 (figure 3). The linking radius defines a circle 6 around each node. Any path which intersects this circle is associated with that node.

For example, for node j as shown, the only path within the linking radius is path 4b. Therefore, the system assigns node j to path 4b. For node k, both path 4b and path 4c are within the linking radius. Thus, in this case the system assigns node k to both path 4b as path 4c.

After this procedure has been completed for all nodes, the system can generate a list of all nodes for a given path. For example, path 4a includes the group 10 of nodes a-f (figure 4) and the path 4b includes the group 12 of nodes i-n.

Subsequently, the system automatically establishes which paths intersect and which nodes are near these intersections. The system finds three intersections 14a, 14b and 14c (figure 5).

After determining to which paths and intersections the nodes of the system belong, the system determines for each node to which neighboring nodes it should send control signals. This determination may depend on a set of predetermined rules. For example, the rules are:

1) on detection of a moving object, the first order neighbors of the detecting node should be activated to an 80% light level; and

2) if the detecting node is close to an intersection, all nodes associated to that intersection should be activated to a 100% level.

For example, for node v the system determines that it has first order neighbors w and u and that node v is not associated with an intersection. Therefore, the processing component sends a message to node v to send the following control signals upon detection of an object:

1) a control signal to node w for switching to an 80% light level (same path); and

2) a control signal to node u for switching to an 80% light level (same path).

Node v stores this information in its memory, for example as two entries in a table.

For node c, the system determines that it is associated with an intersection, therefore the processing component sends a message to node c to send a control signal to control nodes b, d, e and g to switch to 100% upon detection of an object by node c.

In the current preferred embodiment, the set of rules define that each node in an intersection group triggers the other nodes in the group. Furthermore, each node on a path triggers its first order neighbors (as in the previous example).

In this case, the system determines that node b should send the following control signals:

1) a control signal to node a to switch to an 80% light level (same path);

2) control signals to c, d, e and g to switch to a 100% light level (same intersection group).

This information is sent to node b, which stores it in its memory. Upon detecting an object, node b will send the control signals as prescribed by the system according to the instructions in its memory.

An example illustrating the preferred embodiment will be given next. A car Z drives along the road (figure 5). All nodes a-w are initially operating their lights at a low level of 40%. When car Z follows path 4a, it will first pass node a. Upon detecting car Z, node a will switch its light to a level of 100%. Subsequently, it will determine what control signals to send by checking its memory. As explained above, the information in the memory of node a indicates that node a should send a control signal to node b to switch the light of b to an 80% light level. Upon receipt of this message node b operates as requested and switches to an 80% light level. As the car moves further along its path it passes node b. Node b will detect the car and switch its light to a level of 100%. Subsequently, it checks its memory to determine which control signals to send. As explained above, node b will send a message to node a to switch the light level to an 80% level and a message to nodes c, d, e and g to switch their lights to a level of 100%. Node a is already operating at a 100% light level when it receives the message from node b. In one configuration of the system node a reduces its light level to 80% as requested. In a currently preferred configuration the nodes are configured to ignore messages requesting for a lower light level than the current light level. In this case, node a will continue to operate at a 100% light level. All nodes will continue to shine at the requested high level for a predetermined time, after which they will return to their low light level state, preferably gradually. In this example, the message of node b retriggers the timer of node a, such that it will shine at a 100% light level for a longer period of time.

The rules describing which lighting nodes should switch to a higher light level can be made dependent on the speed of the detected object. For example, for an object having a first speed only first order neighbors are activated, while for an object having a second speed, also second order neighbors are activated.

Furthermore, these rules may even vary between different geographical areas. For example, different rules may be applied to rural areas than to urban areas. Whether a geographical area is classified as a rural or urban area can be determined automatically, e.g. on the basis of a digital mapping service.

The nodes (figure 6) communicate wirelessly with each other. They relay messages from other nodes. This network topology has been proven to be reliable, as the nodes will still be able to communicate with each other if one of the nodes fails. The system is further provided with gateway 16. Messages from the nodes a-w to the processing component are collected by gateway 16 and then relayed to server 20 via a secure connection over the internet 18. Server 20 comprises the processing component and the memory component storing the information related to the groups of interrelated coordinates, such as path and/or intersection data. For example, server 20 sends information about the neighbors of node c to node c. Server 20 sends the message to gateway 16 via internet 18, after which gateway 16 sends it via the wireless network of the nodes a-w to node c. Upon receipt of the request, node c updates its list of neighbors.

Of course, multiple gateways 16 can be provided to improve the redundancy and reliability of the system.

The server 20 can be accessed by a user using a terminal, such as PC 22 or a smartphone or tablet. Using a browser, the user navigates to a log-in page on the server 20. Once successfully logged in, the user can obtain an overview of the nodes in the system projected on a map on the display of his PC 22. For example, the map will look similar to figure 2. Furthermore, the user may edit the groups of interrelated coordinates - in this case paths and intersections, the node locations and other settings of the system using the web based control software.

The present invention is by no means limited to the above described preferred embodiments thereof. The rights sought are defined by the following claims, within the scope of which many modifications can be envisaged.

CLAUSES

1. Lighting control system comprising a number of lighting nodes forming a multi-node network, each lighting node comprising:

- a light source;
- a controller connected to the light source; and
- communication means connected to the controller,

wherein the lighting control system further comprises:

- a memory component adapted to store information relating to at least one group of interrelated coordinates defined in a geographical coordinate system; and
- a processing component in communication with the lighting nodes and adapted to automatically associate at least one lighting node with the at least one group of interrelated coordinates on the basis of the geographical location of said at least one lighting node.

2. Lighting control system according to clause 1, the processing component being further adapted to automatically associate at least one first lighting node with at least one second lighting node being associated with the same group of interrelated coordinates.

3. Lighting control system according to clause 2, the processing component being further adapted to automatically determine the separation between said at least one first lighting node and said at least one second lighting node in said group of interrelated coordinates.

4. Lighting control system according to clause 1, 2 or 3, wherein at least one lighting node comprises:

- an object detector connected to the controller; and
- a memory adapted to store information identifying at least one other lighting node which is associated by the processing component to the same group of interrelated coordinates,

wherein this at least one lighting node is adapted to send a control signal to one or more of the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector for controlling the light source of said one or more of the at least one other lighting node.

5. Lighting control system according to clause 4, wherein the control signal comprises light level information for controlling the intensity of the light source of said at least one other lighting node, the light level information being based on information about the separation between the at least one lighting node and said at least one other lighting node.

6. Lighting control system according to clause 4 or 5, wherein the object detector is a motion detector adapted to detect the speed of the detected object and the at least one lighting node is adapted to send a control signal to a selected at least one other lighting node based upon the speed detection by the motion detector.

7. Lighting control system according to clause 4, 5 or 6, wherein the lighting node which comprises the object detector is arranged to send a control signal to a selection of the at least one other lighting node identified by the information in the memory upon detection of an object by the object detector, the selection being based on a control signal previously received by said lighting node.

8. Lighting control system according to any of the clauses 1-7, wherein each lighting node is adapted to communicate its location to the processing component.

9. Lighting control system according to any of the clauses 1-8, further comprising a database component connected to the processing component, the database component comprising a database which relates information identifying the lighting nodes to the geographical location of the nodes.

10. Lighting control system according to any of the clauses 1-9, further comprising a visualization component connected to the processing component and adapted to show the locations of the lighting nodes in the network and/or the at least one group of interrelated coordinates on a map on an electronic display.

11. Lighting control system according to any of the clauses 1-10, further comprising a configuration component connected to the memory component of the lighting control system and adapted to edit the information related to the at least one group of interrelated coordinates stored in said memory component on the basis of user input.

12. Lighting control system according to any of the clauses 1-11, wherein at least one of the at least one group of interrelated coordinates represents a path defined in the geographical coordinate system.

13. Lighting control system according to clause 12, wherein the processing component is further adapted to determine intersections of paths and to automatically associate at least one lighting node with at least one intersection on the basis of the location of the respective lightning node.

14. Lighting control system according to any of the clauses 1-13, wherein the processing component is further adapted to automatically generate groups of interrelated coordinates on the basis of geographical data.

15. Method for associating a node of a multi-node network with at least one other node of the network, comprising

- storing information relating to groups of interrelated coordinates defined in a geographical coordinate system;
- determining the location of said node in the geographical coordinate system;
- automatically associating said node to at least one of the groups of interrelated coordinates on the basis of the location of the node; and
- automatically associating said node to at least one other node being associated with the same group of interrelated coordinates.

16. Method according to clause 15, further comprising automatically determining the separation between said node and said at least one other node being associated with the same group of interrelated coordinates.

17. Method according to clause 15 or 16, further comprising:
- storing the information relating to the groups of interrelated coordinates on a server connected to the multi-node network;
- sending information from the server to the node on the basis of the associated group of interrelated coordinates.

18. Method according to any of the clauses 15-17, wherein determining the location of the node comprises providing a database which associates nodes with geographical locations.

19. Method according to clause 18, wherein determining the location of the node comprises:
- providing the node with an identifier;
- determining the identifier associated with the node;
- determining the geographical location of the node; and
- storing the identifier and corresponding geographical location in the database.

20. Method according to any of the clauses 15-19, further comprising showing the location of at least one of the nodes and/or at least one of the groups of interrelated coordinates on a map on an electronic display.

21. Method according to any of the clauses 15-20, further comprising automatically determining groups of interrelated coordinates on the basis of geographical data.

CONCLUSIES

1. Verlichtingregelsysteem dat een aantal verlichting-nodes omvat die een multi-node network vormen, waarin elke verlichting-node omvat:

- een lichtbron;
- een regelaar verbonden met de lichtbron; en
- communicatiemiddelen verbonden met de regelaar,

waarin het verlichtingregelsysteem verder omvat:

- een geheugencomponent ingericht om informatie op te slaan betreffende ten minste één groep van onderling gerelateerde coördinaten gedefinieerd in een geografisch coördinatenstelsel; en
- een verwerkingcomponent in communicatieve verbinding met de verlichting-nodes en ingericht om automatisch ten minste één verlichting-node te associëren met de ten minste ene groep van onderling gerelateerde coördinaten op basis van de geografische locatie van deze ten minste ene verlichting-node.

2. Verlichtingregelsysteem volgens conclusie 1, waarin de verwerkingcomponent verder ingericht is om automatisch ten minste één eerste verlichting-node te associëren met ten minste één tweede verlichting-node die geassocieerd is met dezelfde groep van onderling gerelateerde coördinaten.

3. Verlichtingregelsysteem volgens conclusive 2, waarin de verwekingcomponent verder ingericht is om automatisch de separatie te bepalen tussen de ten minste ene eerste verlichting-node en de ten minste ene tweede verlichting-node in de groep van onderling gerelateerde coördinaten.

4. Verlichtingregelsysteem volgens conclusies 1, 2 of 3, waarin ten minste één verlichting-node omvat:

- een objectdetector verbonden met de regelaar; en
- een geheugen ingericht om informatie op te slaan die ten minste één andere verlichting-node identificeert die door de verwerkingcomponent geassocieerd is met dezelfde groep van onderling gerelateerde coördinaten,

waarin de ten minste ene verlichting-node is ingericht om een regelsignaal naar één of meer van de ten minste één door de informatie in het geheugen geïdentificeerde andere verlichting-node te zenden wanneer een object wordt gedetecteerd door de objectdetector voor het regelen van de lichtbron van de één of meer van de ten minste één andere verlichting-node.

5. Verlichtingregelsysteem volgens conclusie 4, waarin het regelsignaal lichtniveau-informatie omvat voor het regelen van de intensiteit van de lichtbron van de ten minste één andere verlichting-node, waarin de lichtniveau-informatie is gebaseerd op informatie betreffende de separatie tussen de ten minste ene verlichting-node en de ten minste ene andere verlichting-node.

6. Verlichtingregelsysteem volgens conclusie 4 of 5, waarin de objectdetector een bewegingdetector is die is ingericht om de snelheid van het gedetecteerde object te detecteren en waarin de ten minste ene verlichting-node is ingericht om een regelsignaal te zenden naar een geselecteerde ten minste één andere verlichting-node op basis van de snelheiddetectie door de bewegingdetector.

7. Verlichtingregelsysteem volgens één van de conclusies 4, 5 of 6, waarin de verlichting-node die de objectdetector omvat, is ingericht om een regelsignaal te zenden naar een selectie van de ten minste ene andere verlichting-node die door de informatie in het geheugen is geïdentificeerd wanneer een object wordt gedetecteerd door de objectdetector, waarin de selectie gebaseerd is op een eerder door de verlichting-node ontvangen regelsignaal.

8. Verlichtingregelsysteem volgens één van de conclusies 1-7, waarin de verlichting-node is ingericht om zijn locatie aan de verwerkingcomponent te communiceren.

9. Verlichtingregelsysteem volgens één van de conclusies 1-8, verder omvattende een met de verwerkingcomponent verbonden databankcomponent die een databank omvat die informatie die verlichting-nodes identificeert relateert aan de geografische locatie van de nodes.

10. Verlichtingregelsysteem volgens één van de conclusies 1-9, verder omvattende een visualisatiecomponent die is verbonden met de verwerkingcomponent en ingericht om de locatie van de verlichting-nodes in het netwerk en/of de ten minste ene groep van onderling gerelateerde coördinaten weer te geven op een kaart op een elektronisch scherm.

11. Verlichtingregelsysteem volgens één van de conclusies 1-10, verder omvattende een met de geheugencomponent van het verlichtingregelsysteem verbonden configuratiecomponent die is ingericht om informatie betreffende de ten minste ene groep van onderling gerelateerde coördinaten die is opgeslagen in de geheugencomponent aan te passen op basis van gebruikersinvoer.

12. Verlichtingregelsysteem volgens één van de conclusies 1-11, waarin ten minste één van de ten minste ene groep van onderling gerelateerde coördinaten een pad representeert dat is gedefinieerd in het geografische coördinatenstelsel.

13. Verlichtingregelsysteem volgens conclusie 12, waarin de verwerkingcomponent verder is ingericht om kruisingen van paden te bepalen en om automatisch ten minste één van de verlichting-nodes te associëren met ten minste één kruising op basis van de locatie van de respectieve verlichting-node.

14. Verlichtingregelsysteem volgens één van de conclusies 1-13, waarin de verwerkingcomponent verder is ingericht om automatisch groepen van onderling gerelateerde coördinaten te genereren op basis van geografische data.

15. Werkwijze voor het associëren van een node in een multi-node netwerk met ten minste één andere node in het netwerk, omvattende

- het opslaan van informatie betreffende groepen van onderling gerelateerde coördinaten gedefinieerd in een geografisch coördinatenstelsel;
- het bepalen van de locatie van de node in het geografische coördinatenstelsel;
- het automatisch associëren van de node met ten minste één van de groepen van onderling gerelateerde coördinaten op basis van de locatie van de node; en
- het automatisch associëren van de node met ten minste één andere node die geassocieerd is met dezelfde groep van onderling gerelateerde coördinaten.

16. Werkwijze volgens conclusie 15, verder omvattende het automatisch bepalen van de separatie tussen de node en de ten minste ene andere node die geassocieerd is met dezelfde groep van onderling gerelateerde coördinaten.

17. Werkwijze volgens conclusie 15 of 16, verder omvattende:
- het opslaan van de informatie betreffende de groepen van onderling gerelateerde coördinaten op een server die verbonden is met het multi-node netwerk;
- het zenden van informatie van de server naar de node op basis van de geassocieerde groep van onderling gerelateerde coördinaten.

18. Werkwijze volgens één van de conclusies 15-17, het bepalen van de locatie van de node omvattende het voorzien van een databank die nodes associeert met geografische locaties.

19. Werkwijze volgens conclusie 18, het bepalen van de locatie van de node omvattende:
- het voorzien van de node met een identificatie;
- het bepalen van de identificatie geassocieerd met de node;
- het bepalen van de geografische locatie van de node; en
- het opslaan van de identificatie en corresponderende geografische locatie in de databank.

20. Werkwijze volgens één van de conclusies 15-19, verder omvattende het tonen van de locatie van ten minste één van de nodes en/of ten minste één van de groepen van onderling gerelateerde coördinaten op een kaart op een elektronisch scherm.

21. Werkwijze volgens één van de conclusies 15-20, verder omvattende het automatisch bepalen van groepen van onderling gerelateerde coördinaten op basis van geografische data.

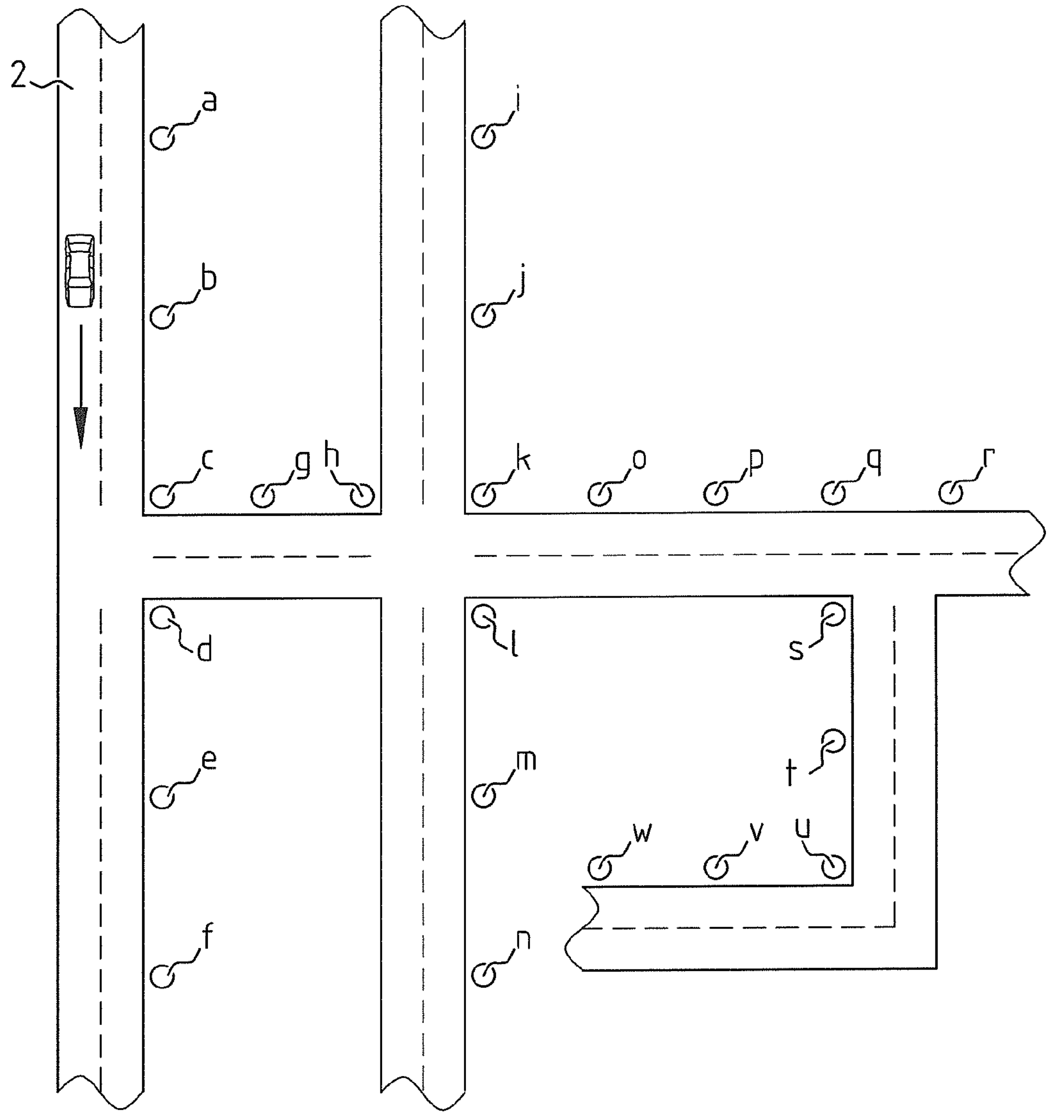

FIG. 1

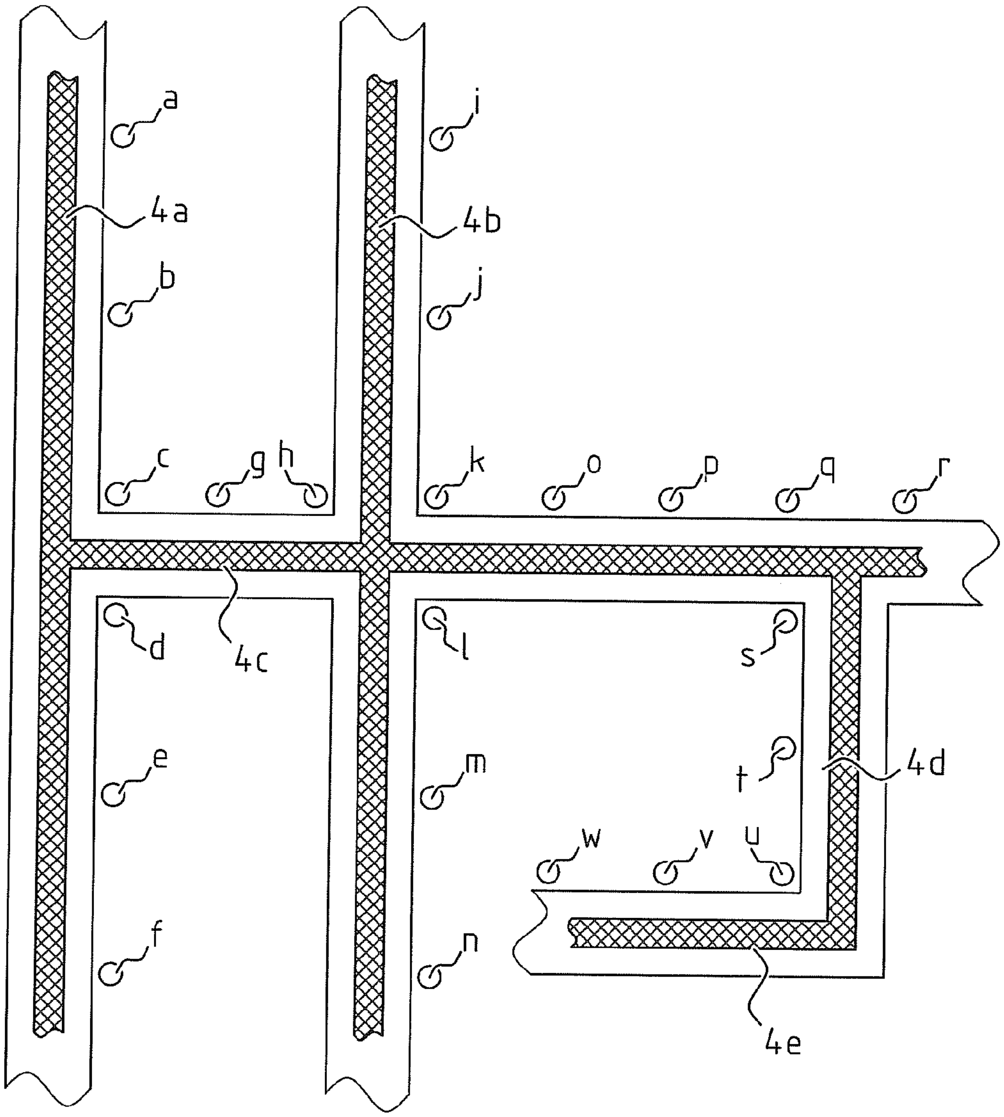

FIG. 2

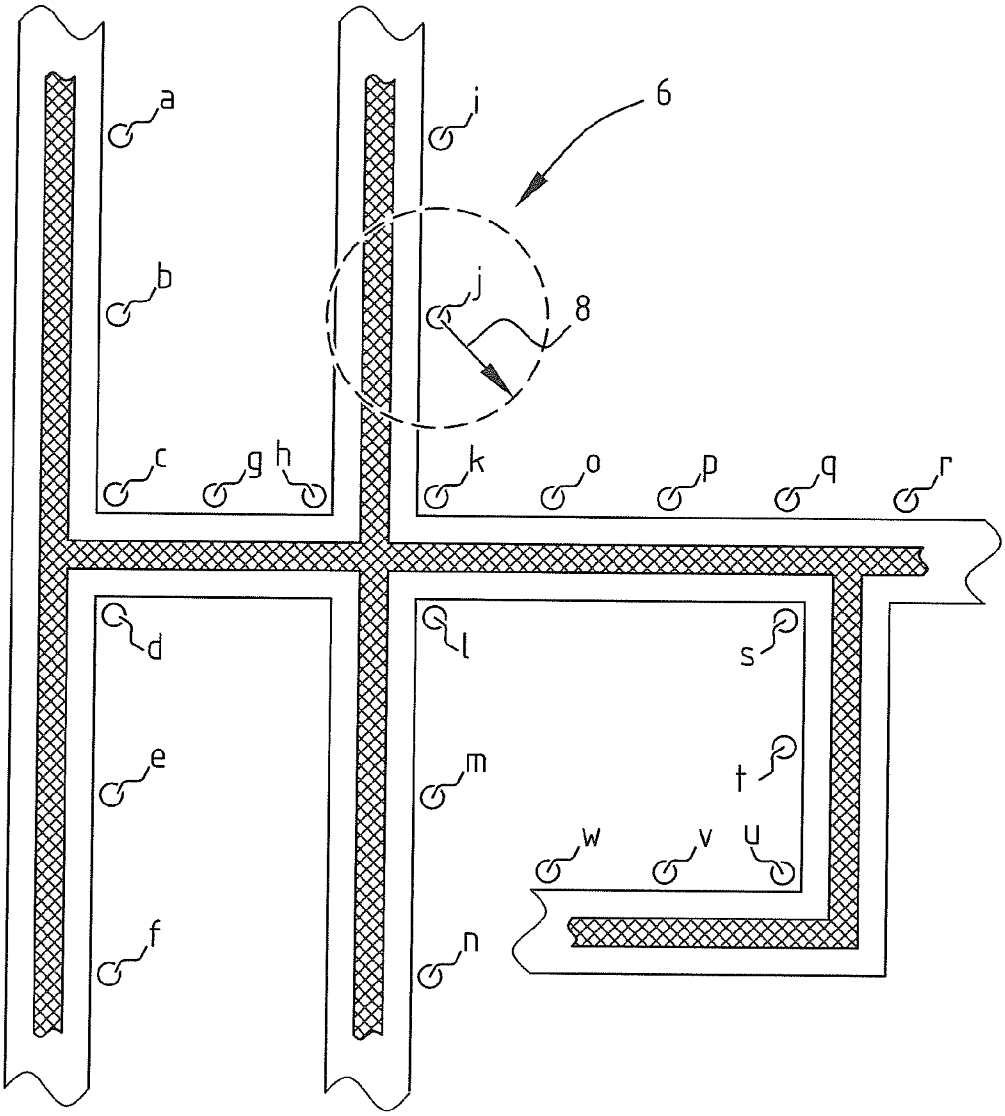

FIG. 3

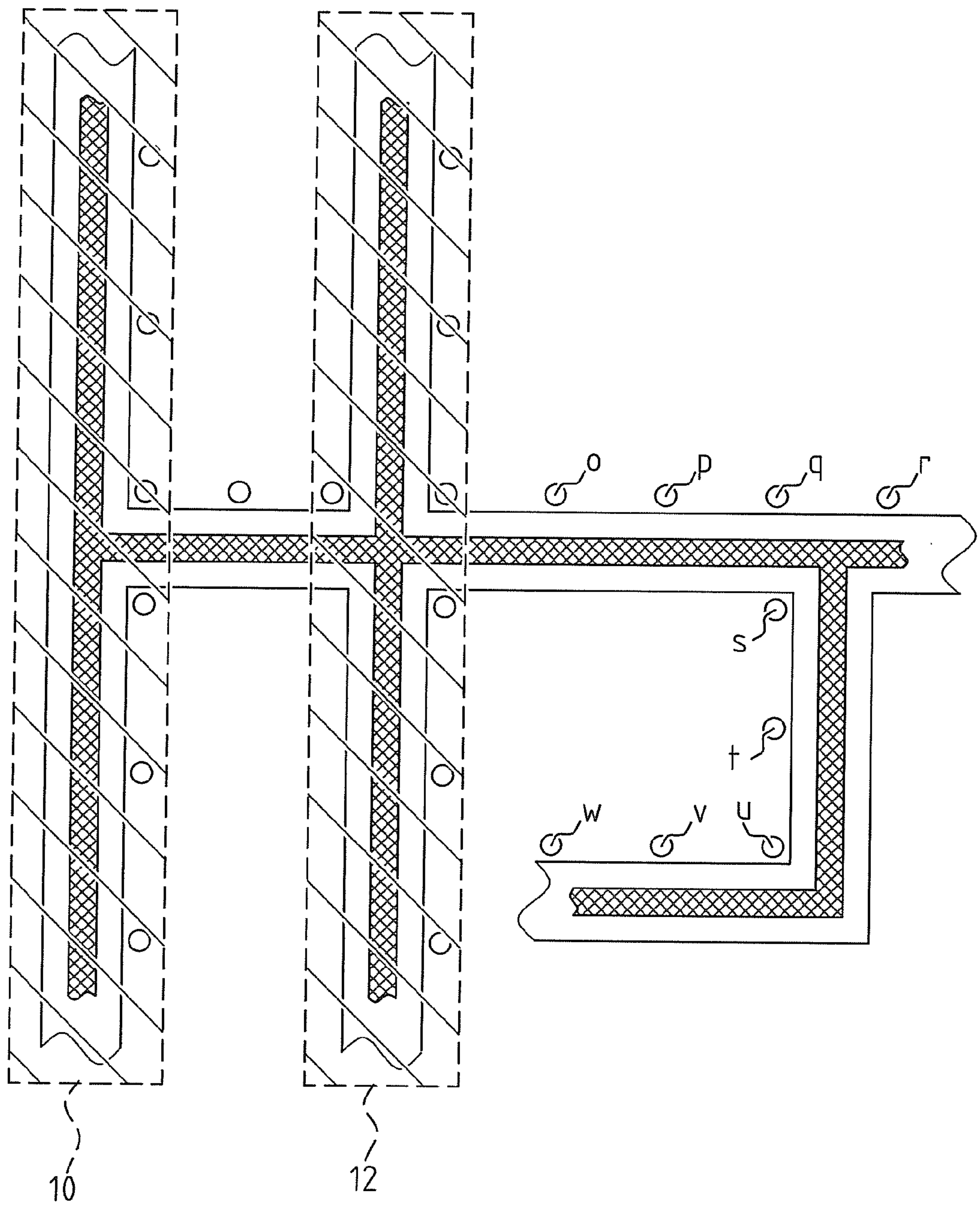

FIG. 4

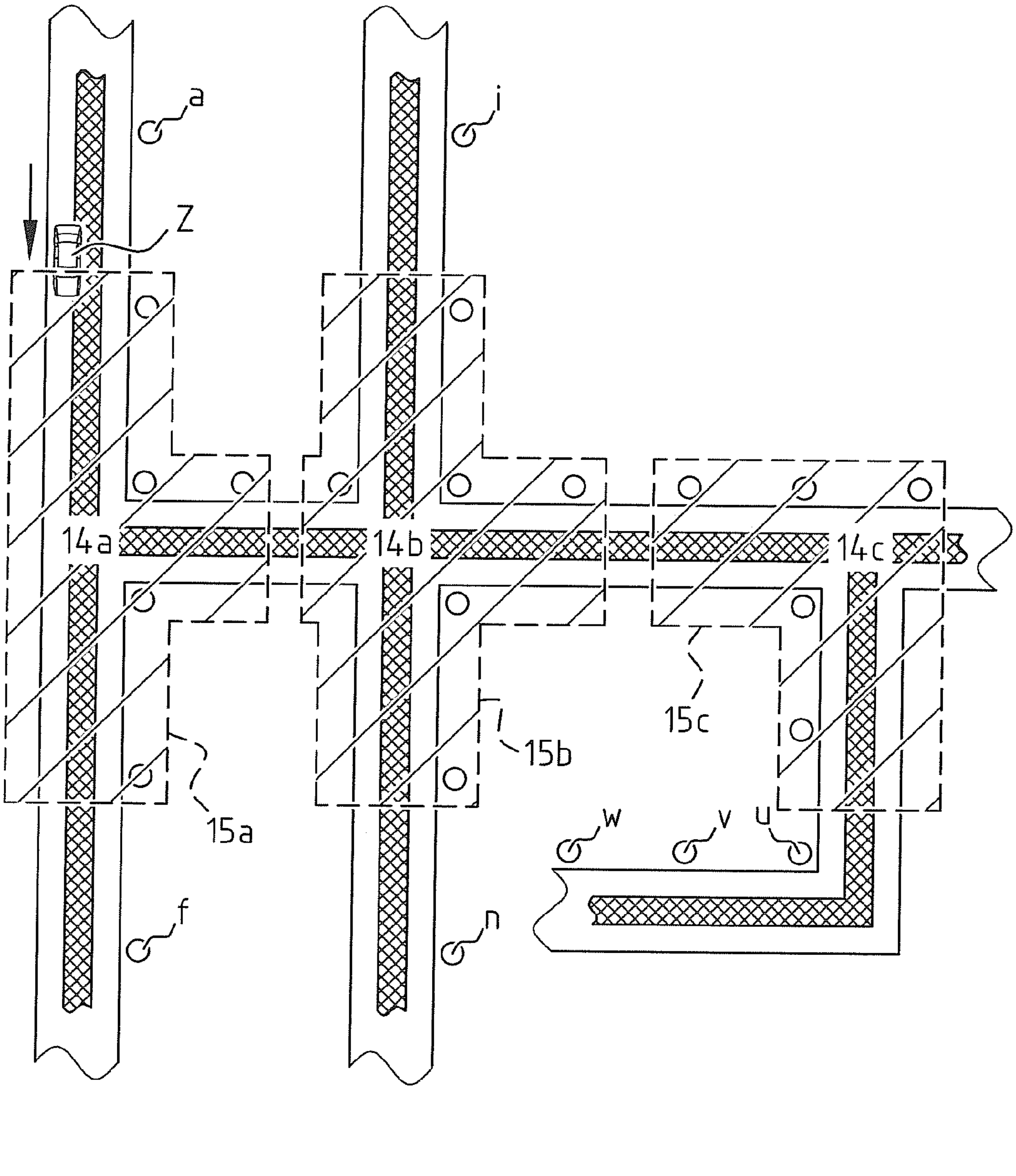

FIG. 5

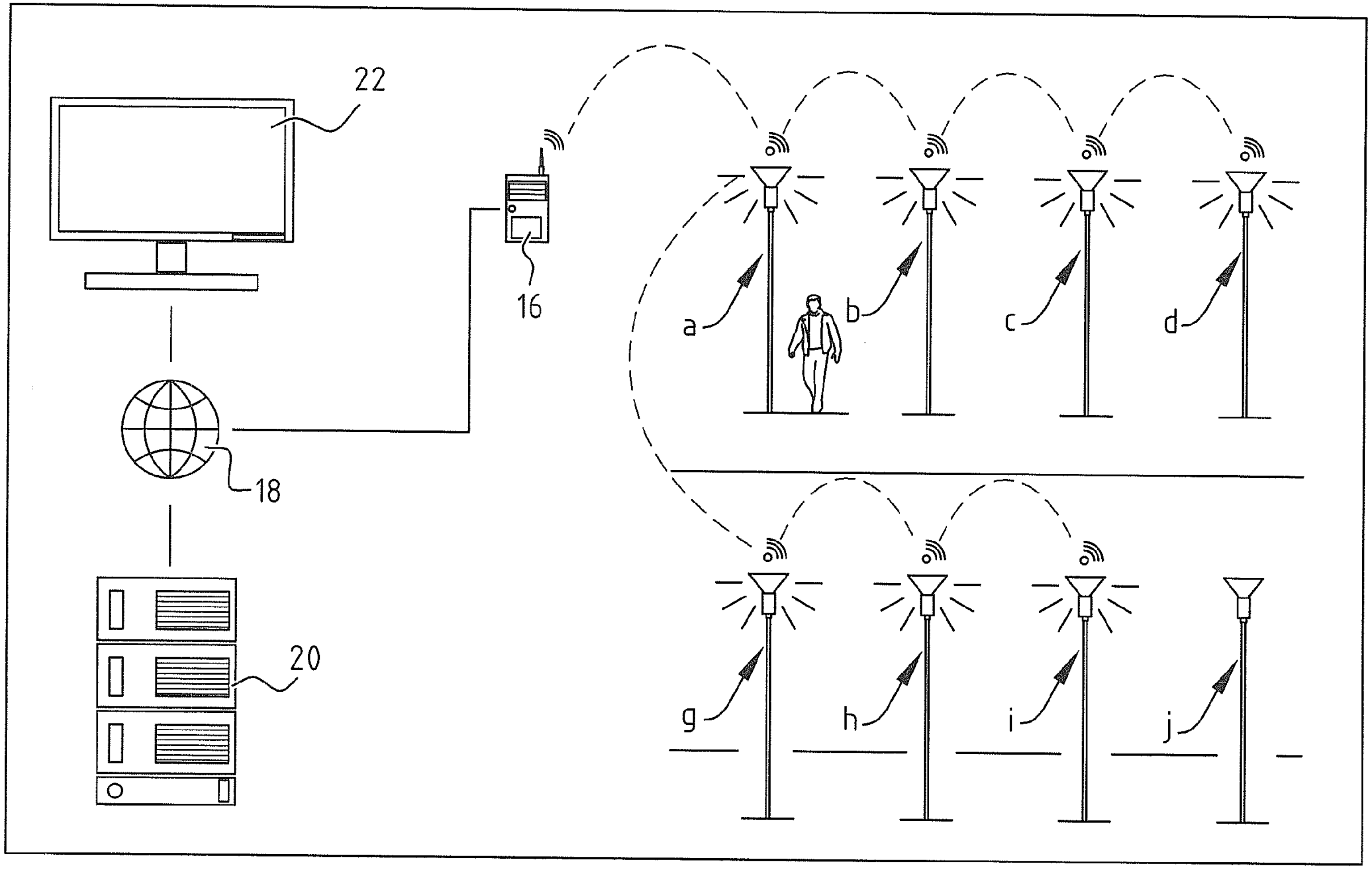

FIG. 6

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE **4B/2NS94/2**
Nederlands aanvraag nr. **2010324**	Indieningsdatum **18-02-2013**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Tvilight B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **08-06-2013**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 60169**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

H05B37/02

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**H05B**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

Form PCT/ISA 201 A (11/2000)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2010324

A. CLASSIFICATIE VAN HET ONDERWERP
INV. H05B37/02
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
H05B

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 2012/143383 A1 (COOPERRIDER PAUL H [US] ET AL) 7 juni 2012 (2012-06-07) * alineas [0003] - [0011] * * alineas [0071] - [0081], [0130] - [0140], [0163] - [0185]; figuren 1-19 * * alineas [0233] - [0251], [0340] - [0358]; figuren 21-24 * * alineas [0532] - [0537]; figuur 52 * -----	1-21
X	US 2012/059622 A1 (CACACE VINCENZO [IT] ET AL) 8 maart 2012 (2012-03-08) * alineas [0042] - [0063]; figuren 1-5 * -----	1,15
E	WO 2013/109765 A1 (CIMCON LIGHTING INC [US]) 25 juli 2013 (2013-07-25) * bladzijden 1-5; figuur 1 * -----	1,15

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

30 oktober 2013

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

De bevoegde ambtenaar

Albertsson, Gustav

Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2010324

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 2012143383 A1	07-06-2012	GEEN	
US 2012059622 A1	08-03-2012	GEEN	
WO 2013109765 A1	25-07-2013	US 2013181609 A1	18-07-2013
		US 2013181614 A1	18-07-2013
		US 2013181636 A1	18-07-2013
		WO 2013109765 A1	25-07-2013

OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

File No. SN60169	Filing date *(day/month/year)* 18.02.2013	Priority date *(day/month/year)*	Application No. NL2010324
International Patent Classification (IPC) INV. H05B37/02			
Applicant Tvilight B.V.			

This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☒ Box No. II — Priority
- ☐ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI — Certain documents cited
- ☐ Box No. VII — Certain defects in the application
- ☐ Box No. VIII — Certain observations on the application

	Examiner Albertsson, Gustav

WRITTEN OPINION

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box II Priority

This opinion has been established as if the claimed priority date were valid, unless indicated otherwise on the **separate sheet**

WRITTEN OPINION

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	3, 13, 14, 16, 21
	No:	Claims	1, 2, 4-12, 15, 17-20
Inventive step	Yes:	Claims	
	No:	Claims	1-21
Industrial applicability	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VI Certain documents cited

☒ Certain published documents

see the Search Report

☐ Non-written disclosures

Re Item II

Priority

The present application appears to be a first filing, which implies that the filing date and priority date are the same, namely 18-02-2013.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Prior art

Reference is made to the following documents:

D1 US 2012/143383 A1 (COOPERRIDER PAUL H [US] ET AL) 7 juni 2012 (2012-06-07)

D2 US 2012/059622 A1 (CACACE VINCENZO [IT] ET AL) 8 maart 2012 (2012-03-08)

D3 WO 2013/109765 A1 (CIMCON LIGHTING INC [US]) 25 juli 2013 (2013-07-25)

2 Clarity

Claims 1, 14, 15 and 21 are not clear.

2.1 Claim 1

The expression "one group of interrelated coordinates" used in claim 1 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

From the description page 25 it appears that the above expression refers to paths or intersections on a map (coordinate system).

The term "associated" used in claim 1 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

From the description page 25 it appears that the above term refers to linking a node to a path, intersection or other structure on a map (coordinate system).

Claim 1 does not meet the requirement of clarity because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result. More particularly, claim 1 expresses a wish to "automatically associate .. one lighting node with", without defining this "association" step in any detail.

From the description on page 25 it appears that the "association" step is carried out by determining the distance between a node and a path, intersection or other map structure.

2.2 Independent claim 15

Method claim 15 corresponds to system claim 1 and has the same deficiencies as claim 1.

2.3 Dependent claims 14 and 21

The expression "groups of interrelated coordinates" used in claims 14 and 21 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

From the description page 25 it appears that the above expression refers to paths or intersections on a map (coordinate system).

Claims 14 and 21 do not meet the requirement of clarity because the matter for which protection is sought is not clearly defined. The claims attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result. More particularly, claims 14 and 21 expresses a wish to "automatically generate groups of interrelated coordinates", without defining this "generation" step in any detail.

The description does not appear to provide any further details on the above "generation" step.

In the following analysis of novelty and inventive step, the above interpretation of claims 1,14,15 and 21, as defined in the description of the present application, will be used.

3 Novelty

Furthermore, the above-mentioned lack of clarity notwithstanding, the subject-matter of claims 1,2,4-12,15,17-20 is not new, and the criteria of patentability are therefore not met.

3.1 Claim 1

Document D1 discloses:

Lighting control system (see fig. 19) comprising a number of lighting nodes (lamp posts) forming a multi-node network (mesh network), each lighting node (lamp post) comprising:

- a light source (paragraphs 80, 135);

- a controller connected (paragraphs 4, 71-72) to the light source; and

- communication means (paragraph 77) connected to the controller, wherein the lighting control system further comprises:

- a memory component adapted to store information relating to at least one group of interrelated coordinates defined in a geographical coordinate system (see paragraphs 79 and 354); and

- a processing component (control station fig. 19 and paragraphs 340, 354) in communication with the lighting nodes and adapted to automatically associate at least one lighting node with the at least one group of interrelated coordinates on the basis of the geographical location of said at least one lighting node.

The scope of protection of claim 1 is very broad, it includes a variety of lighting systems with lights in a network and having means for determining the location each light. This general idea is well known in the field of lighting networks, as is further illustrated by documents D2 and D3.

3.2 Claim 15

Independent method claim 15 corresponds to the teaching of claim 1. Consequently claim 15 lacks novelty, for the same reasons as claim 1.

3.3 Dependent claims 2,4-12,17-20

Dependent claim 2,4-12,17-20 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty.

Claim 2: the additional features are known from doc. D1, see for example paragraph 134.

Claims 4, 6: the additional features are known from doc. D1, see for example paragraphs 138-139.

Claim 5: the additional features are known from doc. D1, see for example paragraphs 532-537 and figure 52.

Claim 7: the additional features are known from doc. D1, see for example paragraphs 240-243 and 138-139.

Claim 8: the additional features are known from doc. D1, see for example paragraphs 240-243, 340 and fig. 23-24.

Claims 9, 10, 18, 20: the additional features are known from doc. D1, see for example paragraphs 340 and 354.

Claim 11: the additional features are known from doc. D1, see for example paragraphs 249-251.

Claim 12: the additional features are known from doc. D1, see for example paragraphs 340, 354-358 and 532-537.

Claim 17: the additional features are known from doc. D1, see for example paragraphs 340-358.

Claim 19: the additional features are known from doc. D1, see for example paragraphs 233-250 and fig. 23,24.

4 Inventive step

The present application does not meet the criteria of patentability, because the subject-matter of claims 3,13,14,16,21 does not involve an inventive step.

Claims 3, 16: the additional features are suggested in document D1, see for example paragraphs 138-139, 532-537. Furthermore, to automatically determine the separation between two nodes, which both have known coordinates, is just standard routine for a programmer of ordinary skill in the art.

Claim 13: to automatically determine intersections of paths in a coordinate system, and to determine which (lighting) nodes are in proximity, where all nodes have known coordinates, is just standard routine for an engineer of ordinary skill in the art.

Claims 14 and 21: firstly these claims are not clear, because "interrelated coordinates" does not have a clear technical meaning and secondly "geographical data" is not technically precise, as it could be any of the following: sets of coordinates, photographs, drawings, printed maps. If we assume that "interrelated coordinates" represent a path, road or intersection on a map, and that "geographical data" represents aerial photographs, then the automatic process of claim 1 is merely well known image processing.

Re Item VI

Certain documents cited

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
PCT/ US2013/021957	25/07/2013	17/01/2013	19/01/2012

The above document D3 could be considered as being part of the prior art for some states, because its priority date is prior to the filing date of the present application.