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 LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,  
 SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
 GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

## (54) Title: MULTI-POINT SYNCHRONIZABLE AND SCALABLE LIGHTING CONTROL SYSTEMS

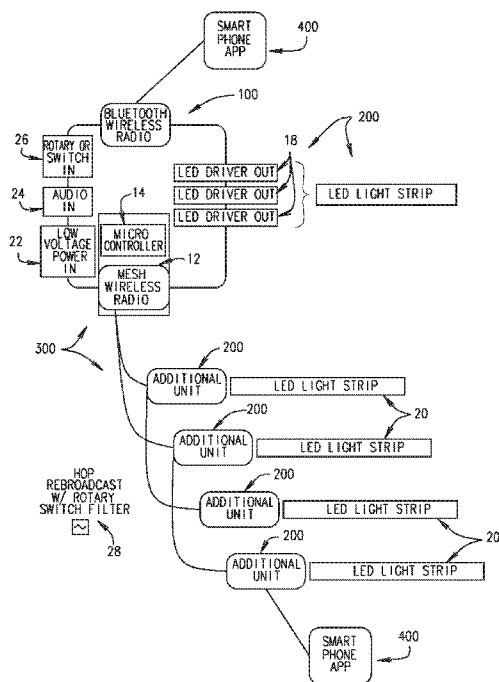


FIG. 2

(57) Abstract: A system, particularly adaptable for lighting and music presentations, such as for mood, ambience, or party settings includes a flat, wireless broadcast multi-point, synchronizable and scalable operation. The system includes a control system having an electronic circuit which includes a wireless mesh radio, a microcontroller, a wireless short-range radio link unit, a plurality of field-effect transistor (FET) drivers to connect to one or more individual light or sound producing devices or sets thereof, a low voltage DC power supply, an audio input rectifier and filter, and a rotary switch. The system is set up such that a plurality of these control systems are interconnected in a non-hierarchical mesh network, wherein the mesh wireless radio of a given control system has the capacity to signal nearby control systems, one or more control systems have a rotary switch filter configured to permit hop signal rebroadcasting, and a plurality of light or sound producing devices are functionally connected to the plurality of FET drivers of control systems interconnected in the mesh network.



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MULTI-POINT SYNCHRONIZABLE  
AND SCALABLE LIGHTING CONTROL SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

- 5 [0001] This application claims the benefit of U.S. provisional application No. 62/272,567, filed on December 29, 2015. The above application is incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
10 DEVELOPMENT

- [0002] Not applicable.

BACKGROUND OF THE INVENTION

- 15 [0003] The subject matter described herein relates generally to light and sound control systems, and more particularly, to a multi-point, synchronizable and scalable system not dependent on the internet, a gateway hub, or master coordinator for operation.

- [0004] Light and sound systems, such as those conventionally available, require the use of multiple switches or additional wiring to control multiple  
20 lights and/or sound units. This requires installation of more wiring, professional installation (at added cost) services, and compliance with building codes. Such conventional systems also suffer from such systemic limitations as a reduced area of coverage between switch controlling lights in any given area.

- 25 [0005] Even smart, wireless lighting and/or sound systems which are currently available require the use of a coordinator hub device, such as a WiFi hub. This involves setup and use constraints and complications. For example, as to setup, use of a WiFi hub or other coordinator hub device still typically requires professional installation or an advanced technical  
30 knowledge by the system user to set up the hub and pair it to other system devices intended to be under the hub's control. Moreover, conventional

-2-

smart lighting and sound systems only allow the user to control a single device or area at a time, e.g., to turn on or off the front lighting.

[0006] Safety and environmental issues are also involved with the use of conventional systems. As to safety, conventional lighting/sound, as well  
5 as conventional smart lighting/sound systems operate at high voltages, and are thus inherently less safe. Similarly, such systems are not waterproof, precluding their use outdoors when inclement weather is a risk (and precluding permanent or semi-permanent outdoor installation).

[0007] Thus, a need exists for a new generation of lighting and/or sound  
10 systems which address these concerns and provide wireless, multi-point, synchronizable and scalable control to their users.

#### BRIEF SUMMARY OF THE INVENTION

[0008] Accordingly, a flat, wireless, broadcast, multi-point,  
15 synchronizable and scalable lighting/sound control system is provided which allows the user quick and easy setup and use. This easy-to-use system also addresses the aforementioned safety and environmental issues, such as avoidance of high voltage and water hazard concerns. The system uses a hop topology with a synchronizable mesh wireless network  
20 which allows for seamless synchronization, on/off control of system lighting components, and pinpoint user control to separate or segregate the manner of use of distinct lights or lighting units.

[0009] Thus, for example, each individual light or light station or strip can be set to use a music audio signal input, run a predefined light show,  
25 operate as a group, or only operate as a specific group channel ignoring all (or certain) commands. A user can control a specific area, synchronize all lights to party music, or change the mood lighting color of an entire room or several rooms to a specific color, all while the system operates using low-voltage direct current (DC) and requires no professional installation and  
30 minimal user expertise. Further, by using rotary switch channel segregation, the system provides for music to light coordination not offered

-3-

by conventional systems. The system may be operated with a mobile application (app) such as may be operated using a smart phone, e.g., to automatically find and operate the control system for immediate use. For example, the system may use a wireless, short-range radio link unit (such as a smart Bluetooth™ Low Energy 4.0+, Bluetooth Sig, Inc., hereinafter “Bluetooth”), in which the application software scans for the system devices and connects automatically to the closest device that it finds within a defined time window.

[0010] Thus, the control system as disclosed herein includes an electronic circuit having a wireless mesh radio, a microcontroller, a wireless short-range radio link unit (e.g., Bluetooth), a plurality of field-effect transistor (FET) drivers to connect to LED lights or light strips, a DC (e.g., buck regulator) power supply, an audio input rectifier and filter, and a rotary or other switch.

[0011] In another aspect, the invention provides a light and/or sound system which includes a plurality of control systems preferably such as those described above, wherein the light and/or sound system is configured so that the plurality of control systems are interconnected in a non-hierarchical mesh network, wherein the mesh wireless radio of a given unit has the capacity to signal nearby units, one or more units have a rotary switch filter configured to permit hop signal rebroadcasting, and a plurality of light or sound-producing devices (e.g., light-emitting diodes) are functionally connected to the plurality of FET drivers.

[0012] In yet a further aspect, the light and sound system includes a smart phone application or music signaling unit which is configured to provide for variation of system performance parameters, such as synchronization of color and light intensity within area zones within the system's coverage.

[0013] The invention also includes a microcontroller software platform including an embedded microcontroller firmware configured to implement flat, wireless, multi-point broadcast hopping communication schemes

-4-

including device property filtration and device property synchronization. The device types coordinated by the software platform include ones having common properties with the capacity to be modified individually or wirelessly synchronized.

5

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The presently disclosed subject matter will be better understood from reading the following description of non-limiting embodiments, with reference to the attached drawings, wherein below:

10 [0015] Figure 1 is a schematic depiction of an exemplary embodiment of the control system of the invention.

[0016] Figure 2 is a schematic of an exemplary embodiment of the invention wherein a synchronizable and scalable lighting system is shown, including the control system exemplified in Figure 1.

15

#### DETAILED DESCRIPTION OF THE INVENTION

[0017] The foregoing summary, as well as the following detailed description of certain embodiments will be better understood when read in conjunction with the appended drawings. As used herein, an element or  
20 step recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding the plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" or "an embodiment" are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the  
25 recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising" or "having" an element or a plurality of elements having a particular property may include additional such elements not having that property.

[0018] Various embodiments as described and shown herein, therefore,  
30 provide a flat, wireless broadcast multi-point synchronizable and scalable lighting/sound control system, software platform, and a lighting/sound

system which permits quick and easy setup and use. They address safety and environmental issues by permitting low-voltage DC power usage, and simultaneous avoidance of water hazard concerns at such low voltages. In certain embodiments, the system is configured to run on a standard  
5 automotive or marine grade battery. For example, a 12 VDC (24W) wall wart power supply may be utilized to operate a 16 foot 300 foot LED light strip. In another embodiment, the described system can be used to run, e.g., 48 feet of LED lights with a single controller at 66W potential power output at 12 VDC.

10 [0019] Using the teachings of the instant invention, one skilled in the art can devise alternative embodiments benefitting from low VDC operation providing for safe and waterproof systems which provide the array of lighting and sound system benefits as disclosed herein. As such, various embodiments of the system are provided which are low power, portable,  
15 and with light spread across a long or large area. From a safety standpoint, the system may be operated on standard batteries or portable UPS power and can light walk ways or stairs easily, such as on a boat, house, or building, and can be backed up with a very low power low voltage backup, exterior lighting system, or solar panel, for example.

20 [0020] In alternative embodiments, the system of the invention can be adapted to work with a 120 VAC, e.g., or, with the more common 24 VAC in use for many outdoor lighting systems, utilizing a package including a converter box to go from 24 VAC to, e.g., 12 VDC power, as is sufficient for the instant system.

25 [0021] The system's flat, wireless, multi-point mesh broadcasting capacity and rotary or other switches allow for a device "hopping" topology and for seamless segregation and/or synchronization of light and sound to provide an ideal party or mood atmosphere. The system permits the "on/off" master control, via, e.g., a smart phone app, of system lighting and  
30 individual components, as well as permitting the user control to separate the manner of use of distinct lights or lighting units.

[0022] Accordingly, individual lights or integrated light stations within an area can be set to use a particular music audio signal's input. Similarly, they can be set up to run a predefined light show. They may be programmed to operate as a group, operate dynamically, or only operate  
5 as a specific group channel, ignoring all (or certain) commands. Thus, e.g., a user can use the rotary switches attached to particular configured devices to provide station to station control of a specific area, synchronize all lights to party music, or change the mood lighting color or intensity of an entire room or multiple rooms or venues. The system can also be set up to  
10 operate seamlessly in moving vehicles such as cars or boats or large outdoor venues, such as for an outdoor concert. The system is operated easily by a consumer – no complicated connectors or hubs to synchronize or pair up, and in a safer, energy efficient manner, due to its ability to make use of a low-voltage direct current (DC) power source. Set up is also  
15 greatly improved due to the simplicity of the system.

[0023] By using rotary switch channel connection and segregation, the system provides for a seamless music to light coordination not offered by conventional systems. The system may be operated with a mobile software application (app) such as may be operated using a smart phone, e.g., to  
20 automatically find and operate the lighting/sound control system for immediate use.

[0024] The zone or group can be a software variable switch that can, e.g., be set and stored using, in one embodiment, a regular momentary switch unit rather than a hardware-based rotary switch position. This  
25 regular push button switch can physically replace the rotary switch, and include software programmed with the capacity to track the counts/state, and “remember” the after power cycle.

[0025] Referring to the drawings, in one embodiment of the invention, the control system 100 for a lighting and/or sound unit system 200 may be  
30 seen in Fig. 1 and as a component of the lighting and/or sound system 200 in Fig. 2. The control system as disclosed herein comprises an electronic



-7-

circuit, such as a printed circuit board having a wireless mesh radio 12, a microcontroller 14, a wireless short-range radio link unit (e.g., Bluetooth™) 16, a plurality of field-effect transistor (FET) drivers 18 to connect to LED lights or light strips 20, a power supply (e.g., a buck regulator) 22, which  
5 feeds low voltage direct current (DC) power, an audio input rectifier and filter 24, and a rotary or other switch 26.

[0026] As depicted, the control system 100, an embodiment of which is depicted in Fig. 1, operates a light and/or sound system 300 (see embodiment schematically depicted in Fig. 2) which includes a plurality of  
10 light or sound units 200 (here depicted as LED light strips) having the control systems 100 as described above. In this embodiment, the light and sound system 300 is configured so that the plurality of units 200 with the inventive control system 100 are interconnected in a non-hierarchical mesh network, wherein the mesh wireless radio 12 of a given unit 200 has the  
15 capacity to send radio signals to nearby units, and one or more, or even, all, units 200 have a rotary switch filter 28 configured to, e.g., permit hop signal rebroadcasting. The units 200, in this embodiment, include a plurality of LED light strips 20 which are functionally connected to the plurality of FET drivers 18. The system's range is essentially unlimited,  
20 since the number of "hops" that a system can utilize is simply a software variable. In one embodiment, a device unit may have a 400 foot range, and the system is defaulted to 1200 feet, which utilizes 3 device hops to cover the system's area of operation.

[0027] In many preferred applications, such as the embodiment depicted in Fig. 2, the light and sound system 300 can be managed by one  
25 or more smart phone apps 400 or other music signaling units, e.g., such as where it is configured to provide for area synchronization of color and light intensity within the system.

[0028] The invention also includes a microcontroller 14 software  
30 platform including an embedded microcontroller firmware program configured to implement flat, wireless, multi-point broadcast hopping

communication schemes including device property filtration and device property synchronization.

[0029] The microcontroller provides support for hopping and, e.g., 2.4 GHz FCC functions. Hardware/software components for a gateway, hub or  
5 coordinator unit are not required, and hence a simple, inexpensive mesh network is provided where the network device components readily communicate one to the other. Thus, additionally, unique device IDs are optional at the stack level, and pairing of devices is not required, as the network is a flat one. However, despite the simplicity of the microcontroller  
10 platform, the system can provide, in certain embodiments, for a hardware abstraction layer and callback function capability. Moreover, in additional embodiments, “transmit retry” functionality is built in to make the system more reliable.

[0030] As an illustration of use of a particular embodiment, the user  
15 simply executes a button, switch or other signaling mechanism dedicated to “turn lights on”, and if the device in question has a “light” property, it turns on. Similarly, the user may provide the signal or command for “turn lights to X color”, and if the device in question is capable of color activation, it goes to the X color. Coordinated lighting schemes are readily produced,  
20 e.g., RGB hex formats, blended whites, and synchronized dimming are lighting techniques known to those skilled in this art.

[0031] The device types coordinated by the software platform include ones having common properties with the capacity to be modified individually or wirelessly synchronized. The system software can act as a  
25 bridge from Bluetooth™, e.g., to the mesh network. In particular embodiments, a rotary switch is used to determine the “receive state” of the local device. However, in such embodiments of the invention, the device can be configured to pass messages out onto the mesh from an App over Bluetooth™ regardless of its rotary receive mode setting. For example, a  
30 user can be sitting on his back deck (with back deck lights set on a “channel 2” rotary), yet he may want to turn on the porch lights (in this

example, on rotary channel 3). He is, in this embodiment, despite the difference in channels, connected to the porch lights as follows: he is connected to the unit on the back porch over Bluetooth™, because he is on the back deck. The deck unit takes the "message" and sends it along; it  
5 hops around on the mesh until it gets to the porch unit (on channel 3). Thus, the steps of traversing a traditional hierarchical mesh to a gateway (or even to the cloud, via Internet) to decide what type of device it is, what it is paired to, and then having the signal message redirected to the porch unit, are all avoided. Accordingly, in these embodiments of the invention,  
10 this circuitous routing with its many chances for a wireless "handshake" message to fail, are precluded, making the system more reliable, simpler, faster, and less expensive.

[0032] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described  
15 embodiments and aspects thereof may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the various embodiments of the invention without departing from their scope. While the dimensions and types of materials described herein are intended to define the parameters  
20 of the various embodiments of the invention, the embodiments are by no means limiting and are exemplary embodiments. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the various embodiments of the invention should, therefore, be determined with reference to the appended claims,  
25 along with the full scope of equivalents to which such claims are entitled. Include if relevant: In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein."

[0033] This written description uses examples to disclose various  
30 embodiments of the invention, and to enable any person skilled in the art to practice the various embodiments of the invention, including making and

-10-

using any devices or systems and performing any incorporated methods. The patentable scope of the various embodiments of the invention may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if the examples

5 have structural elements that do not differ from the literal language of the claims, or if the examples include equivalent structural elements with insubstantial differences from the literal languages of the claims.

CLAIMS

1. A control system comprising an electronic circuit having a wireless mesh radio, a microcontroller, a wireless short-range radio link unit, a plurality of field-effect transistor drivers to connect to one or more  
5 individual light or sound producing devices or sets of said devices, a low voltage power supply, an audio input rectifier and filter, and a rotary or other switch.

2. The control system of claim 1 wherein the rotary or other switch is a rotary switch.

10 3. The control system of claim 1 wherein the rotary or other switch is a push button switch.

4. A light or sound system comprising a plurality of control systems, wherein the light or sound system is configured so that the plurality of control systems are interconnected in a non-hierarchical mesh  
15 network, wherein the mesh wireless radio of a given control system has the capacity to signal nearby control systems, one or more control systems have a switch filter configured to permit hop signal rebroadcasting, and a plurality of light or sound producing devices are functionally connected to a plurality of field-effect transistor drivers of control systems interconnected in  
20 the mesh network.

5. A light or sound system as set forth in claim 4 wherein one or more of said plurality of control systems comprises an electronic circuit having a wireless mesh radio, a microcontroller, a wireless short-range radio link unit, a plurality of field-effect transistor drivers to connect to one or more  
25 individual light or sound producing devices or sets of said devices, a low voltage power supply, an audio input rectifier and filter, and a rotary or other switch.

6. A light or sound system as set forth in claim 5 wherein all of said plurality of control systems comprises an electronic circuit having a wireless  
30 mesh radio, a microcontroller, a wireless short-range radio link unit, a plurality of field-effect transistor drivers to connect to one or more individual light or

-12-

sound producing devices or sets of said devices, a low voltage power supply, an audio input rectifier and filter, and a rotary or other switch.

7. A light or sound system as set forth in claim 5 further comprising a smart phone having a software application or other music signaling unit  
5 which is configured to provide for area synchronization of color and light intensity within the system by wirelessly functionally connecting to one or more of the wireless short-range radio link units.

8. A microcontroller software platform comprising an embedded microcontroller firmware configured to implement flat, wireless, multi-point  
10 broadcast hopping communication schemes, the schemes comprising device property filtration or device property synchronization of device types having the capacity to be coordinated by the software platform, modified individually or wirelessly synchronized.

1/2

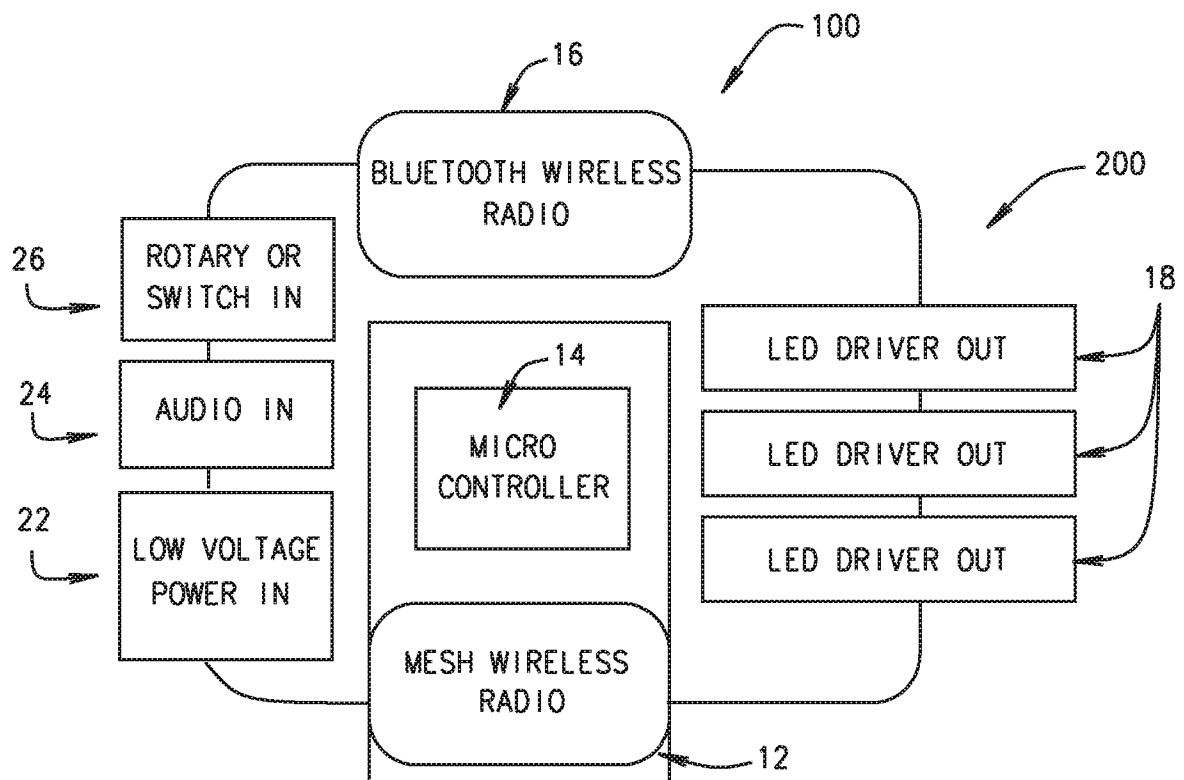


FIG. 1

2/2

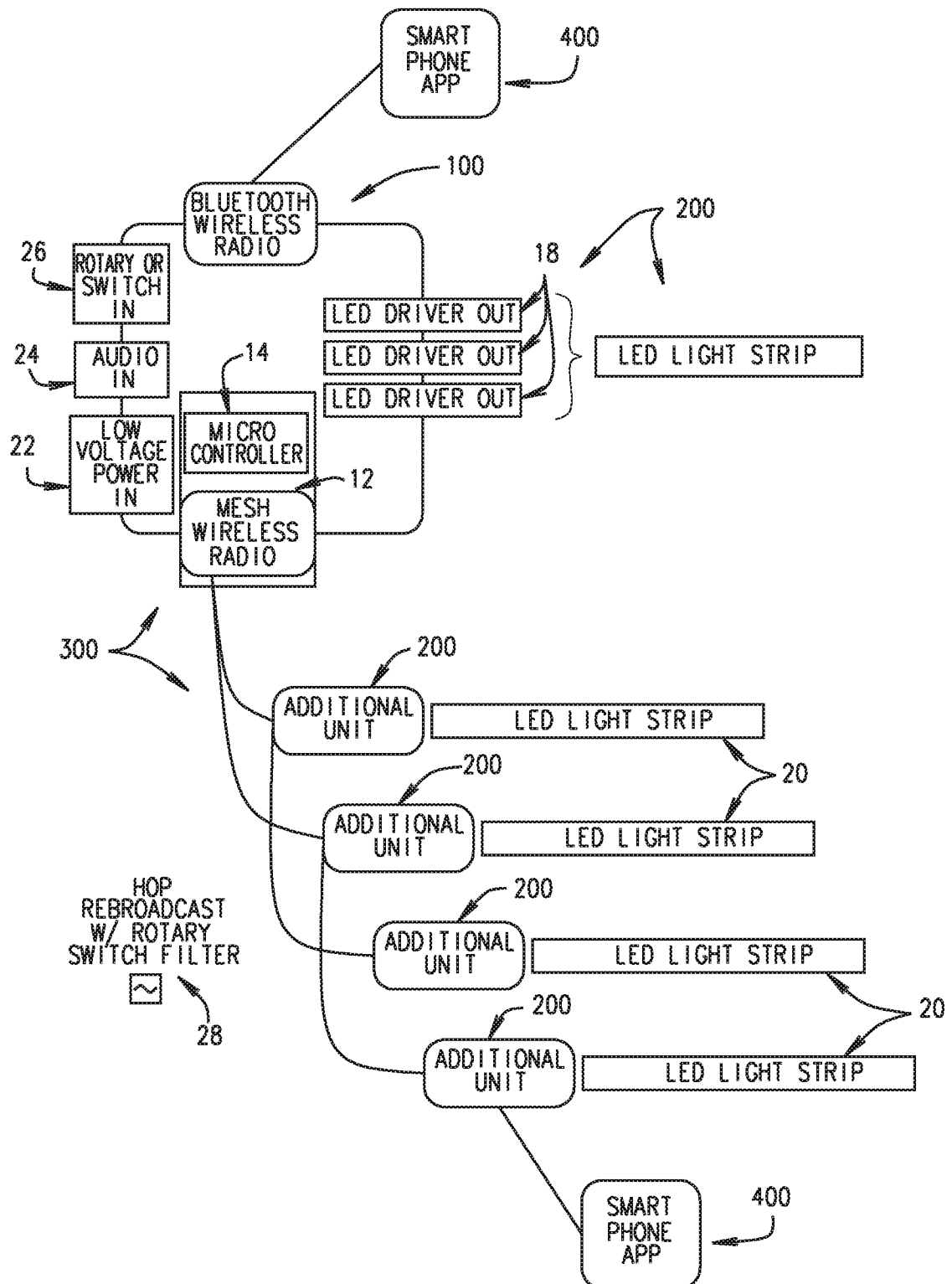


FIG. 2



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/68911

## A. CLASSIFICATION OF SUBJECT MATTER

IPC - H04W 84/18, 4/00; G08C 17/02; H04L 12/28; H05B 37/02; G05B 15/02 (2017.01)

CPC - H04W 84/18, 4/008; G08C 17/02; H04L 67/125, 12/2816; H05B 37/02; G05B 15/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/168931 A1 (JIN, K) June 18, 2015; figures 1, 4, 6c, paragraphs [0037], [0040], [0053], [0054], [0058], [0068], [0071], [0072], [0080], [0085]	4
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Y		---
---		7
A		
Y	US 2013/0169186 A1 (STEINER, J et al.) July 4, 2013; figures 5, 23, paragraphs [0070], [0074], [0083], [0087], [0136]	1-3
Y	US 2007/0208841 A1 (BARONE, G et al.) September 6, 2007; figure 7, paragraphs [0086], [0113], [0117], [0118], [0167], [0171], [0263], [0281]	1-3, 5, & 6
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A		7
Y	US 2012/0218101 A1 (FORD, T) August 30, 2012; figures 1, 2, paragraphs [0027], [0028]	2
Y	US 2009/0278479 A1 (PLATNER, B et al.) November 12, 2009; figure 8, paragraph [0055]	3
A	US 2015/102731 A1 (SEASONAL SPECIALTIES, LLC) April 16, 2015; figures 1, 8, paragraphs [0179], [0194], [0195]	7

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

11 April 2017 (11.04.2017)

Date of mailing of the international search report

08 MAY 2017

Name and mailing address of the ISA/

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PCT OSP: 571-272-7774

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/68911

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:  
see extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:  
1-7
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

---Continued from Box III: Observations where unity of invention is lacking---

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-3 appear to be directed towards a control system.

Group II: Claims 4-7 appear to be directed towards a light or sound system.

Group III: Claim 8 appears to be directed towards a microcontroller software platform.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features.

The special technical features of Group I include at least an electronic circuit, a microcontroller, a low voltage power supply, an audio input rectifier and filter, and a rotary or other switch, which are not present in Groups II and III.

The special technical features of Group II include at least wherein the light or sound system is configured so that the plurality of control systems are interconnected in a non-hierarchical mesh network and a switch filter configured to permit hop signal rebroadcasting which are not present in Groups I and III.

The special technical features of Group III include at least a microcontroller software platform comprising an embedded microcontroller firmware configured to implement flat, wireless, multi-point broadcast hopping communication schemes, the schemes comprising device property filtration or device property synchronization of device types having the capacity to be coordinated by the software platform, modified individually or wirelessly synchronized, which are not present in Groups I and II.

The common technical features shared by Groups I-III are a light or sound system comprising a control system, wherein the mesh wireless radio of a given control system has the capacity to signal nearby control systems, a plurality of light or sound producing devices are functionally connected to a plurality of field-effect transistor drivers of the control system; and a microcontroller.

However, these common features are previously disclosed by US 2015/0168931 A1 (JIN). Jin discloses a light or sound system comprising a control system (lighting lamps 160-162 (light system) comprising switch devices 100-108 each with a control module 120 (a control system); figure 1, paragraphs [0037], [0040], [0054]), wherein the mesh wireless radio of a given control system has the capacity to signal nearby control systems (a Bluetooth module 150 (wireless radio) operating on a mesh switch network and so having the capacity to signal nearby adjacent (nearby) Bluetooth modules 150 in switch devices 100-108; paragraphs [0054], [0058], [0080]), and a plurality of light or sound producing devices are functionally connected to a plurality of field-effect transistor drivers of the control system (lighting lamps 160-162 may be functionally connected to MOSFETs 133 of switch devices 100-108 to drive the lighting lamps 160-162; figure 1, paragraph [0040], [0058]); and a microcontroller (control module 120; paragraph [0042]).

Since these common features are previously disclosed by Jin, they are not special and so Groups I-III lack unity.