

Title: An intelligent wireless lighting control system using IEEE802.15.4 and local area network or wifi (IEEE802.11) technology

Description:

The present invention relates to a control system and method thereof, and more particularly relates to a wireless light control system with control modules and method thereof for controlling light fixtures such as lighting on and off status, lighting on and off duration, and brightness of the lighting apparatus.

Brief description of drawing

Figure 1 is an electrical block diagram of an exemplary embodiment of the invention with internet access. It consists of:

- dimmer modules(1) with IEEE802.15.4 wireless connectivity (11)
- relay modules (2) with IEEE802.15.4 wireless connectivity (11)
- normal wall mounted light switches (3)
- gateway (4) which is also the coordinator of the IEEE802.15.4 wireless network (11) with Ethernet or wifi connectivity (13)
- dimmable light fixtures (5)
- non dimmable light fixtures (6)
- internet router (7) with Ethernet and wifi connectivity (13)
- mobile phone (8) with wifi (13) and mobile data connection (14)
- remote control (9) with IEEE802.15.4 wireless connectivity (11)
- wall or ceiling motion detector (10) with IEEE802.15.4 wireless connectivity (11)
- wall or ceiling mounted presence detector (12) with IEEE802.15.4 wireless connectivity (11)
- wall or ceiling mounted temperature and humidity sensor (15) with IEEE802.15.4 wireless connectivity (11)
- wall or ceiling mounted gas sensor (16) with IEEE802.15.4 wireless connectivity (11). The gas sensor can be a smoke or carbon monoxide or carbon dioxide sensor

Detailed description of the system

The dimmer modules 1 and relay modules 2 are normally sited above the ceiling board. The dimmer modules are connected to light fixture 5 which are dimmable light sources and the relay modules are connected to light fixture 6 which are non dimmable light sources. The mains connected light switches (3) are normally mounted on the walls of Room1, Room 2, Room 3, Room 4. In one corner of the building where the internet router (7) is residing, a coordinator (4) is connected to the router via a RJ-47 cable or wifi module. The coordinator is the controlling node of the IEEE 802.15.4 compliant wireless personal area network (WPAN) (11). The modules (1, 2, 4, 9, 10, 12, 15, 16) are controlled by a microcontroller with 2.4 Ghz IEEE 802.15.4 transceiver. Communication between all the modules are through software commands sent and received by the microcontrollers residing in each module, via WPAN (11). The software in the modules are programmed to control the light fixtures in the house.

The following is a more detailed description of the modules and the software system running on the modules:

1. Gateway module (4) : The gateway is also the coordinator module (4). It is controlled by software running on the microcontroller in the module. Its primary function is to start the wireless personal network (11) (WPAN) as a coordinator with its unique ID called the network ID. The network (11) is IEEE802.15.4 compliant. Once the network is started, other modules which can be dimmer, relay, remote control module or sensor modules on the network with the same network ID will be able to join the network by sending requests to the coordinator. A feature is incorporated in the coordinator which will allow new modules not having any network ID to join the network. The feature is implemented by sending the MAC ID of new modules to the end user via mobile app or via a webpage. The end user will then decide whether to admit the modules to the network. If the module is admitted, the MAC ID of the modules will be saved in the non volatile memory of the coordinator. The coordinator will also generate a unique ID which will be its network key. The network key is generated using the MAC ID of the coordinator and the time at which the first node is accepted as a member of the network. This will introduce an element of randomness to the network key. The network key will be stored in the non volatile memory of the coordinator and in the non volatile memory of all the modules in the network. Whenever there is a reset of the modules or coordinator that result in the modules rejoining the WPAN, a criteria for admitting the modules is to check whether it has the same network key as the coordinator. Once the modules are checked to have the same network key, they will join the WPAN network and be marked as online. Modules with existing network ID which are dissimilar to the coordinator network ID will not be allowed to join the WPAN. In this way, we can have a few WPANs operating on the same channel frequency because they have different network key and will not interfere each other's operations.

The coordinator will periodically collect data of the other modules on the network. This is to enable it to have an updated information of all the modules on the network. If the coordinator is connected to a wifi router (7), it will provide updated information of the wireless network when there are requests from remote units (8) which can be a mobile phone or tablet pc or pc. The coordinator will send data on the state of all the modules on the network to the remote unit 8, including the modules which are active (i.e. functioning and controllable) or inactive (i.e. it is not functioning or controllable). It will also check that the remote unit 8 is still connected to it, by checking that the remote unit polls a request to it at an appropriate interval. If there are no polling requests, the gateway will also terminate the connection to the remote unit 8. This is to prevent unnecessary resources spent on updating inactive remote unit. The gateway module is powered by an external DC power supply.

2. Dimmer module (1): The dimmer module (1) is controlled by software running on the microcontroller in the module. It is a router node which means it is able to relay messages from its parent node to its child nodes. Its primary function to provide dimming ability to the dimmable light fixture 5 base on the commands it receive from the remote control modules (9) or the gateway (4) via the wireless network (11). When the module is powered up, it will try to join the network with the same network ID. Once it has joined the network, it will also periodically report its status to the gateway. This is to enable the gateway to be aware that the module is still active. If it cannot find any network, it will scan all the network channels to see if there are any network it can join. This exercise will go on indefinitely. The dimmer module is powered by the live and neutral of the mains cable.
3. Relay module (2): The relay module (2) is controlled by software running on the microcontroller in the module. It provides relay switching of mains power to the light fixture which can be dimmable or non dimmable. Non dimmable light fixture (6) can only use this module to switch the lights on or off. The relay module (2) receives its commands to switch the lights from the gateway (4) and the remote control modules (9). When the module is powered up, it will try to join the network with the same network ID. Once it has joined the network, it will also periodically report its status to the gateway. This is to enable the gateway to be aware that the module is still active. Like the dimmer module (3), if the relay module

were to lose connection to the coordinator, it will automatically scan all the network channels to see if it can rejoin the network with the same network ID. This exercise will go on indefinitely. The relay module is also a router. It act as a message repeater, i.e. it will relay any message to and fro any modules. The relay module is powered by the live and neutral of the mains cable.

4. Wall mounted mains light switches (3): The mains light switches is used for providing electrical isolation of the mains supply to the dimmer or relay modules or mains powered sensor modules. It is not part of the WPAN.
5. Remote control module (9): The remote control module (9) is controlled by software running on the microcontroller in the module. When the module is powered up, it will try to join the network with the same network ID. Once it has joined the network, it will also periodically report its status to the gateway. This is to enable the gateway to be aware that the module is still active. It is set to sleep mode when not in use. As such it consumes very little power. The remote control module (9) is an end device. This means that it can only respond to its parent module in the network and cannot relay messages to other modules. It is powered by battery. There are 4 to 10 buttons on the remote control allowing it to control different zones in the WPAN network. The function of the buttons are programmable via mobile app or webpages. It can be configured as a ON button, OFF button or TOGGLE button, meaning that alternate press will switch the lights on or off. The brightness setting associated with the button, allow it to switch the dimmable lights on at the preset brightness level. The zones can be individual lights or different groups of lights. Groups of lights can be all the lights on the WPAN network, different rooms of lightS or different groups of lights in one room. One button can be assigned to one group only or numerous individual lights in different groups. If the button is set to ON only, pressing it once or repeatedly will switch the lights to on. If the button is set to OFF only, pressing it once or repeatedly will set the lights to off. If the button is set to TOGGLE, then if the lights are off or if some lights associated with the button are on, pressing it once will switch all the lights to on. If all the lights on, then pressing it again will switch all the lights associated with the button to off.
6. Motion detector sensor module (10) : The motion detector sensor module (10) is controlled by software running on the microcontroller in the module. It provides detection of infra red movement. When motion is detected, the resulting switching actions can be programmed using mobile app or web pages. Switching commands will be sent to groups of nodes to switch the lights to ON or OFF, and to the coordinator to update the information to web server or mobile app connected to it. Brightness preset can also be programmed on the mobile app or web pages such that the lights can be switched on at a defined brightness level. The motion detection sensor module can be programmed as a router module or end device module. If it is a router module, it has parent and child nodes. If it is a end device module, it only has parent node and no child node. When it is an end device, it will sleep at regular intervals.
7. Presence detector sensor module (12) : The presence detector sensor module has a MEMS thermal sensor on it. The thermal sensor will detect human presence, not by motion of infra red but by infra red heat emitted. The infra red temperature detected will be used to decide whether there is human presence or not. The switching function of the presence detector sensor module is the same as the motion detector sensor module. It is programmable via mobile app or web pages. A group of light nodes can be switched to ON/OFF at defined brightness settings using the mobile app or web pages. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals.

8. Temperature and humidity sensor module (15) : The temperature and humidity sensor is used for providing information to the coordinator about the temperature and humidity of the area it is located. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals. This information can then be used to control the air conditioner or heater using another software system.
9. Gas sensor (16) : The gas sensor can be a smoke, carbon dioxide (CO₂) or carbon monoxide (CO) sensor module. It provides information to the coordinator of the smoke / CO₂ /CO level of the location where the module is sited. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals. The information can be used to provide smoke alarm or smoke alerts via mobile phone for smoke sensor, or ventilation fan control for CO₂/CO sensor.
10. Remote unit 8: The remote unit 8 can be the mobile phone or tablet pc or personal computer. The remote unit communicates with the coordinator via the mobile network (13) or wifi (14). The application running on the remote unit is a mobile application software when it is a mobile phone or tablet pc. When it is a personal computer, the application running on it is a web application software. The software contains a method to connect to the coordinator (4). Upon a successful connection, the coordinator will send messages to the remote unit to report the status of every module on the WPAN. The remote unit can configure the remote controls (9), motion detector sensors (10) and presence detector sensor (12) to control the dimmers and relay modules. The remote unit also has to poll the coordinator regularly while it is still connected to the gateway. Failure to do so will cause the connection to be broken on the coordinator side. In order to conserve resource on the coordinator and the battery power of the remote unit, should there be no activity for a certain duration on the remote unit, the connection will also be broken on the remote unit side.

As with all RF channels on the WPAN, provisions are made for multiple channels in the RF transceiver so as to provide as many uses of the same network with as little noise interference as possible. Channels can be changed at the coordinator node using the mobile app or web pages. When channel changes take place at the coordinator and if the router and end device nodes has lost connection to the network, they will automatically reset and do a scan of the channels until a channel with its network key is found.

Claims:

1. A wireless light control system comprising at least a gateway and any or all of the following modules: dimmer module, relay module, remote control module, motion detector sensor module, presence detector sensor module, temperature and humidity sensor module, gas (smoke or carbon monoxide or carbon dioxide) sensor module, and application software running on remote units like mobile phone or tablet pc or desktop pc, for configuring and controlling the entire system. All the electronics modules has a microcontroller with a rf transceiver which allows it to connect wirelessly to a IEEE802.15.4 compliant wireless network (WPAN). Information is sent amongst all the nodes using this WPAN network.
2. The system in claim 1 can be configured such that neighboring similar systems cannot control or join the system unless they have the same network ID. The network ID is created using combination of the coordinator MACID and the time the first non coordinator node becomes a member of the network. The gateway will first start the WPAN. Other modules which are powered up will then try to join the WPAN network if their network ID is the same. New modules which are not gateway modules and has no network ID, can join the network if approval is given via the mobile or pc application software.
3. The gateway in claim 1 is the coordinator of the WPAN system. It monitors the entire WPAN network and is the interface between remote units like mobile phone, tablet pc and external pc or server.
4. The dimmer module in claim 1 is used for controlling the brightness of dimmable light fixtures using triac phase control to vary the amount of voltage and power to the light. The phase control is
5. The relay module in claim 1 is used for switching mains power to the non dimmable light fixtures using a relay or other electronics switching method.
6. The remote control module in claim 1 is programmable by the mobile application or pc application software. It can be used to switch the lights on or off and the dimmable lights can be switched on at user defined brightness.
7. The motion detector sensor module in claim 1 is used to send switching information to the dimmer and relay modules and the gateway when motion is detected.
8. The presence detector sensor module in claim 1 is used to send switching information to the dimmer and relay modules and the gateway when human presence is detected.
9. The temperature and humidity sensor module in claim 1 is used to provide the temperature and humidity of the area it is located. It sends its information regularly to the gateway.
10. The gas sensor module in claim 1 is used to collect information of the smoke/carbon monoxide/carbon dioxide of the the environment it is located in. It sends its information regularly to the gateway

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Brief description of drawing

Figure 1 is an electrical block diagram of an exemplary embodiment of the invention with internet access. It consists of:

- dimmer modules 1 with IEEE802.15.4 wireless connectivity 11
- relay modules 2 with IEEE802.15.4 wireless connectivity 11
- normal wall mounted light switches 3
- gateway 4 which is also the coordinator of the IEEE802.15.4 wireless network 11 with wifi connectivity 13. Wifi connectivity is provided by an onboard wifi module at the gateway which is a SOC system on chip semiconductor with integrated TCP/IP stack. It is controlled by the coordinator via the serial bus. There is only one coordinator in the same IEEE802.15.4 wireless network 11
- dimmable light fixtures 5
- non dimmable light fixtures 6
- internet router 7 with wifi connectivity 13
- remote unit 8 eg mobile phone or tablet PC with wifi 13 and mobile data connection 14 or remote desktop PC with internet connectivity
- remote control 9 with IEEE802.15.4 wireless connectivity 11
- wall or ceiling motion detector 10 with IEEE802.15.4 wireless connectivity 11
- wall or ceiling mounted presence detector 12 with IEEE802.15.4 wireless connectivity 11
- wall or ceiling mounted temperature and humidity sensor 15 with IEEE802.15.4 wireless connectivity 11
- wall or ceiling mounted gas sensor 16 with IEEE802.15.4 wireless connectivity 11. The gas sensor 16 can be a smoke or carbon monoxide or carbon dioxide sensor
- remote server 17 which contains the MQTT broker, database and webserver

Detailed description of the system

The IEEE802.15.4 connectivity is provided by a microcontroller with IEEE802.15.4 transceiver. All the modules of the system with IEEE802.15.4 connectivity will have this semiconductor. The IEEE802.15.4 wireless network is also known as wireless personal area network (WPAN). It operates on 2.4 Ghz carrier. The dimmer modules 1 and relay modules 2 are normally sited above the ceiling board. The dimmer modules 1 are connected to light fixture 5 which are dimmable light sources and the relay modules 2 are connected to light fixture 6 which are non dimmable light sources. The mains connected light switches 3 are normally mounted on the walls of Room1, Room 2, Room 3, Room 4. In one corner of the building where the internet router 7 is residing, a coordinator 4 is connected to the router via wifi. The gateway is the controlling node of the WPAN 11. The modules (1, 2, 4, 9, 10, 12, 15, 16) being part of the WPAN are controlled by a microcontroller with 2.4 Ghz IEEE

802.15.4 transceiver. Communication between all the modules is through software commands sent and received by the microcontrollers in each module, via WPAN 11 . The modules can function as routers or end devices. Routers are repeaters of wireless information between routers, end devices and coordinator. End devices are generally sleeping devices. They can only send or receive information from itself to its parent which can be a router

The following is a more detailed description of the modules and the software system running on the modules:

1. Gateway module 4 : The gateway is also the coordinator module. It is controlled by software running on the microcontroller in the module. Its primary function is to start the WPAN 11 as a coordinator with its unique security key called the network security key. Once the network is started, other WPAN modules which can be dimmer, relay, remote control module 9 or sensor modules on the network with the same network application ID , PAN ID (personal area network ID) and network security key will be able to join the network by sending requests to the coordinator. A feature is incorporated in the coordinator which will allow new modules not having any network security key to join the network. The messages from the new modules are initially encrypted by a commission key which is generated by a formula which is present in both the coordinator and the nodes. The commission key is different for every node but the coordinator using the same formula is able to generate the node's commission key and decrypt the incoming message. If the incoming message contains the same network application ID, then the node is put up for acceptance by the end user via mobile app or via a webpage. The end user will then decide whether to admit the modules to the network. If the module is admitted, the MAC ID of the modules will be saved in the non volatile memory of the coordinator. The PANID of the coordinator will also be saved on the nodes. The coordinator will also transfer its network security key to the accepted node. This network security key is used for encrypting messages between the coordinator and all the other nodes. The network security key is generated using the MAC ID of the coordinator and the time at which the first node is accepted as a member of the network. This will introduce an element of randomness to the network security key. The network security key will be stored in the non volatile memory of the coordinator and in the non volatile memory of all the modules in the network. Whenever there is a reset of the modules or coordinator that result in the modules rejoining the WPAN, the modules having the same network security key will be able to send and receive messages from the coordinator. Once the modules are checked to have the same network application ID and PAN ID, they will join the WPAN network and be marked as online. In this way, we can have a few WPANs operating on the same channel frequency because they have different network security key and will not interfere each other's operations.

The coordinator will periodically collect data of the other modules on the WPAN. This is to enable it to have an updated information of all the modules on the network. An onboard wifi module with TCP/IP stack allows the coordinator to be connected to a wifi router 7 and onwards to the remote server 17. The coordinator will provide updated information of the WPAN modules to the remote server 17 whenever there are changes in the WPAN module data. The information provided is for both online and offline modules. Modules which are offline are those modules which were previously online but no longer detected in the network. The protocol for sending data to the remote server 17 is MQTT. The architecture of using the coordinator with IEEE802.15.4 connectivity connected to a wifi module with TCP/IP stack allows a low cost and simple WPAN system to be networked to other similar WPAN systems in the vicinity via wifi. The system can thus be scalable. Data transfer between the remote units 8 and the WPAN system is through the remote server 17.

Control requests sent by remote units 8 to the WPAN modules via the remote server 17 are checked by the coordinator to prevent too many similar events from happening at the same to the affected modules. Eg. If there are many requests to switch the same light on from off, only

the first request will be processed. In so doing, it will prevent crowding the wireless bandwidth of WPAN with unnecessary requests.

2. Dimmer module 1 : The dimmer module 1 is controlled by software running on the microcontroller in the module. It is a router node which means it is able to relay messages from its parent node to its child nodes .Its primary function to provide dimming ability to the dimmable light fixture 5 base on the commands it receive from the remote control modules 9 or the gateway 4 via the wireless network 11 . When the module is powered up, it will try to join the network with the same network application ID. Once it has joined the network, it will report its status to the gateway whenever there are changes. This is to enable the gateway to be aware that the module is still active. If it cannot find any network, it will scan all the network channels to see if there is any network it can join. This exercise will go on indefinitely. The dimmer module 1 is powered by the live and neutral of the mains cable.
3. Relay module 2 : The relay module 2 is controlled by software running on the microcontroller in the module. It provides relay switching of mains power to the light fixture which can be dimmable or non dimmable. Non dimmable light fixture 6 can only use this module to switch the lights on or off. The relay module 2 receives its commands to switch the lights from the gateway 4 and the remote control modules 9 . When the module is powered up, it will try to join the network with the same network application ID. Once it has joined the network, it will report its status to the gateway whenever there are changes. This is to enable the gateway to be aware that the module is still active. Like the dimmer module 1 , if the relay module 2 were to lose connection to the coordinator, it will automatically scan all the network channels to see if it can rejoin the network with the same network application ID. This exercise will go on indefinitely. The relay module 2 is also a router. It act as a message repeater, i.e. it will relay any message to and fro any modules. The relay module 2 is powered by the live and neutral of the mains cable.
4. Wall mounted mains light switches 3 : The mains light switches is used for providing electrical isolation of the mains supply to the dimmer 1 or relay 2 modules or mains powered sensor modules. It is not part of the WPAN.
5. Remote control module 9 : The remote control module 9 is controlled by software running on the microcontroller in the module. When the module is powered up, it will try to join the network with the same network application ID. Once it has joined the network, it will also periodically report its status to the gateway. This is to enable the gateway to be aware that the module is still active. It is set to sleep mode when not in use. As such it consumes very little power. The remote control module 9 is an end device. This means that it can only respond to its parent module in the network and cannot relay messages to other modules. It is powered by battery. There are 4 to 10 buttons on the remote control allowing it to control different zones in the WPAN network. The function of the buttons are programmable via mobile app or webpages. It can be configured as a ON button, OFF button or TOGGLE button, meaning that alternate press will switch the lights on or off. The brightness setting associated with the button, allow it to switch the dimmable lights on at the preset brightness level. The zones can be individual lights or different groups of lights. Groups of lights can be all the lights on the WPAN network, different rooms of lightS or different groups of lights in one room. One button can be assigned to one group only or numerous individual lights in different groups. If the button is set to ON only, pressing it once or repeatedly will switch the lights to on. If the button is set to OFF only, pressing it once or repeatedly will set the lights to off. If the button is set to TOGGLE, then if the lights are off or if some lights associated with the button are on, pressing it once will switch all the lights to on. If all the lights on, then pressing it again will switch all the lights associated with the button to off.
6. Motion detector sensor module 10 : The motion detector sensor module 10 is controlled by software running on the microcontroller in the module. It provides detection of infra red

movement. When motion is detected, the resulting switching actions can be programmed using mobile app or web pages. Switching commands will be sent to groups of nodes to switch the lights to ON or OFF, and to the coordinator to update the information to web server or mobile app connected to it. Brightness preset can also be programmed on the mobile app or web pages such that the lights can be switched on at a defined brightness level. The motion detection sensor module can be programmed as a router module or end device module. If it is a router module, it has parent and child nodes. If it is a end device module, it only has parent node and no child node. When it is an end device, it will sleep at regular intervals.

7. Presence detector sensor module 12 : The presence detector 12 sensor module has a MEMS thermal sensor on it. The thermal sensor will detect human presence, not by motion of infra red but by infra red heat emitted. The infra red temperature detected will be used to decide whether there is human presence or not. The switching function of the presence detector 12 sensor module is the same as the motion detector 10 sensor module. It is programmable via mobile app or web pages. A group of light nodes can be switched to ON/OFF at defined brightness settings using the mobile app or web pages. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals.
8. Temperature and humidity sensor module 15 : The temperature and humidity sensor 15 is used for providing information to the coordinator about the temperature and humidity of the area it is located. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals. This information can then be used to control the air conditioner or heater using another software system.
9. Gas sensor 16 : The gas sensor 16 can be a smoke, carbon dioxide (CO₂) or carbon monoxide (CO) sensor module. It provides information to the coordinator of the smoke / CO₂ / CO level of the location where the module is sited. The sensor module can be pre-programmed as router or end device. When it is an end device, it will sleep at regular intervals. The information can be used to provide smoke alarm or smoke alerts via mobile phone for smoke sensor, or ventilation fan control for CO₂/CO sensor.
10. Remote unit 8 : The remote unit 8 can be a mobile phone or tablet personal computer (PC) or desktop PC. The remote unit 8 communicates with the coordinator via the mobile network 13 or wifi 14 . The application running on the remote unit 8 is a mobile application software when it is a mobile phone or tablet PC. When it is a desktop PC, the application running on it is a web application software. The remote unit 8 will query the remote server 17 when it is in use, to get the latest information of the network. The remote unit 8 can configure the remote controls 9 , motion detector sensors 10 and presence detector sensor 12 to control the dimmers 1 and relay 2 modules. The remote unit 8 will poll the server 17 regularly while it is connected to it. From time to time, it will also send a command to the gateway via the webserver to resend all the data about WPAN nodes to the database on the webserver.
11. Remote server 17 : The remote server 17 can be a remote personal computer (PC) or cloud server. The remote server 17 contains a MQTT broker, a database and a webserver. The MQTT broker is used for hosting topics published and subscribed by the MQTT clients residing on the gateway, remote units 8 and remote server 17. Encryption and user authentication is implemented for internet message transfer between the gateway and remote server 17 and between android and remote server 17. The database on the remote server 17 is

regularly updated by data sent by the gateway to the MQTT broker. Request for WPAN data by remote units 8 are sent to the remote server 17 which will almost instantly reply. The presence of the remote server 17 serve as a buffer between a huge number of remote units 8 and a single gateway 4. This makes for a scaleable architecture in that the remote server 17 can handle numerous requests for information and control from remote units 8.

As with all RF channels on the WPAN, provisions are made for multiple channels in the RF transceiver so as to provide as many uses of the same network with as little noise interference as possible. Channels can be changed at the coordinator node using the mobile app or web pages. When channel changes take place at the coordinator and if the router and end device nodes has lost connection to the network, they will automatically reset and do a scan of the channels until a channel with its network security key is found.

Claims:

1. A wireless light control system comprising at least one gateway 4, one remote server 17 and at least one remote unit 8 and any or all of the following modules: dimmer module 1, relay module 2, remote control module 9, motion detector 10 sensor module, presence detector 12 sensor module, temperature and humidity sensor 15 module, gas (smoke or carbon monoxide or carbon dioxide) sensor 16 module. Application software running on remote units 8 like mobile phone or tablet personal computer (PC) or desktop PC, is used for configuring and controlling the entire WPAN 11 system.
2. The system in claim 1 can be configured such that neighbouring similar systems cannot control or join the system unless they have the same network application ID, PAN ID and network security key. The network security key is created using combination of the coordinator MACID and the time the first non coordinator node becomes a member of the network. It is used for encrypting and decrypting messages between all the nodes. The gateway 4 will first start the WPAN. Other modules which are powered up will then try to join the WPAN network if their network application ID, PAN ID and network security key is the same. New modules which are not coordinator modules and has no network security key but has the same network application ID and whose encrypted wireless messages can be decrypted by the coordinator, can join the network if approval is given via the mobile application or webpages software.
3. The gateway 4 in claim 1 is the coordinator of the WPAN system. It monitors the entire WPAN network. It uses an onboard wifi module with TCP/IP stack to connect via the router to the remote server 17. The remote units 8 like mobile phone, tablet PC and PC webpages access the WPAN system via the remote server 17. When similar control requests from remote units 8 resulting in the same outcome, are sent to the coordinator, the coordinator will only execute the first request that causes a change of state. If there is no change of state, the request will not be executed. This is to prevent crowding the WPAN bandwidth.
4. The remote server 17 in claim 1 contains a MQTT broker and database and webserver. It allows the system to be scaleable for use in a location with many gateways (and therefore WPANs) and many users. The gateways are low cost, low complexity devices. They can be networked into a scaleable system via the remote server 17 which will reduce access to the gateways from end users because all end user requested data can be provided by the server.
5. The dimmer module 1 in claim 1 is used for controlling the brightness of dimmable light fixtures using triac phase control to vary the amount of voltage and power to the light.
6. The relay module 2 in claim 1 is used for switching mains power to the non dimmable light fixtures using a relay or other electronics switching method.
7. The remote control module 9 in claim 1 is programmable by the mobile application software or webpages software. It can be used to switch the lights on or off and the dimmable lights can be switched on at user defined brightness.
8. The motion detector 10 sensor module in claim 1 is used to send switching information to the dimmer 1 and relay 2 modules and the gateway 4 when motion is detected.
9. The presence detector 12 sensor module in claim 1 is used to send switching information to the dimmer 1 and relay 2 modules and the gateway 4 when human presence is detected.
10. The temperature and humidity sensor 15 module in claim 1 is used to provide the temperature and humidity of the area it is located. It sends its information regularly to the gateway 4.
11. The gas sensor 16 module in claim 1 is used to collect information of the smoke/carbon monoxide/carbon dioxide of the the environment it is located in. It sends its information regularly to the gateway 4