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WIRELESS CONTROL OF UTILITY ELEMENTS USING RADIO BROADCAST CHANNELS AND METHOD THEREOF

Field of the Invention

[0001] The present invention relates to wireless control systems and transmission of signals via radio broadcast channels. In particular, this invention relates to wireless control of utility elements using radio broadcast channels and a method thereof.

Background of the Invention

[0002] Electrical power to utilities such as street lighting is typically controlled via power lines that radiate from local controllers placed at various locations. As is known, different control signals are required to control street lighting at different location. Consequently, a certain amount of time is needed to provide the control signals to the different locations. Generally, control of public utilities and planning for such power lines require coordinated efforts from different groups. The different groups usually include road transport and building authorities.

[0003] An improvement to control street lighting is described in US Patent 4,691,341 Knoble et al in which digital messages of control signals are interspersed with voice messages broadcast by a paging type transmitter. The control signals are then received by radio receivers associated with local controllers for programmed control of city street lighting. This improvement simplified setting up of infrastructure such as power lines to control street lighting and enables a central and flexible management of the street lighting according to weather conditions, daylight saving schedules, etc.

[0004] However, a problem with street lighting control as described in the paging control system of US Patent 4,691,341 is that the paging type transmitter and supporting infrastructure may not be readily available for transmission of control signals. Furthermore, paging systems are less common than other wireless

transmission systems and therefore not always available for implementing a utility control system. Consequently, in the absence of a wireless control system, setting up a new wireless system to control utilities is expensive and not practical. In this situation, it may even be more practical and cheaper to use existing power lines and infrastructure instead of a new wireless control system.

[0005] Therefore, a need exist for wireless control of utility elements without incurring substantial costs required in setting up a new wireless control system and related infrastructure or equipment. Furthermore, such wireless control require some measure of security to prevent sabotage or unauthorized control of utilities that are provided to important or critical installations such as, for example, airports or hospitals.

Summary of the Invention

[0006] The present invention seeks to provide a wireless control system, a remote receiver for receiving utility control signals from the wireless control system, and a method for wireless control of utility elements disposed at remote locations.

[0007] Accordingly, in one aspect, the present invention provides a wireless control system for controlling utility elements via one or more remote receivers, the control system comprising:

a supervisory console comprising:

a user input interface;

and

a system controller having an input and an output, the input being coupled to the user input interface to receive at least one user input signal, and

an encoder, coupled to the output of the system controller, the encoder being further coupled to a voice input source to encode voice data for one or more radio broadcast channels,

wherein the system controller is adapted to provide at least one utility control signal for encoding by the encoder, the at least one utility control signal being based on the at least one user input signal,

further wherein the encoder is adapted to provide at least one encoded utility control signal, based on the at least one utility control signal, for modulating onto a sub-carrier, the sub-carrier being simultaneous transmitted with one or more carriers respectively associated with the one or more radio broadcast channels.

[0008] In another aspect, the present invention provides a remote receiver for receiving utility control signals from a wireless control system, the remote receiver comprising:

a tuner for receiving and demodulating a carrier to thereby obtain a baseband signal, the baseband signal having a sub-carrier component, the carrier being transmitted by one or more transmission networks;

a decoder, coupled to an output of the tuner, for decoding the sub-carrier component to obtain a decoded utility control signal;

and

a processor having an input and one or more outputs, the input being coupled to the decoder, at least one output of the outputs being coupled to one or more utility elements, wherein the processor is adapted to process the decoded utility control signal to obtain a utility control signal and thereby control the one or more utility elements.

[0009] In yet another aspect, the present invention provides a method for wireless control of utility elements at remote locations by one or more remote receivers, the method comprising:

receiving an encrypted utility control signal, the encrypted utility control signal being modulated on a sub-carrier for transmission together with one or more carriers to at least one remote receiver, the one or more carriers being associated with one or more radio broadcast channels;

and

processing the encrypted utility control signal to obtain a utility control signal and thereby control one or more utility elements based on the utility control signal.

Brief Description of the Drawings

[0010] A preferred embodiment of the present invention will now be more fully described, by way of example, with reference to the drawings of which:

[0011] FIG. 1 is a functional block diagram of a wireless control system in accordance with the preferred embodiment of the present invention;

[0012] FIG. 2 illustrates an exemplary format of a baseband signal transmitted by a transmission network coupled to the wireless control system of FIG. 1;

[0013] FIG. 3 is a functional block diagram of a remote receiver for receiving and processing the baseband signal of FIG. 2; and

[0014] FIG. 4 is a flow chart of a method for wireless control of utility elements at a remote location by the remote receiver of FIG. 3.

Detailed Description of the Drawings

[0015] A wireless control system, a remote receiver for receiving utility control signals from the wireless control system, and a method for wireless control of utility elements disposed at remote locations are described in accordance with a preferred embodiment of the invention. In the following description, details are provided to describe the preferred embodiment. It shall be apparent to one skilled in the art, however, that the invention may be practiced without such details. Some of these details may not be described at length so as not to obscure the invention.

[0016] There are many advantages of the invention. One advantage of the invention is that the wireless control system use radio broadcast channels or carriers transmitted by existing radio broadcast systems to transmit the utility

control signals to the remote receiver. Hence, such utility control signals are enabled by the invention without incurring substantial costs required in setting up a new wireless control system and related infrastructure or equipment.

[0017] Another advantage of the invention is that the wireless control system and the remote receiver have security features to prevent or at least alleviate sabotage or unauthorized control of utilities. The security features also require authenticating of the utility control signals when the remote receiver to control utility elements at a remote location applies the method.

[0018] A further advantage of the invention is that a plurality of remote receivers at different remote locations is able to receive a single utility control signal simultaneously. Thus, time needed to control the utility elements is reduced. This reduction of time is useful when different local controllers control the utility elements and such controllers need separate control signals in the absence of a single system controller.

[0019] Yet another advantage of the invention is that supervisory consoles of the wireless control system can identify different groups of remote receivers based on logical addresses of such remote receivers. As such, the utility control signal can be flexibly provided to the different groups. Furthermore, these different groups may be predetermined groups or dynamically formed by a user through the supervisory consoles.

[0020] Referring now to the drawings, FIG. 1 is a functional block diagram of a wireless control system 10 in accordance with the preferred embodiment of the present invention. The wireless control system 10 comprises a supervisory console 12 and an encoder 14. The supervisory console 12 comprises a user input interface 16, a system controller 18 and a storage medium 20. The supervisory console 12 allows an authorized user, via the user input interface 16, to configure, control and operate utility elements that are disposed at remote locations.

[0021] The system controller has an input 22a and an output 22b. The input 22a is coupled to the user input interface 16 and an encoder input 24 of the encoder 14 couples to the output 22b. User input 26 is provided by an authorized user to the user input interface 16 that then generates at least one user input signal to the output 22b. The system controller 18 is adapted to provide at least one utility control signal for encoding by the encoder 14. The utility control signal is based on the user input signal and comprises an identification code and a mode-setting code. The identification code and the mode-setting code are used as security features of the wireless control system 10. The encoder 14 is further coupled to a voice input source 28 to encode voice data for one or more radio broadcast channels.

[0022] The encoder 14 is adapted to provide at least one encoded utility control signal at an encoder output 30, based on the utility control signal, for modulating onto a sub-carrier. The sub-carrier is generated by the encoder 14 and simultaneously transmitted with one or more carriers 32a,32b,32c, respectively associated with the radio broadcast channels of one or more transmission networks 34a,34b,34c. The sub-carrier is transmitted via one or more antennas 36a,36b,36c to one or more remote receivers (not shown in FIG. 1). Each of the remote receivers is coupled to control one or more utility elements disposed at a remote location.

[0023] It is to be noted that the encoder 14 in the preferred embodiment of the invention is a radio data system (RDS) encoder. However, other encoders may be applied to encode the utility control signal if such encoders are also able to encode voice data and provide both the utility control signal and the voice data to the transmission networks 34a,34b,34c for subsequent transmission on radio broadcast channels.

[0024] The system controller 18 comprises a security management module 38, a scheduler module 40, a logical grouping module 42, a transmission network management module 44, and a log manager 46. The scheduler module 40 is coupled to the security management module 36.

[0025] The security management module 36 enables privacy of data transmission, authentication, and encryption key management. These security features allow data to be seen or accessed only by authorized users and ensure that only such authorized users control the utility elements. The security management module 36 generates the identification code and the mode-setting code. These codes are then used with the user input signal to form the utility control signal.

[0026] Prior to encoding by the encoder 14, the security management module 36 encrypts the utility control signal. After encryption by the security management module 36, the scheduler module 40 schedules the utility control signal for encoding. The scheduler module 40 handles time schedules of the supervisory console 12. Such time schedules can be programmed and stored into the storage medium 20 for the supervisory console 12 to turn on or turn off the utility elements during different times of the day. As such, the scheduler module 40 accommodates fluctuations in daylight hours due to, for example, seasonal changes. The scheduler module 40 also serves as a time synchronization reference by providing reference time information that is broadcasted to synchronize clocks of the remote receivers.

[0027] If the user input signal specifies that the utility control signal be transmitted to a plurality of the remote receivers, then the logical grouping module 42 groups a plurality of addresses that is respectively associated with such remote receivers. The plurality of addresses is then encoded with the identification code, the mode-setting code and the user input signal to form the utility control signal prior to modulating onto the sub-carrier. Hence, remote receivers that are grouped under predetermined groups each with a unique group address can therefore be controlled to operate independently from other remote receivers controlled by the wireless control system 10 with a single command by an authorized user providing the user input signal.

[0028] The transmission network management module 44 selects one or more of the transmission networks 34a,343b,34c to transmit the one or more carriers with

the sub-carrier. This is especially useful in countries with multiple transmission networks each covering specific and non-overlapping geographical regions.

[0029] The log manager 46 logs operations associated with the supervisory console 12. As such, monitoring of operations and traffic volume, which may be utilized for billing purposes, is thus enabled.

[0030] FIG. 2 illustrates an exemplary format 100 of a baseband signal that is modulated on a carrier and transmitted by a transmission network 34 coupled to the wireless control system 10. The baseband signal has a sub-carrier component 102 at a frequency of 57 Kilohertz (KHz).

[0031] Referring now to FIG. 3, a functional block diagram of a remote receiver 200 for receiving and processing the signal of FIG. 2 is shown. The remote receiver 200 comprises a tuner 202, an RDS decoder 204, and a processor 206.

[0032] The tuner 202 receives and demodulates a carrier to thereby obtain a baseband signal that corresponds, for example, to the baseband signal of FIG. 2. The carrier is transmitted by one or more of the transmission networks 34.

[0033] The RDS decoder 204 couples to an output 208 of the tuner 202. Receiving the sub-carrier component 102 from the output, the RDS decoder 204 decodes the sub-carrier component 102 to obtain a decoded utility control signal.

[0034] The processor 206 comprises a control module 210, a decryption module 212, an authenticating module 214 and a blocking module 216. The processor has an input 220 and three outputs 222a,222b,222c. The remote receiver 200 has a storage medium 224 that stores settings for the processor 206. Such settings include logical addresses of the remote receiver 200, identification codes and decryption keys associated with supervisory consoles of the wireless control system 10. The processor 206 is adapted to process the decoded utility control signal to obtain a utility control signal and thereby control the utility elements 224.

[0035] Logical addresses are divided into two groups: a unique address to identify the remote receiver 200 and one or more group addresses for logical grouping operations. Such logical addresses enable the remote receiver 200 to be controlled individually or in logical groups identified by the one or more group addresses. Hence, the supervisory console 12 or any other supervisory consoles can therefore provide the utility signal to different groups of remote receivers. These different groups may be predetermined groups or dynamically formed by a user via the user input interface 16.

[0036] The input 220 is coupled to output of the RDS decoder 204 and two outputs 222b,222c are outputs from the control module 210 to one or more utility elements 226. The output 222b provides a serial interface control signal having a message-based protocol-governed serial data exchange interface where control information is packaged in a special format and transmitted over serial interfaces such as, for example, RS232C/RS485/USB. The output 222c provides a dry contact control signal that closes or opens, for example, voltage-free relay contacts. This allows program control switching to apply power to a load.

[0037] The output 222a is an output of the control module 210 and couples to electronically tune the tuner to a desired carrier associated with a radio broadcast channel. This remote receiver 200 is therefore able to change the desired carrier to, for example, a selected frequency modulation (FM) frequency in the FM radio band between 87.5 (Megahertz) MHz and 108 MHz.

[0038] For security, the decryption module 212 decrypts the decoded utility control signal using a decryption key stored in the storage medium 224 in association with, for example, the supervisory console 12. The authenticating module 214 authenticates the utility control signal after decryption using an identification code within the utility control signal and associated with the supervisory console 12.

[0039] The blocking module 216 sets the remote receiver 200 to a mode setting that determines whether the utility control signal is to be applied to control the utility elements 226. With the mode setting, the processor 206 can be controlled to act on control information provided with the utility control signal. The mode setting includes "unblocked, normal operation" or "blocked, halt operation" where latter mode setting blocks subsequent processing of the utility control signal.

[0040] It is to be noted that other types of decoders may be used instead of the RDS decoder 204 of the preferred embodiment. Such other types of decoders are possible if encoded voice data and encoded utility control signals in the baseband signal can be decoded to obtain both the voice data and the utility control signal.

[0041] It is further to be noted that other mobile or portable supervisory consoles (not shown) may connect via the supervisory console 12 to control utility elements at remote locations. Connections between such mobile or portable supervisory consoles to the supervisory console 12 may be provided via wired or wireless network connections. These network connections include leased lines or modem dial-ups via conventional public switch telephone networks (PSTNs).

[0042] A method 300 for wireless control of utility elements at a remote location by the remote receiver 200 is illustrated with a flowchart in FIG. 4. Starting 302 with receiving 304 an encrypted utility control signal. The encrypted utility control signal is modulated on a sub-carrier for transmission together with one or more carriers to the remote receiver 200. The one or more carriers are associated with one or more radio broadcast channels. The method 300 then processes the encrypted utility control signal to obtain a utility control signal and thereby control one or more utility elements based on the utility control signal.

[0043] Processing the encrypted utility control signal starts with determining 306 whether a logical address of the encrypted utility control signal is matched to one or more logical addresses stored in the storage medium 226. A 'No' to the

determining 306 leads to the starting 302 at which the remote receiver is in a wait state prior to the receiving 304.

[0044] Otherwise, with a 'Yes' to the determining 306, the method 300 proceeds to decrypting 308 the encrypted utility control signal using a decryption key that is stored in the storage medium 226 to obtain the utility control signal.

[0045] Authenticating 310 the utility control signal in the method 300 is based on determining whether an identification code retrieved from the utility control signal is stored in the storage medium 226. If 'No' results from the authenticating 310, the method 300 goes to the wait state at the starting 302.

[0046] Otherwise, with a 'Yes' following the authenticating 310, the method 300 proceeds to checking 312 whether the remote receiver 200 is blocked from subsequent processing of the utility control signal. If 'Yes' to the checking 312, the method 300 goes to the wait state at the starting 302. Otherwise, with a 'No' following the checking 312, the method 300 proceeds to generating 314 one or more actuation signals to control the utility elements. These one or more actuation signals are based on the utility control signal.

[0047] Generating 314 of the actuations signals are for setting the remote receiver 200 and include mode setting 315a, time synchronization 316b, diagnostics 316c, local address programming 316d, controls 316e, update of operating mode 316f, update of timer 316g, built-in self test 316h, update of address tables 316i, and sending of commands 316j to the outputs 222. After the setting of the remote receiver 200, the method 300 proceeds to updating 318 the storage medium 226 based on the actuation signals.

[0048] The present invention therefore provides the wireless control system 10, the remote receiver 200 and the method 300 for wireless control of utility elements disposed at remote locations to overcome, or at least alleviate, the problems of the prior art.

[0049] It will be appreciated that although one preferred embodiment has been described in detail, various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention.

Claims

1. A wireless control system for controlling utility elements via one or more remote receivers, said control system comprising:

a supervisory console comprising:

a user input interface;

and

a system controller having an input and an output, said input being coupled to said user input interface to receive at least one user input signal; and

an encoder, coupled to said output of said system controller, said encoder being further coupled to a voice input source to encode voice data for one or more radio broadcast channels;

wherein said system controller is adapted to provide at least one utility control signal for encoding by said encoder, said at least one utility control signal being based on said at least one user input signal;

further wherein said encoder is adapted to provide at least one encoded utility control signal, based on said at least one utility control signal, for modulating onto a sub-carrier, said sub-carrier being simultaneous transmitted with one or more carriers respectively associated with said one or more radio broadcast channels; and

wherein said system controller comprises a transmission network management module for selecting one or more transmission networks to transmit said one or more carriers with said sub-carrier.

2. The control system as claimed in Claim 1, wherein said system controller comprises a security management module to encrypt said at least one utility control signal prior to said encoding.

3. The control system as claimed in Claim 2, wherein said at least one utility control signal comprises an identification code, said identification code being generated by said security management module.

4. The control system as claimed in Claim 2, wherein said at least one utility control signal comprises a mode setting code, said mode setting code being generated by said security management module.

5. The control system as claimed in Claim 2, wherein said system controller comprises a schedule module, coupled to said security management module, for scheduling said at least one utility control signal for said encoding after encryption.

6. The control system as claimed in Claim 1, wherein said system controller comprises a logical grouping module for grouping a plurality of addresses, said plurality of addresses being respectively associated with a plurality of said remote receivers.

7. The control system as claimed in Claim 6, wherein said at least one utility control signal comprises said plurality of addresses.

8. The control system as claimed in Claim 1, wherein said system controller comprises a log manager for logging operations associated with said supervisory console.

9. A remote receiver for receiving utility control signals from a wireless control system, said remote receiver comprising:

a tuner for receiving and demodulating a carrier to thereby obtain a baseband signal, said baseband signal having a sub-carrier component, said carrier being transmitted by one or more transmission networks;

a decoder, coupled to an output of said tuner, for decoding said sub-carrier component to obtain a decoded utility control signal; and

a processor having an input and one or more outputs, said input being coupled to said decoder, at least one output of said outputs being coupled to one or more utility elements, wherein said processor is adapted to process said

decoded utility control signal to obtain a utility control signal and thereby control said one ore more utility elements;

wherein said processor comprises a blocking module to block subsequent processing of said utility control signal.

10. The remote receiver as claimed in Claim 9, wherein said processor comprises a control module having said at least one output.

11. The remote receiver as claimed in Claim 10, wherein one of said at least one output provides a serial interface control signal.

12. The remote receiver as claimed in Claim 10, wherein one of said at least one output provides a dry contact control signal.

13. The remote receiver as claimed in Claim 10, wherein said control module comprises an output, coupled to said tuner, to electronically tune said tuner to said carrier.

14. The remote receiver as claimed in Claim 9, wherein said processor comprises a decryption module for decrypting said decoded utility control signal.

15. The remote receiver as claimed in Claim 9, wherein said processor further comprises an authenticating module to authenticate an identification code within said utility control signal.

16. The remote receiver as claimed in Claim 9, wherein said processor further comprises at least one storage medium for storing settings, said settings including identification codes and decryption keys associated with supervisory consoles of the wireless control system.

17. The remote receiver as claimed in Claim 16, wherein said settings further include logical addresses of said remote receiver.

18. A method for wireless control of utility elements at remote locations by one or more remote receivers, said method comprising:

receiving an encrypted utility control signal, said encrypted utility control signal being modulated on a sub-carrier for transmission together with one or more carriers to at least one remote receiver, said one or more carriers being associated with one or radio broadcast channels; and

processing said encrypted utility control signal to obtain a utility control signal and thereby control one or more utility elements based on said utility control signal;

wherein said processing further comprises checking whether said at least remote receiver is blocked from subsequent processing of said utility control signal.

19. The method of Claim 18, wherein said processing further comprises determining whether a logical address of said encrypted utility control signal is stored in a storage medium of each of said at least one remote receiver.

20. The method of Claim 18, wherein said processing further comprises decrypting said encrypted utility control signal using a decryption key stored in said storage medium to obtain said utility control signal.

21. The method of Claim 18, wherein said processing further comprises authenticating said utility control signal based on determining whether an identification code retrieved from said utility control signal is stored in said storage medium.

22. The method of Claim 18, wherein said processing further comprises generating one or more actuation signals, based on said utility control signal, to control said one ore more utility elements.

23. The method of Claim 22, wherein said generating comprises setting each of said at least one remote receiver based on said one ore more actuation signals.

24. The method of Claim 23, wherein said processing further comprises updating said storage medium based on said one or more actuation signals.