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INTEGRATED AUTOMATION SYSTEM, APPARATUS AND METHOD FOR CONTROLLING AN ENVIRONMENT

Field of the Invention

5 **[0001]** The present invention relates to smart home and small environment automation systems. In particular, this invention relates to an integrated automation system, apparatus and method for controlling an environment.

Background of the Invention

10 **[0002]** Automation systems in which various environmental conditions are monitored to control a building or home environment are known. In such systems, detectors are typically placed within specific areas of a building or a home to monitor the various environmental conditions. For example,
15 detectors like heat, smoke, light intensity, motion sensors may be placed at different areas in a building or home to control lighting or other amenities based upon presence of people in such areas. A combination of light intensity sensors and/or motion sensors enable control features of a lighting control system to reduce power consumption for efficiency reasons. Heat sensors, smoke sensors and motion sensors therefore enhance human and building
20 safety.

[0003] As a result of developments to provide cost benefits, some control systems combine sensors for sensing or detecting different environmental parameters into a single multifunction sensor. For example, US Patent
25 5,971,597 Baldwin et al., assigned to Hubbell Corporation, describes a multifunction sensor and network sensor system that combines a plurality of parameter sensors in one sensor module that interfaces with and control operation of one or more processor control systems in an occupied space networked environment.



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5 [0004] However, prior art multifunction sensors, such as that described in US Patent 5,971,597 Baldwin et al., have separate controllers for each of the plurality of parameter sensors. Consequently, the different parameters sensed in such prior art multifunction sensors are not combined to provide an integrated control of an environment. Hence, users would still need to control each of the separate controllers to set conditions to a desired ambience.

10 [0005] Moreover, household appliances or equipment may be continually upgraded for improvements and it is a complex task to build an embedded household appliance or equipment command code learner and transceivers for multiple functions and multifunction controls. Currently, a command code learner has to process signals received at various frequencies and in different formats such as, for example, infrared, radio frequencies, wireless local area
15 networks (LANs), Bluetooth™, etc.

20 [0006] Hence, dimming lights, changing air-conditioning temperatures and controlling background audio-visual effects to achieve a romantic or a celebrative ambience require users to initiate separate actions to attain such desired ambiances. Furthermore, existing home automation systems require extensive and complex cabling to connect various distributed devices in addition to software configuration to set up such systems. As a result of extensive and complex cabling, these existing systems need specialized home installers and are generally more expensive to install for a new environment.
25 Consequently, these existing systems are expensive or difficult to set up and are generally unsuitable for users for costs reasons, especially when control of the environment of a small area such as, for example, a room or a kitchen, is desired.

30 [0007] Therefore, a need clearly exists for an integrated automation system and apparatus for controlling the environment of a small area and that

alleviates the need for users to set conditions for separate controllers to attain a desired ambience.

Brief Summary of the Invention

5 **[0008]** The present invention seeks to provide an apparatus, an integrated automation system having the apparatus and a method for controlling an environment by the integrated automation system.

10 **[0009]** Accordingly, in one aspect, the present invention provides an apparatus for controlling an environment in an integrated automation system, the apparatus comprising:

 a wireless transceiver for receiving one or more user-actuated ambience-setting signals, the wireless transceiver having:

 an ambience controller;

15 and

 a storage medium for storing one or more ambience settings respectively associated with the one or more user-actuated ambience-setting signals;

20 at least one parameter sensor for generating, respectively, at least one sensing signal, each of the parameter sensor being associated with an environmental parameter;

 and

 a processor, coupled to the ambience controller and the parameter sensor, for processing the sensing signal,

25 wherein, in response to a single user-actuated ambience-setting signal, the ambience controller is adapted to generate control signals to control one or more devices and thereby attain a desired ambience within the environment, the desired ambience being based upon an ambience setting stored in the storage medium and associated with the single user-actuated
30 ambience-setting signal.

[0010] In another aspect, the present invention provides an integrated automation system for controlling an environment, the system comprising:

one or more devices, each of the devices having a wireless receiver;

and

5 an apparatus, coupled to the one or more devices, the apparatus comprising;

 a wireless transceiver for receiving one or more user-actuated ambience-setting signals, the wireless transceiver having:

 an ambience controller;

10 and

 a storage medium for storing one or more ambience settings respectively associated with the one or more user-actuated ambience-setting signals;

15 at least one parameter sensor for generating, respectively, at least one sensing signal, each of the parameter sensor being associated with an environmental parameter;

 and

 a processor, coupled to the ambience controller and the parameter sensor, for processing the sensing signal,

20 wherein, in response to a single user-actuated ambience-setting signal, the ambience controller is adapted to generate control signals to control at least one of the devices and thereby attain a desired ambience within the environment, the desired ambience being based upon an ambience setting stored in the storage medium and associated with the single user-actuated
25 ambience-setting signal.

[0011] In a further aspect, the present invention provides a method for controlling an environment by an integrated automation system, the method comprising the steps of:

30 receiving, by an ambience controller, a single user-actuated ambience-setting signal associated with a desired ambience within the environment;

processing, by the ambience controller, the single user-actuated
ambience-setting signal to determine one or more control signals;

and

transmitting, by a wireless transceiver coupled to the ambience
controller, the one or more control signals to control one or more devices
and thereby attain the desired ambience within the environment.

Brief Description of the Drawings

[0012] A preferred embodiment of the present invention shall be more fully
described, by way of example, with reference to the drawings of which:

[0013] FIG. 1 illustrates a functional block diagram of an integrated
automation system in accordance with the present invention;

[0014] FIG. 2 is a simplified circuit schematic showing key elements of
various blocks within a lighting controller of the integrated automation
system of FIG. 1;

[0015] FIG. 3 is a flow chart of a method for learning device commands for
ambience setting by an apparatus of the integrated automation system of
FIG. 1;

and

[0016] FIG. 4 is a flow chart of a method for controlling an environment by
the integrated automation system of FIG. 1.

Detailed Description of the Drawings

[0017] An apparatus, an integrated automation system having the apparatus
and a method for controlling an environment by the integrated automation

system in accordance with a preferred embodiment of the invention are described. In the following description, details are provided to describe these embodiments. However, it shall be apparent to one skilled in the art 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.

[0018] There are many advantages of the invention. One advantage of the invention is that users can attain a desired ambience in an environment with a single user-actuated ambience-setting signal. This is different from existing home automation systems that require users to initiate separate actions to attain the desired ambience.

[0019] Another advantage of the invention is that ambience settings can be stored for automatic retrieval or actuation based upon sensing signals that are generated when presence of users is detected. Hence, there is no need for users to physically actuate a desired ambience.

[0020] A further advantage of the invention is that a lighting controller is provided to interface via a communication resource with an ambience controller so that appropriate lighting for the desired ambience is attained. Solid-state components within the lighting controller enable control of an alternating current (AC) power supply that supplies power to one or more lights within the environment.

[0021] Yet another advantage of the invention is that manual control of lighting sources is possible to override software control via a processor within the lighting controller. Hence, if such a processor fails to respond to the software control or when users prefer to control the lighting sources manually, then such software control can be bypassed.

[0022] Referring now to FIG. 1, a functional block diagram of an integrated automation system 10 for controlling an environment in accordance with the present invention is illustrated. The integrated automation system 10 comprises an apparatus 100, one or more devices that include, for example, a lighting controller 200 and at least one wireless remote controller 290. Although not shown in FIG. 1, other devices may include television sets, air-conditioners, radios, etc., that are placed for use within the environment. The lighting controller 200 controls at least one light source that provides illumination within the environment.

[0023] In the preferred embodiment of the invention, wireless communication within the integrated automation system 10 such as, for example, between the apparatus 100 and the wireless remote controller 290 is via infrared signals. For some of the other devices, infrared signals may also be used.

[0024] The apparatus 100 comprises an infrared (IR) transceiver 110 having an ambience controller 120 and a storage medium 122 coupled thereto, parameter sensors 130,131,132,133 each for generating, respectively, one or more sensing signals, and a processor 140 for processing the sensing signals received from the parameter sensors 130,131,132,133. The processor 140 is coupled to the ambience controller 120 and the parameter sensors 130,131,132,133.

[0025] Each of the parameter sensors 130,131,132,133 is associated with an environmental parameter. In the preferred embodiment, the parameter sensors 130,131,132,133 are respectively associated with occupancy, ambient light, heat and smoke. Hence, the parameter sensor 130 has, for example, a motion detector for detecting presence of a person in the environment.

5 [0026] The lighting controller 200 comprises various circuits to control the light source such as, for example, fluorescent lamps. The various circuits include a lamp control circuit 210, a dimming circuit 220, a bypass circuit 230 and a two-way switch circuit 240. The lighting controller 200 further comprises a processor 250, an alarm activation circuit 260, a control panel 270 and a zero-crossing detector 280. The alarm activation circuit 260 and the control panel 270 are coupled to the processor 250. The zero-crossing detector 280 provides timing signals to the processor 250 based upon detection of zero-crossings of a line voltage that supplies voltage to the light source.

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[0027] The processors 140,250 are coupled to each other via a communication resource 285 that is implemented with, for example, electrically conductive wires such as, for example, a telephone-grade cable that is suitable for a 12-Volt power supply system.

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[0028] In response to receiving a single user-actuated ambience-setting signal, the ambience controller 120 is adapted to generate control signals for transmission by the IR transceiver 110 to actuate at least one of the devices and thereby attain a desired ambience within the environment. The desired ambience is based upon an ambience setting stored in the storage medium 122 and associated with the single user-actuated ambience-setting signal. The single user-actuated ambience-setting signal is received by the IR transceiver 110 from the wireless remote controller 290 or from the processor 140.

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25 [0029] The storage medium 122 stores one or more ambience settings. These ambience settings are identified with ambience indices. An ambience index relates to a grouping of device commands that is stored for each of the ambience settings.

[0030] However, prior to the grouping of device commands for each of the ambience indices, the device commands has to be learnt by the ambience controller 120.

5 **[0031]** The bypass circuit 230 provides fail-safe operation for the lighting controller 200. The bypass circuit 230 has a double-pole single-throw (DPST) relay connected to the lamp control circuit 210. During normal operation, the DPST relay is held at a "normally open" position, thereby allowing the lamp control circuit 210 and the dimming circuit 220 to operate via software
10 control of the processor 250. In the event that the processor 250 has software or hardware errors, the DPST relay falls back to a "normally closed" position, thereby bypassing logic controls imposed by the processor 250. This therefore allows the lamp control circuit 210 to work normally, activating or deactivating the at least one light source via manual switches. As such, the
15 integrated automation system 10 provides a fail-safe feature with which the lamp control circuit 210 is operable to manually control the at least one light source even when the processor 250 fails.

20 **[0032]** FIG. 2 is a simplified circuit schematic showing key elements of various blocks within the lighting controller 200. For example, two optically-coupled triacs 310,320 of the lamp control circuit 210 are indicated. Each of these two optically-coupled triacs 310,320 has, respectively, an input 312, 322 from the processor 250. Two triacs 330, 340 of the dimming circuit 220 are operatively coupled to the two optically-coupled triacs 310,320. A manual
25 switch 350 of the two-way switch circuit 240 receives line voltage via a voltage input 352. The bypass circuit 230 has a watchdog function provided by a watchdog relay 360 that is coupled to two transistors 370,380. The watchdog relay 360 serves as the DPST relay described above. An input 362 for a watchdog signal from the processor 250 is coupled to the watchdog
30 relay 360 via the two transistors 370,380. An output 390 of the triac 340 is coupled to output of the watchdog relay 360.

[0033] Loads connected at the output 390 are switched on or off via the manual switch 350 or via the two triacs 330, 340. From the voltage input 352, the line voltage is switched, using the manual switch, to either one of the two lines with the two triacs 330, 340 in series. The processor 250 via control
5 signals from the inputs 312, 322 controls the two triacs 330, 340. Upon receiving lighting control commands from the ambience controller 120, the triac 330 or the triac 340 is switched on to enable supply of line voltage to the load. The logic state of the triac 330 is the exact opposite of the triac 340 for correct operation of two-way switching. For safety, voltage isolation between
10 low voltage of the inputs 312, 322 and high voltage circuitry of the triacs 330, 340 is provided by the optically-coupled triacs 310, 320.

[0034] Referring now to FIG. 3, a method 400 for learning the device commands for the ambience settings by the ambience controller 120 is shown
15 with a flowchart. The method 400 starts at step 401 after the apparatus 100 is set to a learning mode using the control panel 270. During the learning mode, the ambience controller 120 receives input signals at step 402 via the IR transceiver 110 or the processor 140.

[0035] At decision step 403, the ambience controller 120 determines whether an input signal is an infrared command or a time period command. For an infrared command, decision step 403 proceeds with a 'Yes' to step 404 at which the IR transceiver 110 scans for IR codes within the environment. Otherwise, with a 'No', the ambience controller 120 considers the input
20 signal as a time period command. For such a time period command, the ambience controller 120 stores a time period, derived from the time period command, into the storage medium 122 at step 405.
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[0036] While scanning for the IR codes at step 404, the ambience controller
30 120 also checks at decision step 406, at predetermined time intervals, whether an IR code is from the wireless remote controller 290. This decision step 406

allows for IR codes from the wireless remote controller 290 that are for setting the lighting controller 200 to control the at least one light source in accordance with a desired ambience setting. Hence, with a 'Yes' from the decision step 406, the method 400 proceeds to the step 407 of sending the infrared command to the lighting controller 200. Otherwise, with a 'No' from the decision step 406, the method 400 proceeds to the step 408 at which the ambience controller 120 learns the IR code.

[0037] From steps 407 or 408, the method 400 proceeds to step 409 at which the ambience controller 120 stores the infrared command associated with the IR code into the storage medium 122. A command counter of the ambience controller 120 is then incremented at step 410 to keep track of commands for the desired ambience setting.

[0038] For each of the ambience settings that are stored in the storage medium 122, a predetermined number of device commands can be set. The predetermined number of device commands depends on how many devices require settings within the environment. A predetermined number of the device commands are grouped to form an ambience index for storing in the storage medium 122. Accordingly, one or more ambience indices are stored depending on how many ambience setting is desired. In the preferred embodiment of the invention, each of the predetermined number of device commands therefore has a maximum number of device commands. Hence, the command counter is incremented with each device command that is learnt for an ambience setting and the ambience controller 120 checks at decision step 411 whether the maximum number of device commands has been reached.

[0039] For a 'No' at decision step 411, the method 400 proceeds to decision step 412 at which the ambience controller 120 checks whether the learning

mode has ended. Otherwise, with a 'Yes' following the decision step 411, the method 400 ends at step 413 and the learning mode is not maintained.

5 **[0040]** A 'No' following decision step 412 results in the method 400 returning to step 402. This occurs when another device command has to be learnt by the ambience controller 120 and the maximum number of device commands for the ambience setting has not been reached. Otherwise, with a 'Yes' following decision step 412, the method 400 also ends at step 413 and the learning mode is ended.

10 **[0041]** With the device commands grouped according to various ambience settings that are each identified with a respective ambience index, the apparatus 100 is ready to control the devices to attain a desired ambience. Referring now to FIG. 4, a method 500 for controlling an environment by the integrated automation system 10 is shown. The method 500 starts at step 501 and proceeds when the ambience controller 120 at step 502 receives a single user-actuated ambience-setting signal associated with a desired ambience within the environment.

20 **[0042]** The single user-actuated ambience-setting signal may be received either from the wireless remote controller 290 when a user actuates a button or from the processor 140 in response to a sensing signal from one of the parameter sensors 130,131. Such a sensing signal may be from the parameter sensor 130 when presence of a person is detected in the environment. A
25 desired ambience that corresponds to an ambience setting stored in the storage medium 122 and associated with the sensing signal is then processed.

30 **[0043]** Thereafter, the ambience controller 120 processes the single user-actuated ambience-setting signal to determine one or more control signals. Processing of the single user-actuated ambience-setting signal includes the step 503 of identifying an ambience index associated with the single user-

actuated ambience-setting signal. Upon identifying the ambience index, the ambience controller 120 retrieves at step 504 one or more device commands stored in the storage medium 120 in association with the ambience index.

5 **[0044]** The one or more device commands or control signals may be provided either as IR commands for transmission by the IR transceiver 110 to one or more devices in the environment or via the communication resource 285 to the lighting controller 200. Hence, at decision step 505 in the method 500, the ambience controller 120 checks whether a device command is an
10 infrared command. For a 'Yes', the IR command is transmitted via the IR transceiver 110 at step 506. Otherwise, for a 'No', the ambience controller 120 checks at decision step 507 whether the device command is a lighting command for the lighting controller 200.

15 **[0045]** For a 'No' following the decision step 507, the ambience controller 120 processes the device command as a time period command and executes the time period command at step 508. Otherwise, with a 'Yes' following the decision step 507, the lighting command is transmitted via the communication resource 285 to the lighting controller 200 at step 509.

20 **[0046]** Line voltage phase-control technique is utilized for the lighting command that is for dimming operations. Hence, upon receiving a dimming lighting command from the ambience controller 120 during the step 509, the triac 330 or the triac 340 is fired by a pre-set time delay of the processor 250 by activating control signals from the inputs 312, 322 and, respectively, the
25 optically-coupled triacs 310,320. A short delay results in higher luminance and long delays result in low luminance. Hence, control signals from the inputs 312,322, in conjunction with the optically-coupled triacs 310, 320 and the triacs 330,340, serve as electronic switches and dimming controls.

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- 5 **[0047]** Thereafter, following steps 508 or 509, the method 500 proceeds to a decision step 510 at which the ambience controller 120 checks whether another device command is to be processed. Hence, with a 'Yes' following the decision step 510, the ambience controller 120 proceeds to a next device command for the desired ambience at step 511. Otherwise, with a 'No' following the decision step 510 because there are no more device commands to be processed for the ambience setting, then the method 500 ends at step 512.
- 10 **[0048]** The present invention thus provides the integrated automation system 10 having the apparatus 100 and the method 500 for controlling an environment to thereby overcome, or at least alleviate, the problems of existing home automation systems.
- 15 **[0049]** It will be appreciated that although only one preferred embodiment has been described in detail, various modifications and improvements can be made by persons skilled in the art without departing from the scope of the present invention.

Claims

- 1) An apparatus for controlling an environment in an integrated automation system, said apparatus comprising:
 - a wireless transceiver for receiving one or more user-actuated
5 ambience-setting signals, said wireless transceiver having:
 - an ambience controller;
 - and
 - a storage medium for storing one or more ambience settings
10 respectively associated with said one or more user-actuated
ambience-setting signals;
 - at least one parameter sensor for generating, respectively, at least one
sensing signal, each of said parameter sensor being associated with an
environmental parameter;
 - and
 - 15 a processor, coupled to said ambience controller and said parameter
sensor, for processing said sensing signal,
 - wherein, in response to a single user-actuated ambience-setting signal,
said ambience controller is adapted to generate control signals to control
one or more devices and thereby attain a desired ambience within said
20 environment, said desired ambience being based upon an ambience
setting stored in said storage medium and associated with said single
user-actuated ambience-setting signal.
- 2) The apparatus as claimed in Claim 1, wherein said wireless transceiver
25 comprises an infrared transceiver.
- 3) The apparatus as claimed in Claim 1, wherein said processor is adapted to
generate said user-actuated ambience-setting signals in response to one of
said sensing signal, said sensing signal being received in response to
30 detection of user presence within said environment.

- 4) The apparatus as claimed in Claim 1, wherein said at least one parameter sensor comprises a motion detector.
- 5) The apparatus as claimed in Claim 1, wherein said at least one parameter sensor comprises an ambient light detector.
- 6) The apparatus as claimed in Claim 1, wherein said at least one parameter sensor comprises a heat detector.
- 7) The apparatus as claimed in Claim 1, wherein said at least one parameter sensor comprises a smoke detector.
- 8) An integrated automation system for controlling an environment, said system comprising:
 - one or more devices, each of said devices having a wireless receiver;
and
an apparatus, coupled to said one or more devices, said apparatus comprising:
 - a wireless transceiver for receiving one or more user-actuated
ambience-setting signals, said wireless transceiver having:
 - an ambience controller;
and
a storage medium for storing one or more ambience
settings respectively associated with said one or more user-
actuated ambience-setting signals;
 - at least one parameter sensor for generating, respectively, at
least one sensing signal, each of said parameter sensor being
associated with an environmental parameter;
and
a processor, coupled to said ambience controller and said
parameter sensor, for processing said sensing signal,

wherein, in response to a single user-actuated ambience-setting signal, said ambience controller is adapted to generate control signals to control at least one of said devices and thereby attain a desired ambience within said environment, said desired ambience being based upon an ambience setting stored in said storage medium and associated with said single user-actuated ambience-setting signal.

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9) The integrated automation system as claimed in Claim 8, and further comprising at least one lighting controller, each of said at least one lighting controller being to control at least one light source.

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10) The integrated automation system as claimed in Claim 9, wherein each of said at least one lighting controller comprises at least one switch, a control panel and a processor coupled to said at least one switch and said control panel.

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11) The integrated automation system as claimed in Claim 10, wherein each of said at least one lighting controller further comprises at least one optically-coupled triac.

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12) The integrated automation system as claimed in Claim 10, wherein each of said at least one lighting controller further comprises at least one relay.

13) The integrated automation system as claimed in Claim 10, wherein said processor of each of said at least one lighting controller is adapted to receive light switching signals directly from said at least one switch.

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14) The integrated automation system as claimed in Claim 10, wherein each of said at least one lighting controller further comprises a zero-crossing detector for providing timing signals to said processor based upon detection of zero-crossings of a line voltage supplying voltage to said at least one light source.

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- 15) The integrated automation system as claimed in Claim 8, wherein said wireless transceiver comprises an infrared transceiver.
- 5 16) The integrated automation system as claimed in Claim 8, wherein said at least one parameter sensor comprises a motion detector.
- 17) The integrated automation system as claimed in Claim 8, wherein said at least one parameter sensor comprises an ambient light detector.
- 10 18) The integrated automation system as claimed in Claim 8, wherein said at least one parameter sensor comprises a heat detector.
- 19) The integrated automation system as claimed in Claim 8, wherein said at least one parameter sensor comprises a smoke detector.
- 15 20) A method for controlling an environment by an integrated automation system, said method comprising the steps of:
- receiving, by an ambience controller, a single user-actuated ambience-setting signal associated with a desired ambience within said environment;
- 20 processing, by said ambience controller, said single user-actuated ambience-setting signal to determine one or more control signals;
- and
- 25 transmitting, by a wireless transceiver coupled to said ambience controller, said one or more control signals to control one or more devices and thereby attain said desired ambience within said environment.
- 21) The method as claimed in Claim 20, wherein said receiving step comprises the step of receiving said single user-actuated ambience-setting signal from a wireless remote controller.
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22) The method as claimed in Claim 20, wherein said processing step comprises the steps of:

obtaining an ambience index;

5 retrieving one or more device commands associated with said ambience index and stored in a storage medium, said one or more device commands being to generate said one or more control signals;

and

10 determining whether said single user-actuated ambience-setting signal is received from a wireless infrared remote device.

23) The method as claimed in Claim 22, and further comprising the step of learning said device commands for storing in said storage medium prior to said receiving step.

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24) The method as claimed in Claim 23, wherein said learning step comprises the step of receiving said device commands from said wireless remote controller.

25) The method as claimed in Claim 22, and further comprising the step of
20 grouping a predetermined number of said device commands to form one or more ambience indices for storing.

26) The method as claimed in Claim 20, wherein said receiving step comprises the step of receiving said single user-actuated ambience-setting signal from a
25 processor of said integrated automation system in response to a sensing signal generated by a parameter sensor.