

Configurable System For Electric Device Storing and Tracking

Field of Invention

[0001] The present invention relates to configurable system for device storing and tracking. In particular, the invention relates to a system for providing secure storage compartments for portable electric and electronic devices with controlled power sockets and a system for tracking users and compartment usage.

Background

[0002] With advances in information technology, there is a prolific use of portable computing devices. For example, more and more business professionals, educators and students alike are using computer notebooks, laptops and tablet personal computers while moving about and carrying on their activities. In the foreseeable future, these portable computers would also become indispensable learning, teaching and communication tools in schools and educational institutions.

[0003] These portable computers and other electronic devices, such as, handphones and PDAs, typically run on energy storage cells or batteries. There is, therefore, a need for such educational institutions to provide students and staff with facilities for re-charging the storage cells or batteries of their computers and portable electronic devices. At the same time, there is also a need for such educational institutions to provide safe and secure storage facilities for the students' and staff portable devices. These facilities pose new implementation problems as such educational institutions grow.

[0004] Attempts have been made to solve some of these problems. For example, US patent no. 6,771,044, issued to Vinciguerra et al., discloses a power management system for managing available electric power for re-charging a plurality of battery-powered computers.

In another US patent no. 5,631,536, issued to Tseng, it discloses a multi-port charger for charging a plurality of batteries; in one example, it discloses a carousel vending machine for a user to exchange a discharged battery for a charged battery so that the discharged battery is re-charged at the vending machine. In US patent no. 6,879,243, issued to Penso Products, Inc. et al., it discloses an electronically controlled locker system for use by a plurality of authorized users.

[0005] Despite development in the prior art, it can be seen that there exists a need for another system to provide safe and secure storage compartments for portable electric/electronic devices with controlled power sockets, for example, for recharging their batteries, be it in educational institutions, libraries, cafes, hotels, airports and so on.

Summary

[0006] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

[0007] The present invention provides a secure storage system for portable electric/electronic devices with controlled power sockets. The system comprises: a station with a plurality of storage compartment, each storage compartment comprises a door, a light indicator, a content sensor, a power socket, an electronic lock operable to lock and unlock the door, and a compartment controller, said compartment controller comprises a lock driver, a light indicator driver, and a power socket switch; a station controller; a card reader; a display panel; a buzzer; and a server; wherein: a user flashes one's identification card near the card reader to request for a storage compartment or request retrieval of one's portable electric/electronic device stored in a compartment; the station controller controls the compartment controllers, each compartment controller in turn controls the lock driver, the

indicator light driver and the power socket switch; the station controller cooperates with the server, the card reader, the compartment controller, the display panel and buzzer to provide man-machine communication with the user; and the power socket provides the user with electric power for the portable electric/electronic device kept in the storage compartment.

[0008] In one embodiment, the light indicator is a selectable green and red indicating light. The indicating light is operable to illuminate or flash. In addition, a buzzer is provided. The buzzer provides visual and audio alerts.

[0009] In another embodiment, the server comprises a database, a data-logger and a dialer. The data-logger records in the database details of storage requests and retrieval and security alerts.

[0010] In another embodiment, the storage system further includes a terminal. The terminal may comprise an administrator terminal, a security terminal and a maintenance terminal. Each of these component terminal hosts its own manager. The administration manager may include a user account manager, a compartment manager and a payment manager. The compartment manager may remind a user via SMS of the use of a compartment near the end of an operating time. The payment manager may charge a fee to a user for use exceeding a predetermined storage period.

[0011] In another embodiment, the security manager alerts a security personnel via an SMS when an alarm is set off.

[0012] In yet another embodiment, the storage system further comprises one or more cell controllers. Each cell controller controls a group of station controllers.

Brief Description of the Drawings

[0013] The present invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0014] FIG. 1 illustrates secure storage compartments for portable electric/electronic devices in accordance with an embodiment of the present invention;

[0015] FIG. 2 illustrates a compartment controller according to another embodiment of the present invention;

[0016] FIG. 3 illustrates a display panel configured according to another embodiment of the present invention;

[0017] FIG. 4 illustrates a carousel arrangement of secure storage compartments for portable electric/electronic devices in accordance with another embodiment of the present invention;

[0018] FIG. 5 illustrates a system configuration according to another embodiment of the present invention;

[0019] FIG. 6 illustrates a further system configuration according to yet another embodiment of the present invention;

[0020] FIG. 7 illustrates input and response control logic of the compartment controller according to another embodiment of the present invention;

[0021] FIG. 8 illustrates a user interaction logic of the station controller according to another embodiment of the present invention;

[0022] FIG. 9 illustrates control logic of the station controller according to another embodiment of the present invention;

[0023] FIG. 10 illustrates a security event according to another embodiment of the present invention; and

[0024] FIG. 11 illustrates the system sending a reminder to a user for extended storage utilization according to a further embodiment of the present invention.

Detailed Description

[0025] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0026] FIG. 1 shows a perspective view of a storage system 100 in accordance with a first embodiment of the present invention. As shown in FIG. 1, the storage system 100 has a cabinet 102 having a row of storage compartments 104. Each compartment 104 is sized and dimensioned to accommodate at least one portable electric/electronic device, such as, a computer notebook, a laptop, a tablet personal computer and so on, together with accessories like a computer bag, a mouse, a charger and some typical interconnecting wires. Each compartment 104 is secured by a door 108 hinged to a side jamb. The side jamb forms a structural part of each compartment 104 or the entire cabinet 102. On the outside of each compartment 104 and directly above the door 108 is a light indicator 112. On the outside face of each door 108 is a label 116 with a unique identification number for identifying each compartment 104. In addition, each door 108 has a handle 118.

[0027] Mounted on the inside of each compartment 104 and near to an upper jamb of each door is an electronic lock 120. The electronic lock 120 is operable to lock or unlock the door 108 of each associated compartment 104. In addition, the inside of each compartment 104 is equipped with a power socket 130. The power socket 130 may be suitable for recharging an energy storage cell, micro-fuel cell or battery or spare battery of a user's portable electric/electronic device. Further, there is a content sensor 140 inside each compartment 104.

[0028] As shown in FIG. 1, there is a compartment controller 150 in each compartment 104. The compartment controller 150 may be located at an upper part of the associated compartment 104. The compartment controller 150 controls the usage of each compartment and its function will be clearer when the operation of the system 100 is described. Each compartment controller 150 is connected to a station controller 160. As shown in FIG. 1, the station controller 160 is installed inside the cabinet 102. Also as shown in FIG. 1, a card reader 170 and a display panel 180 are installed on top of the cabinet 102. The card reader 170 and display panel 180 are each connected to the station controller 160.

[0029] In one embodiment of the electronic lock, the electronic lock 120 has an integrated door sensor 124. In another embodiment, the door sensor 124 (not shown in FIG. 1) is a separate sensor mounted inside each compartment 104 and near to an associated closed door 108.

[0030] In another embodiment of the cabinet 102, the door 108 of each compartment 104 has ventilation louvres 190. Additional ventilation louvres or holes may also be provided at the back-side and/or top-side of the cabinet 102.

[0031] Whilst a cabinet with a row of compartment 104 is shown in FIG. 1, the present invention is not restricted by the arrangement of the compartments. The compartments 104 may be arranged in a single-tier (as shown in FIG. 1), in a double-tier, or in multiple-tiers according to the size of each compartment and available system installation space. In

another embodiment, two or more cabinets are arranged back-to-back to each other. It is also possible to have two or more compartment cabinets arranged in a cluster arrangement, such as in a H-formation.

[0032] The cabinet or a cluster of cabinets 102 in one location form a storage station or storage system 100-1, 100-2, etc. Each storage station or storage system 100-1, 100-2, etc. may require only one station controller 160. In another embodiment, the station controller 160 may be housed in an enclosure separate from the cabinet 102. In yet another embodiment, the card reader 170 and display panel 180 are provided within the cabinet 102.

[0033] In another embodiment, compartments 104 of different sizes are made available at different stations.

[0034] FIG. 2 illustrates an embodiment of the compartment controller 150. As shown in FIG. 2, each compartment controller 150 is connected to the station controller 160 by two power cables 151 and two signal cables 152, 153. The signal cable 152 carries input signals from the station controller 160, whilst the signal cable 153 sends response signals to the station controller 160. Inside each controller 150 are: an electronic lock driver 154, a power socket switch 155, an indicator light driver 156 and a timer 157. The electronic lock driver 154, the power socket switch 155, the indicator light driver 156 and timer 157 are controlled by the respective compartment controller 150, which in turn is controlled by the station controller 160.

[0035] Each electronic lock driver 154 regulates the power to the associated electronic lock 120. Each power socket switch 155 controls power to the associated power socket 130, whilst each indicator light driver 156 controls the power to the associated light indicator 112.

[0036] The light indicator 112 indicates the availability of a compartment 104. When a compartment is occupied, the light indicator 112 lights up. In one embodiment of the

indicator, the light indicator 112 is made of a light-emitting diode (LED). In one embodiment of the LED, the light-emitting diode is of the organic type and emits a selectable red and green light. In another embodiment, the light indicator 112 is made up of two light indicators, one green and another red in colour.

[0037] The card reader 170 is an input device of the storage system 100. Each registered user is issued with a user identification or smart card 174 for requesting a compartment 104 and relinquishing a compartment 104 after use. When a user flashes one's identification card 174, such as a student flashing one's student card, within a reading zone of the card reader, the card reader 170 reads the user identification and sends the user information to the station controller 160 for verification. If the station controller 160 recognises the user as an authorized user, the system 100 then checks the cabinet 102 for an available compartment. When a vacant compartment 104 is available, the station controller 160 hands control over to the compartment controller 150 in compartment 104. In response, the compartment controller 150 causes the indicator light driver 156 to turn ON and the associated "green" light indicator 112 to illuminate and/or flash; at the same time, the compartment controller 150 causes the electronic lock driver 154 to power up and to turn OFF the electronic lock 120 to unlock the compartment door 108. After a user has put one's belonging into the compartment 104, the content sensor 140 senses that the compartment 104 is occupied. Upon the user closing the door 108, the door sensor 124 senses that the door 108 is closed. The signals from the door sensor 124 and content sensor 140 interlock and cause the compartment controller 150 to activate both the lock driver 154 and the electronic lock 120 for locking the door 108; in addition, the compartment controller 150 also causes the indicator light driver 156 to power up, the "green" light indicator light to turn off and the "red" light indicator 112 to illuminate.

[0038] In one embodiment of the compartment controller 150, the activation of the electronic lock 120, door sensor 124 and content sensor 140 interlock and provide a tamper signal 192 to set off an alarm or buzzer 193. If a door 108 of a compartment 104 is forced open when the electronic lock 120 and door sensor 124 are active, the tamper signal 192

sends a signal to the station controller 160 to set of the alarm/buzzer 193. In one embodiment, the alarm/buzzer 193 provides an audio alert. In another embodiment, the alarm/buzzer 193 provides a visual alert. In yet another embodiment, the alarm/buzzer 193 provides both audio and visual alerts. The audio alerts may have different tones or frequencies to represent different alert signals, for example short and long beeping sounds. In another embodiment of the compartment controller 150, an additional or alternative tamper or theft sensor 195 is provided for each compartment 104. In another embodiment, the buzzer 193 provides a man-machine communication with the user, in addition to a text message 183 on the display panel 180 and indicator light 112. For example, when a compartment is allocated by the station controller 160,260, the green indicator light 112 may flash and the buzzer 193 may emit a short beeping sound; if no vacant compartment is available, the red indicator light 112 may flash and the buzzer may emit a long beeping sound. Further details of the above process flow will be described with reference to FIGs. 7-9.

[0039] FIG. 3 shows the display panel 180 for use in the present invention. As shown in FIG. 3, the display panel 180 has a display screen 182. In one embodiment of the display panel, the display screen 182 is programmed as a touch screen with a text box 183, a blue button 184, a red button 185 and an OK confirmation button 186. The functions of the display panel and screen buttons will be clearer when the operation of the system is described with the flow charts shown in FIGs. 7-9.

[0040] In another embodiment of the display panel, the display panel 180 has, additionally, a speaker 187. In use, the speaker 187 is configured as the alarm/buzzer 193.

[0041] FIG. 4 shows a carousel system 200 of compartments according to a second embodiment of the present invention. As shown in FIG. 4, the storage compartments 204 are arranged around the peripheral face of a circular cabinet or carousel 202. As in the first embodiment, each compartment 204 has a door 208, a light indicator 212, a compartment identification number 216, a door handle 218, an electronic lock 220, a door sensor 224 (not

shown), a power socket 230 (not shown), a content sensor 240 (not shown), a compartment controller 250 (not shown), ventilation louvers 290, and so on. As shown in FIG. 4, the compartments 104 are grouped into three stations 200-1, 200-2, 200-3. Each station has a station controller 260, a card reader 270 and a display panel 280, such that when a user flashes one's identification card 174 at a station, all the compartment doors 108 in this station are within view of the user. While FIG. 4 shows a three-tiers carousel, one, two or more than three tiers may be provided. In addition or alternative, the carousel may be rotatable in another embodiment.

[0042] FIG. 5 shows a system architecture 300 according to the storage system 100, 200 of the present invention. As shown in FIG. 5, the storage system 100, 200 is made up of a server 310, a system terminal 320, a database 330, a data-logger 340, a dialer 350, the cabinet 102, 202 having a plurality of compartments 104, 204, compartment controllers 150, 250 and the station controllers 160, 260. The system terminal 320, the database 330, the data-logger 340, the dialer 350 and the station controller 160, 260 are separately in communication with the server 310.

[0043] The system terminal 320 is a computer that provides a man-machine interface with the server 310. In one embodiment of the system terminal, the system terminal 320 hosts a program P that allows an administrator to directly control an application running in the server 310 and indirectly the entire system 100, 200. In another embodiment, the system terminal 320 is made up of three separate terminals 321, 322, 323. The first terminal 321 may be used by an administrator, the second terminal 322 by a security personnel, and the third terminal 323 by a maintenance personnel. A program P-322 running on the security terminal 322 may provide limited administrative but enhanced security features than a program P-321 running on the administrative terminal 321. Similarly, a program P-323 running on the maintenance terminal 323 may also provide limited administrative features but enhanced trouble-shooting features than that of P-321.

[0044] In an embodiment of the administrative program, the administrative program P-321 includes a User Account manager 321a, a Compartment manager 321b and a Payment manager 321c. The functions of the User Account, Compartment and Payment managers will be described with the flow charts shown in FIGs. 7-9.

[0045] By providing separate system terminals 320 for personnel with different levels of authority, the entire system 100, 200 is more secure. For example, the security personnel may come from a security contractor, whilst the maintenance personnel may come from a separate computer contractor. At the same time, the system can be modular. For example, the administrator terminal 321 may be located at an administrative office and the security terminal may be located a separate security office. The maintenance terminal 323 may not be physically provided; the maintenance program P-323 may be launched by the maintenance personnel at the administrative or security terminal when maintenance is due; it is also possible that the maintenance terminal 323 is a portable computer that is plugged onto the server 310 during maintenance. Similarly, the number of compartment controllers 150,250 can be expanded and configured as a need arises.

[0046] As shown in FIG. 5, the data-logger 340 is connected to the server 310; it communicates with the database 330 for capturing each transaction relating to each compartment and each user, and records details entered at the system terminal 320 (including administrative, security and maintenance records).

[0047] In one embodiment of the storage system 100, 200, communication between the system terminal 320 (including the administrative terminal 321, the security terminal 322 and the maintenance terminal 323), the database 330 and the station controller 160, 260 with the server 310 is via wires, electrically or optically. In another embodiment, the communication is wireless.

[0048] FIG. 6 shows another system architecture 400 of the present invention. Just as in the first embodiment, the storage system 400 has a server 410, a database 430, a database logger

440, a dialer 450, an administrative terminal 421, a security terminal 422, a maintenance terminal 423, a plurality of station controllers 160, 260, a plurality of cabinets 102, 202 and a plurality of compartments 104, 204 in each cabinet 102, 202. In addition, the system 400 has a cell controller 460. The cell controller 460 controls a plurality of station controllers 160, 260. For example, in an educational institution, a cell controller 460 may be located in each faculty and each station controller 160, 260 controls a cluster of cabinets 102, 202 and compartments 104, 204; in other organizations, a cell controller 460 may be located in each department. In another implementation, a cell controller 460 may be located in each floor of a multi-storey building and a station controller 160, 260 controls a cluster of cabinets and compartments located on the same floor.

[0049] In one embodiment of the system architecture 400, the server 410 is a system application server, which is accessed by a web-client 420W or plurality of web-clients 420W. The web-client 420W may be an administrator 421, a security officer 422, a maintenance officer 423 or an end-user. The web-clients 420W connect to the system application server via the internet. In use, each web-client 420W is given authority, preferably with a log-in name and pass-word, to access the system application server 410 according to the user's role, either as an administrator, a security officer, a maintenance office or an end-user. Each web-client 420W accesses the system application by launching an internet explorer and a web-enabled software is invoked to interface with the system application server 410; no pre-loading of such web-enabled application software into a user's computer is required. In addition, an administration manager 421 and security manager 422 are always running in the system application server 420 to monitor the use and security of all the compartments.

[0050] An operation of the storage system 100, 200 is now described: FIG. 7 illustrates the input signal 152 commands to each compartment controller 150, 250 from the respective station controller 160, 260 according to an embodiment 700 of the present invention. As shown in FIG. 7, each compartment controller 150, 250 receives an input signal 152 from the station controller 160, 260 in step 704. In step 710, the input signal 152 is checked whether it

contains a SELECTED signal. The SELECTED signal informs the compartment controller 150,250 that a user has made a request by flashing the user's identification card 174 near to the card reader 170 and the station controller 160,260 determines that a compartment 104,204 is available in this station. If the decision in step 710 is YES, the compartment controller turns ON the light indicator driver 156 and illuminates, for example the BLUE, light indicator 112,212 in step 714. In another embodiment, the light indicator driver 156 flashes, for example the RED, indicator light 112,212 in step 714.

[0051] If the decision in step 710 is NO, the process flow proceeds to step 720 in which the input signal 152 is checked whether it contains an UNSELECTED signal. If the decision in step 720 is YES, the compartment controller 150,250 turns OFF the light indicator driver 156 and the light indicator 112,212 is extinguished. If the decision in step 720 is NO, the process flow proceeds to step 730.

[0052] In step 730, the input signal 152 is checked whether it contains a power-off command. If the decision in step 730 is YES, the power to the compartment controller 150,250 is turned OFF. If the decision in step 730 is NO, the compartment controller 150,250 checks whether the station controller command signal contains a STORE or RETRIEVE signal in step 740.

[0053] In step 740, if no STORE or RETRIEVE signal is received, the compartment controller sends a COMMAND REJECTED reply, in step 744, to the station controller 160,260. If the decision in step 740 is positive, the process flow proceeds to step 748.

[0054] In step 748, the compartment controller 150,250 responds by turning OFF the electronic lock driver 154, thereby unlocking the compartment door 108. At the same time, the compartment controller 150,250 turns ON the timer 157, in step 750, for the user to complete putting one's electronic device(s) into the compartment 104,204. This is done by checking whether the user has opened the compartment door 108 in step 760.

[0055] If the decision in step 760 is NO, the compartment controller 150,250 checks, in step 762, whether the time set in the timer 157 has elapsed. If the decision in step 762 is YES and the time set in the timer has elapsed, the compartment controller 150,250 turns ON the electronic lock driver 154 to lock the compartment 104,204 in step 764. After locking the compartment in step 764, the compartment controller 150,250 sends a COMMAND EXPIRED reply, in step 766, to the station controller 160,260.

[0056] If the decision in step 760 is YES, the process flow proceeds to step 768. In step 768, the timer 157 is re-set again for the user to complete putting one's electronic device(s) into the compartment 104,204. The process flow then proceeds to step 770.

[0057] In step 770, the compartment controller 150,250 checks whether the compartment door 108,208 is closed by the user. If the decision in step 770 is NO, the compartment controller 150,250 checks, in step 772, whether the time set in the timer 157 has elapsed. If the decision in step 772 is YES and the time set in the timer has elapsed, the compartment controller 150,250 sends a COMMAND UNCOMPLETED reply, in step 774, to the station controller 160,260. If the decision in step 770 is YES and the user has closed the compartment door 108,208, the compartment controller 150,250 responds by turning ON the electronic lock driver 154, in step 780, and sending to the station controller 160,260 a COMMAND DONE reply in step 784.

[0058] After the user has opened the compartment door 108,208 in step 760, put one's electronic devices into the allocated compartment 104,204, the content sensor 140,240 is activated. As soon as the compartment door 108,208 is closed and the door sensor 124,224 is activated, the compartment controller 150,250 turns ON the power socket switch 155,255 and re-sets the compartment timer 157. The allocated compartment is then monitored and tracked for security and payment purposes. Monitoring and tracking of the compartment will be described with the flow chart shown in FIG. 9.

[0059] FIG. 8 illustrates a process flow of a user wishing to use the storage system 100,200. As shown in FIG. 8, the user flashes one's identification card 174 within the read zone of the card reader 170, 270, in step 804. The card reader 170,270 then sends the user identification to the station controller 160,260. The station controller 160,260 sends a query, in step 810, to the database 330,340 whether the user is registered. If the decision in step 810 is NO, the station controller 160,260 sends a signal to the display panel 180 to display a message informing the person flashing the identification card 174 that the identification in the card is not a registered user. At the same time, the station controller 160,260 sets the OK confirmation button 186 active in step 814. The station controller 160,260 then pauses for a response from the user. In addition, a station timer 165 is set, in step 886, for example, to count down. Upon the user activating the OK confirmation button 186,286 on the touch screen 182,282 or the time for response has expired, the station controller 160,260 clears the display message and deactivates the OK button 186 in step 888. The station controller then proceeds, in step 890, to end the control process initiated by a user flashing one's identification card 174 at the card reader 170,270. In an embodiment of the logic control 700 of the compartment controller 150,250, a plurality of users can flash their own identification card 174 at the card reader 170 without having to wait for the compartment controller 150,250 to complete processing another user's request.

[0060] If the station controller's decision in step 810 is YES, the station controller 160,260 sends a query, in step 820, to the database 330,430. In step 820, a decision is made whether the user has occupied any other compartment in another cell and/or station. If the decision is YES, the station controller 160,260 sends a signal to the display panel 180,280 and informs the user, in step 824, by displaying a message such as: "Your item is not stored in this station. Please go to station xxx." At the same time, the station controller 160,260 sets the OK confirmation button 186,286 active in step 824. The station controller 160,260 then pauses for a response from the user before the process proceeds to steps 886, 888 and 890.

[0061] If the decision in step 820 is NO, the station controller 160,260 checks, in step 830, whether the user has occupied any compartment in the present station. If the decision in step

830 is NO, the process flows to step 860. In step 860, the station controller 160,260 queries the database 330,430 and checks the balance in the user account. If user account does not have sufficient balance, the station controller proceeds to step 864, sends a signal to the display panel 180,280 and displays a message to the user, such as: "Your account balance is \$yy. Please top-up your account!." At the same time, the station controller 160,260 sets the OK confirmation button 186,286 active in step 864. The station controller 160,260 then pauses for a response from the user before the process proceeds to steps 886, 888 and 890.

[0062] If the user account balance is positive, the process control in step 860 proceeds to step 870. In step 870, the station controller 160,260 checks whether all the compartments 104,204 in the present station are occupied. If all the compartments 104,204 are occupied and the decision in step 870 is YES, the station controller 160,260 queries the database 330,430 for any un-occupied compartment in neighbouring stations in step 880.

[0063] If the decision in step 880 is NO, the station controller 160,260 sends a signal to the display panel 180,280 in step 882 and displays a message to the user, such as: "This station is full. Compartments are available in station zz." At the same time, the station controller 160,260 sets the OK confirmation button 186,286 active. If the decision in step 880 is YES, the station controller 160,260 sends a signal to the display panel 180,280, in step 884, and displays a message to the user, such as: "All the stations are full." At the same time, the station controller 160,260 sets the confirmation button 186,286 active. In either event, the station controller then pauses for a response from the user before the process proceeds to steps 886, 888 and 890.

[0064] If the decision in step 830 is YES and the user has occupied a compartment 104,204 in the present station, the process in the station controller 160,260 proceeds to step 832. In step 832, the station controller 160,260 sends a SELECT command to the associated compartment controller 150,250. The process control in the compartment controller 150,250 proceeds as described in FIG. 7. At the same time, the process control in the station controller 160,260 proceeds to step 834.

[0065] In step 834, the station controller 160,260 sends a signal to the display panel 180,280 and issues a message to the user, such as: “Your item is stored in compartment ww.” At the same time, the station controller 160,260 sets all the blue button 184, red button 185 and OK confirmation button 186 active. The blue button is assigned to function as a RETRIEVE button, whilst the red button 185 is assigned to CANCEL the process control. The process in the station controller then proceeds to step 836.

[0066] In step 836, the station controller 160,260 starts the station timer 165, for example, to count down. The process control then proceeds to step 840.

[0067] Going back to decision step 870, if the decision is NO and a vacant compartment 104,204 is available, the process in the station controller 160,260 proceeds to step 872. In step 872, the station controller 160,260 sends a SELECT command to the compartment controller 150,250 associated with a vacant compartment 104,204. In addition, the station controller 160,260 also sends a signal to the display panel 180,280, in step 874, and displays a message to the user, such as: “The compartment allocated to you is vv.” At the same time, the station controller 160,260 sets all the blue 184, red 185 and OK confirmation 186 buttons active. The blue 184 button is assigned to function as a STORE button and the red button 185 assigned to CANCEL the compartment allocated. The station process control then continues with step 836.

[0068] In step 840, the station controller 160,260 checks whether the user has completed storing one’s electric device inside the allocated compartment 104,204 or retrieved one’s belongings from the occupied compartment 104,204. The station controller also checks whether the user has activated the OK confirmation button 186 after storing or retrieving the belongings. If the decision in step 840 is NO, the station controller checks, in step 844, whether the user has activated either the RETRIEVE button 184 or STORE button 184.

[0069] If the decision in step 844 is YES, the process control proceeds to step 848. In step 848, if the user has activated the STORE button 184, the newly occupied compartment 104,204 number is updated in the database 330,430 and the use and security of the compartment 104,204 are added to a watch list for monitoring, for example by the security manager 322a running at the security terminal 322. If the user has activated the RETRIEVE button 184, the identification number 116,216 of the newly un-occupied compartment 104,204 is updated in the database 330,430 and added to a watch list for monitoring, for example by the compartment manager 321b. In either event, the station controller 160,260 additionally disables the signal to the display panel 180,280 and clears the function assignments of the red, blue and OK confirmation buttons in step 888, before ending the process control loop at step 890.

[0070] If the blue button 184 is not activated for retrieval or storage, the station controller 160,260 continues to monitor the time elapse of the station timer 165 in step 850. If time of the station timer 165 has not elapsed in step 850, the process control loops back to decision step 840. If the time of the station timer 165 has elapsed in step 850, the station controller 160,260 sends an UNSELECTED COMMAND to the compartment controller 150,250 in step 856. The process control then executes steps 888, before ending the process control loop at step 890.

[0071] FIG. 9 illustrates the control logic of the station controller 160,260 in response to the reply signal 153 from the compartment controller 150,250. The control logic in FIG. 9 begins with step 910. In step 910, the station controller 160,260 receives the reply signal 153, and proceeds in step 920 to determine whether an earlier command to the compartment controller 150,250 has been carried out.

[0072] If the compartment controller response signal 153 in decision step 920 contains a DONE reply, the station controller 160,260 updates the completed transaction in the database 330,430. At the same time, the station controller removes the compartment number from the watch list monitored by the security manager 322a or compartment manager 321b.

Once, the control logic from the compartment controller 150,250 is passed over to the station controller successfully, for example, by some handshaking protocol, the control logic proceeds to step 990 and the logic cycle initiated by a user flashing one's identification card 174 near the card reader 170, 270 ends.

[0073] If the decision in step 920 is NO and the response does not contain a DONE reply, the station controller 260,260 proceeds with step 930. In step 930, a decision is made whether the response contains a REJECTED reply. If the reply is REJECTED, the control logic proceeds to step 934.

[0074] In step 934, the station controller 160,260 identifies the compartment controller 150,250 as faulty and informs the compartment manager 321b of the state of the associated compartment 104,204. In response, the compartment manager 321b updates the database 330,430, informs the maintenance manager 323a and alerts the security manager 322a. Once the actions in step 934 are executed, the control logic terminates by executing step 990.

[0075] If the decision in step 930 is NO and the response does not contain a REJECTED reply, the station controller 160,260 proceeds to step 940. In step 940, a decision is made whether the response contains a FAILED reply. If the reply is FAILED, the control logic proceeds again to step 934.

[0076] If the decision in step 940 is NO and the response does not contain a FAILED reply, the station controller 160,260 proceeds to step 950. In step 950, a decision is made whether the response contains an EXPIRED reply. If the reply is EXPIRED, the control logic proceeds to step 928 and terminates at step 990.

[0077] If the decision in step 950 is NO and the response does not contain an EXPIRED reply, the station controller proceeds to step 960. In step 960, a decision is made whether the response contains an UNCOMPLETED reply. If the reply is UNCOMPLETED, the control logic proceeds to step 970.

[0078] In step 970, the station controller 160,260 checks whether the reply signal 153 corresponds to a user's RETRIEVE request. If the decision in step 970 is YES, the station controller 160,260 proceeds to step 974.

[0079] In step 974, the station controller 160,260 updates the database 330,430 and enters the transaction details of associated compartment and user in the data-logger 340,440 and user account. Once the compartment and user details are updated by the system application server 310,410, the process flows to step 978.

[0080] In step 978, the compartment allocated by the station controller 160,260 is removed from the watch list and is then made available to other users. Once this is done, the station controller control logic ends in step 990.

[0081] If the decision in step 970 is NO, the station controller 160,260 control process jumps to step 978.

[0082] If the decision in step 960 is NO, it means that there is an abnormal occurrence at the selected compartment 104,204. The abnormal occurrence may be caused by a user not closing the compartment door 108,208 after the compartment 104 is allocated after a storage request or after retrieving one's belonging. The station controller 160,260 logic control then proceeds to step 980. In step 980, station controller 160,260 identifies the error with the associated compartment 104,204 and informs the compartment manager 321b. In response, the compartment manager 321b updates the database 330,430 and data-logger 340,440, and alerts the security manager 322a. Once the actions in step 980 are executed, the control logic stops by executing step 990.

[0083] FIG. 10 illustrates a process flow 1000 in the security manager 322a. If a compartment door 108 is forced open, in step 1010, when the electronic lock 120, 220 and door sensor 124, 224 are active, the tamper signal 192 signals the compartment controller

150,250, in step 1020, to activate the security manager 322a for setting off the alarm/buzzer 193, for example, with a siren alert, in step 1024. The compartment controller 150,250 also activates the data-logger 340,440 to keep records, in steps 1030 and 1060, of the compartment number 116,216 belonging to compartment 104,204 that triggers off the siren alert, including the date and time of the incident. In addition or alternatively, the security manager 322a activates the dialer 350,450, in step 1040, to send an alert signal to the security station, for example, via a short-message service (SMS). The siren in step 1024 continues until a security staff checks the alarm situation and deactivates the siren, in step 1050. In yet another embodiment of the storage system, the signal from the theft sensor 195 triggers the security manager 322a and siren alert.

[0084] FIG. 11 illustrates a process flow 1100 for reminding a user that the user is still occupying a compartment 104,204 near the end of a scheduled operating time. As shown in FIG. 11, the compartment manager 321b signals the station controller 160,260 to check all the system's 100,200 compartments 104,204 before the end of the scheduled operating time, in step 1110. For example, the compartment manager 321b signals the station controllers 160,260 and the compartment controllers 150,250 to check the compartments before a school library closes at 9:00 pm. In step 1120, the compartment controllers 150,250 check each and every compartment 104,204 whether any compartment is occupied. If a compartment remains occupied after the scheduled operating time, the compartment manager 321b identifies the compartment number 116,216 and the user identification from the records kept in the database 330,430 by the data-logger 340,440, in step 1130, and activates a dialer 350,450, in step 1140, to send a reminder to the respective user. In one embodiment, the dialer 350,450 sends a reminder to the respective user via a short-message service (SMS). In response to the system's reminder, the user collects his/her belonging and vacates the respective compartment 104,204 in step 1150. If the compartment 104,204 remains occupied, for example, after two reminders, the system 100, 200 activates the payment manager 321c to charge a fee to the respective user for use exceeding the storage period. In one embodiment, the fee is entered electronically into the respective user account for each extended storage period and a fee is deducted by the payment manager 321c. The

storage period may be daily, weekly or periodically as contracted by a user. The date, time and amount of payments are also recorded by the data-logger 340,440.

[0085] In addition to the security terminal 322, the storage system 100,200 according to the present invention includes a security station. The security station has a panel alarm board. The panel alarm board mimicks the location of the alarms at each storage cell and station. In another embodiment of the security station, cameras also provided to monitor each storage cell or station. In another embodiment of the security station, a back-up power supply is provided. Preferably, the back-up power supply supplies power to the station controllers 160,260, cell controllers 460 and security station. This is to ensure that all the compartments 104,204 in the storage system 100, 200 remain in the locked state and the security station is still enabled.

[0086] In an embodiment of the storage system 100, 200, security features are additionally built into the station controller 160,260. For example, all the electronic locks 120, 220 are in the normally lock mode and a resilient member 109, such as a spring, is provided at each door 108 to bias the door to the close position. In the event that a user gives up a compartment after flashing one's card, the additional spring 109 closes the door and after a time-out period, the compartment controller 150,250 would detect that the content sensor 140, 240 is not activated and would then recognize that a compartment is unoccupied and becomes available for other users.

[0087] The present invention provides several advantages. For example, the station controller 160,260 assigns a vacant compartment 104,204 to a user on demand. Such compartment assignment is automatic and it may be random or based on a rule built in the station controller 160,260 and compartment manager 321b; this is to regulate even usage of the compartments so that wear and tear of the compartments are more uniform. A second advantage is that the user does not need to remember the compartment number 116,216 when retrieving one's belonging from a compartment 104,204; the user simply flashes one's identification card 174 near a card reader 170,270 and the station controller 160,260

indicates to the user the compartment in use by illuminating/flashing the indicator light 112, 212 associated with the compartment. In addition or alternatively, the user identification and compartment number 116 are shown on the display panel 180,280. A third advantage is that the content sensor 140, 240 allows the compartment controller 150,250 to detect whether a compartment assigned to a user is occupied after a time-out period. This allows the use of the compartments to be optimised. A fourth advantage is the provision of a secure and convenient storage compartment for one's portable electric/electronic device, even for an extended period from the scheduled operating time, albeit at a cost. The fifth advantage is the provision of a power socket, for example, for charging the battery of one's portable electric/electronic device when it is stored away in a compartment of the present system.

[0088] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention. For example, the system 100, 200 may be modified so that a user may be allowed to use two or more compartments at any one time according to a predetermined number programmed in the compartment manager software. In another example, the storage system 100,200 may be located in a laboratory and the electric device may be a fridge, an incubator, and so on where the specimen stored in the system need to be secure and monitored.

CLAIMS:

1. A secure storage system for a portable electric/electronic device requiring a power socket, the system comprising:

a station with a plurality of storage compartment, each storage compartment comprises a door, a light indicator, a content sensor, a power socket, an electronic lock operable to lock and unlock the door, and a compartment controller, said compartment controller includes a lock driver, a light indicator driver, and a power socket switch;

a station controller;

a card reader;

a display panel;

a buzzer; and

a server;

wherein:

a user flashes one's identification card near the card reader to request for a storage compartment or request retrieval of one's portable electric device stored in a compartment;

the station controller controls the compartment controllers, each compartment controller in turn controls the lock driver, the indicator light driver and the power socket switch;

the station controller cooperates with the server, the compartment controller, the card reader, the display panel and buzzer to provide man-machine communication with the user; and

the power socket provides the user with electric power for the portable electric device kept in the storage compartment.

2. A secure storage system according to claim 1, wherein the light indicator comprises a selectable "green" and a "red" indicating light, which is operable to illuminate continuously or to flash.

3. A secure storage system according to claim 2, wherein the indicator light is "green" when a storage compartment is vacant and the indicator light is "red" when a storage compartment is occupied.
4. A secure storage system according to any one of the preceding claims, wherein the buzzer provides a visual alert and audio alert.
5. A secure storage system according to claim 4, wherein the visual alert is a flashing light and the audio alert is a beeping sound.
6. A secure storage system according to claim 5, wherein the visual alert is a "green" flashing light and the audio alert is a short beeping sound when the station controller determines that a vacant storage compartment is available.
7. A secure storage system according to claim 5, wherein the visual alert is a "red" flashing light and the audio alert is a long beeping sound when the station controller determines that no vacant storage compartment is available.
8. A secure storage system according to claim 5, wherein the visual alert is a "red" flashing light and the audio alert is a short beeping sound when a user requests retrieval and the system unlocks a door to the storage compartment in use.
9. A secure storage system according to claim 5, wherein the visual alert is a "red" flashing light and the audio alert is a long beeping sound when a user requests retrieval and the station controller determines that no storage compartment is in use by the user.
10. A secure storage system according to any one of the preceding claims, wherein the server comprises a terminal, a database, a data-logger and a dialer.

11. A secure storage system according to claim 10, wherein the data-logger records in the database the user identification, data and time of making a storage request or storage retrieval, the location of the station, and the date and time of trigger of an alert at the buzzer.
12. A secure storage system according to claim 10, wherein the system terminal hosts a system program.
13. A secure storage system according to claim 12, wherein the system terminal is configured as an administrator terminal, a security terminal and a maintenance terminal and wherein the system program hosted in each terminal has its own manager.
14. A secure storage system according to claim 13, wherein the administrative manager comprises a user account manager, a compartment manager and a payment manager.
15. A secure storage system according to claim 14, wherein the compartment manager reminds a user via SMS that a storage compartment is still in use near the end of the storage operating time.
16. A secure storage system according to claim 14 or 15, wherein the payment manager charges a storage fee to a user for use exceeding a predetermined storage period.
17. A secure storage system according to any one of claims 13-16, wherein the security terminal is located at a security station.
18. A secure storage system according to claim 17, wherein the security station is equipped panel alarm board, which mimicks the location of each station.
19. A secure storage system according to claim any one of claims 13-18, wherein the security manager sends an SMS to a security personnel when a tamper signal or theft sensor is triggered and the security of a compartment is compromised.

20. A secure storage system according to any one of the preceding claims, wherein the display panel is a touch screen and the screen is programmed to provide a green button, a red button and an OK confirmation button.
21. A secure storage system according to any one of the preceding claims, wherein the compartment controller comprises an input command signal and a reply response signal.
22. A secure storage system according to claim 21, wherein the input command signal is any one of the following: selected; unselected; power-off; and store/retrieve.
23. A secure storage system according to claim 21, wherein the reply response signal is any one of the following: done; rejected; expired; uncompleted; and failed.
24. A secure storage system according to any one of the preceding claims, further comprising one or more cell controllers, wherein each cell controller controls a group of station controllers.
25. A secure storage system according to claim 24, wherein each cell controller is located in each floor of a multi-storey building.
26. A secure storage system according to claim 24, wherein each cell controller is located in each faculty or department.
27. A secure storage system according to any one of the preceding claims, wherein each door further comprises a resilient member to bias the door to its close position.
28. A secure storage system according to claim 10, wherein the server comprises a system application server, the terminal comprises one or more web-client terminals, and a

web-client connects to the system application server via the internet according to the role and authority assigned to the web-client.