Title: A KEYPAD, AN ELECTRONIC DEVICE, AND A METHOD OF CHANGING THE APPEARANCE OF ONE OR MORE KEYS

Abstract: A method of changing the appearance of one or more keys (101) in a keypad (100) of an electronic device (103), is characterized in that the appearance of the key (101) or keys (101) is changed by individually changing the transparency or colour of an electrochromic element (203) in each key responsive to a control signal.
A keypad, an electronic device, and a method of changing the appearance of one or more keys

Background art

The touch’n feel of different electronic devices has generally improved during the last few years. Nevertheless, the man-to-machine interface is still under intensive development work. For example, some manufacturers of mobile terminals bring each year a two-digit number of new models onto the market. While the consumers' awareness has grown, their demands have increased as well. A trend based on user surveys therefore shows that personalization of different electronic devices is still an important factor in pursuing customer satisfaction.

Summary of the invention

An object of the invention is to bring out an improved keypad enabling easy personalization and a new structure. This object of the invention can be achieved in the manner as shown in any one of claims 1 to 6.

Another object of the invention is to bring out an electronic device utilizing the improved keypad. This can be achieved in the manner as in any one of claims 7 to 11.

A still further object of the invention is to bring out a method for changing the appearance of one or more keys in a keypad of an electronic device. This can be achieved in the manner as described in any of claims 12 to 14.

Advantages of the invention

A key can, depending on the electrochromic material chosen, be changed from an opaque state to transparent state, or from one colour to another. In this manner the possibilities to personalize the looks of the keypad can be increased.
When the layer of electrochromic material is connected to connecting means for providing an electrical connection to a control means or to a battery so that the connecting means are adapted to allow an up- or down movement of the layer together with the key, the transparency or colour of the layer of electrochromic material in a key can be changed regardless of the position of the key. At least one key can thus be made movable, thus improving the comfort of using the keypad.

By adding a coloured layer underneath the layer of the electrochromic material, the effect of changing the colour of a key can be achieved also by using a simpler material in the electrochromic layer.

If the coloured layer is exchangeable, the user can easily replace it, possibly even with another one having a different colour. This improves the personalization capabilities further.

If a light source is placed under the layer of electrochromic material, a new manner for back-lighting the keyboard can be obtained. Furthermore, depending on the transparency or colour of the layer of electrochromic material, the feel of personalization can be improved.

If a symbol marking is applied on or above the layer of electrochromic material, it can be ensured that the possible change of transparency, i.e. when the layer of electrochromic material turns towards opaque, does not negatively affect the user comfort e.g. by screening the key codes.

An electronic device comprising a keypad as in any one of claims 1 to 5, and means for defining the transparency or colour of the layer of electrochromic material in a number of keys in the keypad, corresponding to a state of the electronic device, can be used to improve the versatility of
the device. The user can be notified of the state of the electronic device. The user control of some applications can be made more instinctive, for example, by setting the appearance of a number of keys to show that these keys are either enabled or disabled. The effect of this feature can be further improved if the transparency or colour is changed responsive to a state change of the electronic device. Then responsive to a state change, the keys that are to be used in giving user input can have an appearance differentiating them from other keys of the keypad.

List of Figures

In the following, the invention is described in more detail with reference to the examples shown in the appended drawings in Figures 1 to 7C, wherein:

Figure 1A shows a keypad comprising a number of keys;

Figure 1B illustrates an electronic device comprising the keypad;

Figure 2A is a section of a key in the keypad;

Figure 2B is a top view of a key in the keypad;

Figure 2C shows an exploded view showing some structural elements of an illuminated key in the keypad;

Figure 2D shows the illuminated key assembled;

Figure 3 shows a schematic control means for controlling the keypad;

Figure 4A shows a schematic switching unit used in the control means;
Figure 4B shows a second switching unit used in the control means;

Figures 5A and 5B show two predetermined patterns illustrating different transparency or colour of the keys;

Figure 6 shows an electronic device in communication with a network, a peer electronic device, and with a ticket inspecting device; and

Figures 7A, 7B, and 7C show an electric device, an exchangeable coloured layer, and a layer of electrochromic material for a number of keys.

Detailed Description

Figure 1A shows a keypad 100 comprising a number of keys 101. There are different kinds of keypads. For example a keypad used in a mobile telephone might have ten number keys (0 to 9) for dialling numbers and then some special keys, such as * and # for giving commands to the network. With such a keypad, some or all of the number keys together with special keys can be used for entering text when necessary. However, there are also different kinds of keypads, like some comprising two rows of five keys each. Keyboards like those used in computers usually comprise 87 or some 102 keys. In some devices, like stereo recorders, or CD or MP3 players, the number of keys may then be substantially smaller. For understanding the invention, the exact number of keys is irrelevant but the invention may be carried out in different keypads.

Figure 1B illustrates an electronic device 103 comprising a keypad 100 as shown above. Furthermore, the electronic device 103 comprises a display 105. In addition to examples listed above, the specific examples further comprise different household machines (TV sets, DVD players, washing machines,
stoves), their remote controls, and front panels of cars and motorbikes.

Figure 2A is a section of a key 101 in the keypad 100. The key 101 comprises a layer 203 of electrochromic material. In a first embodiment of the invention, the layer 203 of electrochromic material is the uppermost layer. In a second embodiment, it is further covered by a protective layer.

The layer 203 of electrochromic material is assembled onto a support member 201. The support member may comprise leads 209 from control means 300 to the layer 203 of electrochromic material. Instead of a lead 209, copper or other metallic wires, or any other suitable means for effecting a change of electric field can be used. To effect this, there may be a suitable passage in the support member 201 to accommodate the lead 209. The support member 201 resides on switch 200, the switch 200 comprising leads 211 connected to control means 300 for giving user input.

If the key 101 is depressed, the switch 200 is closed, thereby changing the potential in leads 211. This effect can be detected in the control means 300, and, depending on a state of the electronic device 103 whereto the keypad 100 is connected.

Furthermore, between support member 201 and support 213 of switch 200, there may be sealing 207, such as a silicon ring, for isolating the switch 200 from dust, dirt, or moisture. The sealing 207 as well as the support member 201 are optional for carrying out the invention.

The leads 209 are connected to two sides of the layer 203 of electrochromic material. Their purpose is to change electric field over the layer 203 of electrochromic material. The electrochromic material changes its transparency or colour in response to a change in the electric field.
Figure 2B is a top view of a key in the keypad. Now the layer 203 of electrochromic material is on the top i.e. if it is not completely transparent, it is visible for a user. The layer 203 of electrochromic material may have any form. For aesthetic reasons oval, round, square, and rect- or triangular forms are preferable. The layer 203 of electrochromic material does not need to extend over the whole key 101 but the support member 201 may also form a part of the outer surface thereby protecting the layer 203.

Figure 2C shows an exploded view showing some structural elements of an illuminated key 101 in a keypad 100. In addition to the layer 203 of electrochromic material there are shown a coloured layer 205. The coloured layer is preferably at least partly transparent, thereby acting as a filter. In the embodiment where there is further a light source 225, such as a lamp, the coloured layer 205 should not be opaque. Furthermore, a rim 221 is shown. The layer 203 of electrochromic material may further comprise a symbol marking 217, such as a printing or molded form, applied on or above the layer 203 of electrochromic material, representing the value of the key 101.

Figure 2D shows the illuminated key 101 assembled in the keypad 100. The coloured layer 205 is assembled underneath the layer 203 of electrochromic material. The rim 221 penetrates into corresponding rails 223 preferably assembled onto the support 213 of switch 217. The leads 209 for leading a voltage to the layer 203 of electrochromic material can be joined through the rails to the rim 221 which preferably is then metallic for providing a good electrical conductivity. The light source 225 can be assembled below the coloured layer 205 and the layer 203 of electrochromic material.
The layer 103 of electrochromic material can have an opaque resting state. According to an input control signal, a number of predetermined keys 101 are changed to transparent state.

If the electrochromic material has multicolour characteristics, the coloured layer 205 is preferably omitted out, because then the layer 203 of electrochromic material can be changed to have a particular colour by means of changing the electric field over it.

Figure 3 shows schematic control means 300 for controlling the keypad 100. Control means 300 comprises a switching block 315 controlled by a processing unit 303, such as a microprocessor. The processing unit 303 is connected via a bus to display 105, to memory 305, and to communication means 307. Communication means 307 comprise Bluetooth, infra-red, or cellular radio communications means and can be used also for receiving of data.

The switching block 315 comprises a number of switch units 311. The switch units 311 are used to control the electric field over the layer 203 of electrochromic material in a number of keys 101 in the keypad 100. This can be carried out by switching a voltage from a rechargeable battery 301 to a number of keys 101.

Figure 4A shows a schematic of a switch unit 311 used in the control means 300. A switch SW is controllable by a control signal from the processing unit 303. The switch SW can connect terminal $T_1$ to terminal $T_2$ or to terminal $T_3$. When it connects terminal $T_1$ to terminal $T_2$, the resistance over the practically infinite (several $k\Omega$) resistor 401 vanishes, so that the voltage can be risen. For fine-tuning, the potentiometer 403 controllable by the processing unit 303 can also be used to adjust the electric field over the layer 203 of electrochromic material to have almost same transparency.
or colour than the layer 103 of electrochromic material in all other keys 101 has.

A transition of a layer 203 of electrochromic material in a key 101 from the transparent state to opaque state takes place as follows: the position of the switch SW in the corresponding switching unit 311 in the switching block 315 is changed from T₂ to T₃. After a predetermined time period, i.e. after some milliseconds, the position of the switch SW is returned to T₂.

In order to provide the possibility for a reverse transition, e.g. from opaque state to transparent state, there are also provided means 317 for reversing the electric field.

Figure 4B shows one of such means 317 for reversing the electric field, comprising switch SW2, controllable by the processing unit 303, and adapted to connect terminal T₃ from the rechargeable battery to terminal T₅ or terminal T₆ depending on its position.

The electric field over a layer 203 of electrochromic material can be reversed by changing the position of switch SW2 from T₆ to T₅ if the switch SW2 was in position terminal T₆ when the preceding state transition (e.g. from opaque state to transparent state) was performed the switch SW2 connecting terminal T₄ to terminal T₅.

A reason for providing a plurality of switching units 311 in the switching block 315 is that, in this manner, all transitions involving one direction of electric field only can be performed simultaneously. Because there are now only two 317 means for reversing the electric current, some components can be saved.

If, for example, the transition were that some of the keys 101 in the keypad 100 are to be changed from opaque state to
transparent state, and some other keys from transparent state to opaque, then these changes would be performed in two sets, all keys for each type of transition at once.

5 The considerations regarding changes between opaque and transparent states are analogous to changes between one colour and another colour.

Figures 5A and 5B show two predetermined patterns illustrating different transparency or colour patterns for a number of keys 101. For example, assuming that in the beginning all keys 101 are in transparent state, a state of the electronic device 103 changes so that the electronic device 103 is to present a Y-like symbol (e.g. for positive acknowledgement) in the keypad 100. Then keys marked black in Figure 5A would be changed to opaque state.

In contrast to Figure 5A, Figure 5B show an example wherein the state of the electronic device 103 changes so that it is to present a N-like symbol (e.g. for negative acknowledgement) in the keypad. Starting from initially transparent state of all keys 101, the keys 101 marked black in Figure 5B are turned opaque. But were the initial state of that of Figure 5A, then some keys were to changed to transparent state and some to opaque state. As mentioned above, this change can be performed stepwise: first a first kind of transition, then a second kind of transition.

In order to facilitate the transition, the patterns are preferably stored in memory 305, such as Random Access Memory RAM. The processing unit 303 is executing a program code that retrieves from the RAM a pattern via the bus, then compares a present setting of each key 101 and then does changes were necessary. The algorihm need not be that complex, so the comparison step can be neglected if the processing unit 303 is adapted to change the state of the layer 203 of electrochromic material in each key 101 of the keypad 100.
Figure 6 shows an electronic device in communication with a network 603, a peer electronic device 103B, and with a ticket inspecting device 601. The communication connection can be made via communication means 307. Especially, the connection between the network 603 may be made through cellular communication means: particular examples comprise means for GSM, GPRS, WLAN, or UMTS radio communications. The communication means 307 for connections with a peer electronic device 103B or with the ticket inspecting device 601. Particular examples comprise Bluetooth, infra-red, visual, or audial communication means.

The pattern to be shown in the keypad 100 can be loaded from a server 603B in the network 600. If the network 600 is the Internet, then the server 603B can be a web server. The server 603B has a database 604 or other register where different patterns can be stored. The server 603B sends a pattern either as a push or pull-type service. The server 603B can be a game server. If the server 603B sends a new game to the electronic device 103, the game can include a new pattern. Would the game be played in the network 603 using the electronic device 103 as a terminal, then the server 603B could also transmit a pattern message to the electronic device 103 which then would display the pattern in the keypad 100.

The pattern may be loaded from a peer electronic device 103B which has stored it in its register 605. In this manner, users can build user groups. After storing the same pattern in both electronic devices 103, 103B, the pattern on the keypad 100 of the electronic device 103 and/or the electronic device 103B can be changed whenever the devices detect the presence of each other, or if a first electronic device 103 detects the peer electronic device 103B. To facilitate the detection process, an identifier, such as IMSI, MSISDN, or a Bluetooth address, of each electronic device 103, 103B
belonging to the same group can be stored into the memory 305 of the electronic devices 103, 103B. This service can be network-assisted as well, having then some characteristics of the solution discussed in the preceding paragraph.

The pattern on the keypad 100 can be changed responsive to an arrival of a message from a network 603 to which the electronic device 103 is connected; an incoming telephone call or other connection; or to termination of a telephone call or other connection.

The pattern to display in the keypad 100 can also be provided from a ticket inspection device 601. In response to the electronic device 103 presenting an electronic ticket, the ticket inspection device 601 would compare an identifier in the message received from the electronic device 103 with identifiers stored in database 606, or stored in other register. If the result of the comparison would be that a service, such as entering to a tram, bus, subway, airplane, movie theatre, etc., would be allowed, then a positive acknowledgement would be shown on the keypad 100 of the electronic device 103. In the negative case, a negative acknowledgement could be shown. In a similar manner, showing an acknowledgement in the keypad 100 can be used in checking digital signatures or data integrity in general.

Colour profiles can be defined as matrixes having dimensions equivalent to the number of keys 101 in each direction, such as 4x3 for a typical keypad consisting of 12 keys. Each entry in the matrix can store logical values (in case of a bi-state key) or a vector (e.g. 3 dimensional for RGB) to represent a particular colour in case of multi-colour electrochromic material. By means of a conversion performed by the processing unit 303, the colour matrixes are mapped to the corresponding matrices of electrical states (e.g. value indicating the current or voltage) necessary to achieve the electrochromic change in the layer 203 of electrochromic
material. These values will then be used to generate the adequate control signals. To achieve this, the control means 300 may comprise three or even more switching blocks 315, each having leads 209 to the layers 103 of electrochromic material in the keys 101 of the keypad 100.

The profiles can be pre-stored by the manufacturer, or defined by the user by means of an editing application that represents the keypad 100 and permits the user to select the colour for each key 101. The colour or transparency profiles can be made application or function dependent (e.g. some or all keys 101 flash in a different colour when a message, such as an SMS or a Multimedia Message arrives). These colour profiles can also be loaded dynamically upon request of the user, automatically during the start-up of a particular application or by the execution of a game among other possibilities. The colour profiles can also be generated dynamically by an application (e.g. a game) to indicate change of status in the application (e.g. change of gaming level) and/or to indicate a new set (or sets) of active keys 101 that can be used to give input for the application. The application and the control means 300 may be in real-time connection to each other, e.g. using a communication channel.

An embodiment of the invention, different from that in Figures 2A to 2C is shown in Figures 7A to 7C. Figures 7A, 7B, and 7C show an electronic device 103, a matrix 705 comprising a number of coloured layers 205, and a layer 203 of electrochromic material for a number of keys 101.

The electronic device 103 comprises a display 105, and a plurality of switches 200. The switches 200 are grouped to form receiving means 701 for matrix 705 and for key matrix 720. The electronic device 103 may further comprise lock means 703, such as friction locks or snap-locks, for holding the matrix 705 and the key matrix 720. On top of the switches
200 there may further be light sources, or the light sources can also be placed inside the switches.

Figure 7B shows the matrix 705 comprising a number of coloured layers 205 in more detail. There is a plurality of coloured layers 205 in the matrix 705. These coloured layers 205 are preferably partially transparent, and act as filters. The frame 711 around each coloured layer 205 is preferably metallic, such as of copper or silver, for providing an electric connection. For this purpose, it is beneficial to divide the frames 711 into at least two parts each, the parts being electrically isolated from each other. The frames can also be only on two sides of a coloured layer 205. This helps in achieving a unique transparency or color in the layer 203 of electrochromic material. The base 715 of the matrix 705 is preferably of elastic material, such as silicon.

Figure 7C shows a key matrix 720. The key matrix 720 comprises a number of layers 203 of electrochromic material, and lock means 723 that fit to the lock means 703 in the electronic device 103. The key matrix 720 presses the matrix 705 against the receiving means 701 in the electronic device 103 so that it is firmly in place. The layers 203 of electrochromic material can have electric connectors up to the surface of the matrix 705, provided that there is a proper voltage supply in the receiving means 701 in the electronic device 103.

What comes to the choice of the electrochromic material, bistable types of electrochromic materials have the advantage that once the electric field has been applied, the material can maintain its state even in the absence of an electric field until the electric field is reversed. Consequently, it is very power efficient. Recently, new bi-stable electrochromic materials having characteristics suitable for fast switching have also been developed. One of the underlying reasons for their suitability is the ability to
quickly increase light absorption by using nanoparticles. Some materials suitable for use in the layer 103 of electrochromic material are thereby incorporated as reference:


Some electrochromic materials can change to different colours according to electrical input. A list of some further materials suitable for use in the layer 103 of electrochromic material are thereby incorporated as reference:

http://journal.library.iisc.ernet.in/vol200106/paper5/madhuri.pdf

A still further embodiment, combinable with other embodiments discussed above, includes a larger number (2, 3, 4, 5) of layers 203 of electrochromic material above each other in a sandwich-like manner. The different layers 203 may then comprise different electrochromic materials adapted to change transparency or color. Each layer can be controlled separately. The symbol marking 217 of a key 101 can then be implemented in the electrochromic material in one layer 203, such as in the top layer or the layer underneath it. In this manner, the symbol marking 217 can be changed visible when necessary, and hidden at other times. Furthermore, there may be different layers for a numerical marking (such as 1) and for a character marking (such as ABC).
Claims:

1. A keypad (100), characterized in that:
   at least one of the keys (101) in the keypad (100) comprises a layer (203) of electrochromic material.

2. A keypad (100) of claim 1, wherein: the layer (203) of electrochromic material in a key (101) is connected to connecting means (209) adapted to provide an electrical connection to a control means (303) or to a battery (301), the connecting means (209) further adapted to allow an up- or down movement of the layer (203) together with the key (101).

3. A keypad (100) of claim 1 or 2, further comprising: a coloured layer (205) underneath the layer (203) of the electrochromic material.

4. A keypad (100) of claim 3, wherein: said coloured layer (205) is exchangeable.

5. A keypad (100) according to any one of the preceding claims, further comprising: a light source (225) under the layer (203) of electrochromic material.

6. A keypad (100) according to any one of the preceding claims, further comprising: a symbol marking (217) applied on or above the layer (203) of electrochromic material, representing the value of the key (101).

7. An electronic device (103) comprising a keypad (100) according to any one of claims 1 to 6, characterized in that:
   said electronic device (103) further comprises means (300) for defining the transparency or colour of the layer (203) of electrochromic material in a number of keys (101) in the keypad (100), corresponding to a state of the electronic device (103).
8. An electronic device (103) of claim 7, **wherein**: said electronic device (103) is adapted to change the transparency or colour of the layer (203) of electrochromic material for a number of keys (101) in the keypad (100) responsive to a state change of the electronic device (103).

9. An electronic device (103) of claim 8, **wherein**: the state change corresponds to one of the following:
   - arrival of a message from a network (603) to which the electronic device (103) is connected;
   - an incoming telephone call or other connection;
   - termination of a telephone call or other connection;
   - a level change in a game;
   - arrival of a message from a ticket inspecting device (601); or
   - detecting a peer electronic device (103B) in a vicinity of the electronic device (103), the peer electronic device belonging to a predefined group.

10. An electronic device (103) according to claim 8 or 9, **wherein**: said changing of the transparency or colour of the layer (203) of electrochromic material in a number of keys (101) is performed repetitively for a number of times to cause a blinking effect.

11. An electronic device (103) according to any one of claims 7 to 10, further **comprising**: means (307) for receiving a profile () for defining transparency or colour of the layer (203) of electrochromic material in a number of keys (101) in the keypad from a network (603); from a peer electronic device (103B); or from a ticket inspecting device (601).

12. A method of changing the appearance of one or more keys (101) in a keypad (100) of an electronic device (103),
characterized in that: the appearance of the key (101) or keys (101) is changed by individually changing the transparency or colour of an electrochromic element (203) in each key responsive to a control signal.

13. A method claim 12, wherein: the changing the transparency or colour of a number of electrochromic elements (203) is performed in predetermined patterns.

14. A method claim 13, wherein: said patterns are user-defined; downloaded from a network (603); received from a ticket inspecting device (601); or being defined for a predefined group of peer electronic devices (103B).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01M13/70 H04M1/72

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04M H01H G09F G06F

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

Electronic data base consulted during the international search (name of data base inst. where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

5 October 2004

Date of mailing of the international search report

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Name and mailing address of the ISA

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Nieto, J.M.
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### INTERNATIONAL SEARCH REPORT

#### Information on patent family members

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