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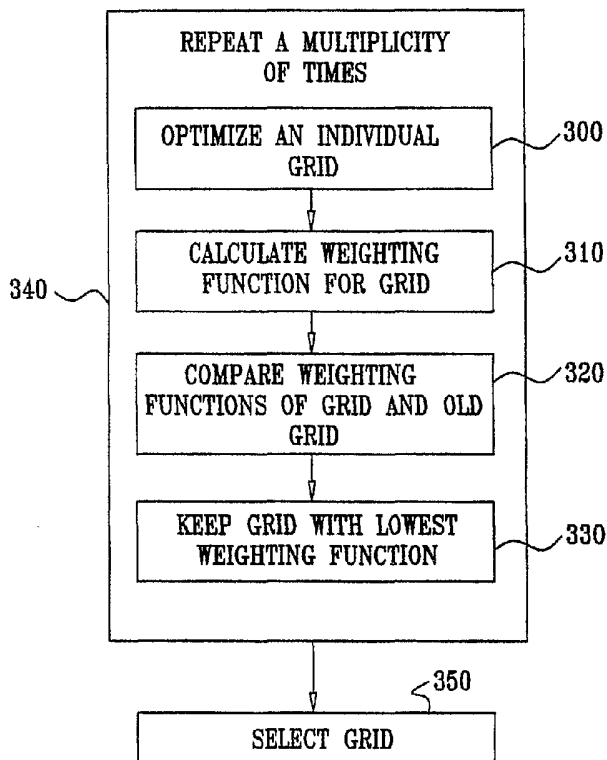
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(54) Title: TEXT ENTRY USING DIRECTION INPUTS



(57) Abstract: A method and system for alphanumeric data entry using a device, the method comprising producing a display of alphanumeric characters arranged in a nonalphabetical, two-dimensional arrangement which is optimized for use with at least one directional navigation actuator on the device, in response to actuation by a user of the at least one directional navigation actuator on the device, navigating the display of alphanumeric characters, and in response to an entry actuation by a user of the device, entering individual alphanumeric characters. Related methods and apparatus are also described.



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TEXT ENTRY USING DIRECTION INPUTS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from UK Patent Application
5 No. 0314303.9 filed 19 June 2003, from UK Patent Application No. 0322405.2 filed
24 September 2003, from US Provisional Patent Application S/N 60/480,832 filed 23
June 2003, and from US Provisional Patent Application S/N 60/506,093 filed 25
September 2003, the disclosures of which are hereby incorporated herein by
reference.

10

FIELD OF THE INVENTION

The present invention relates to apparatus and methods for inputting
text, and particularly but not exclusively to apparatus and methods for inputting text
using devices such as remote controls and game consoles.

15

BACKGROUND OF THE INVENTION

Many consumer devices today have a restricted number of user input
keys, but include direction keys and / or buttons or joysticks. Non-limiting examples
of such devices include Nintendo™ Gameboys®, TV remote controls and game
20 console controllers. Text entry is often required on such devices, for example, and
without limiting the generality of the foregoing, for sending email or SMS messages
via interactive TV. Currently, text entry user interfaces vary from application to
application. Examples of text entry methods include using the direction keys to

navigate around an on-screen QWERTY keyboard, or to navigate around an on-screen alphabetical list of letters.

US Patent 5,748,512 to Vargas describes a method of text entry based on analysis of frequency of a second letter of the alphabet occurring after a given first
5 letter of the alphabet, and the frequency with which a given letter in the alphabet occurs after a combination of two letters. Occurrence frequency is used in the method of Vargas to determine which character is pressed on a contact sensitive keyboard based on previously entered characters.

The use of frequency analysis has been well known in cryptanalysis
10 since the 1460s when Leon Alberti first described a technique to compare the frequency of the appearance of letters in a ciphertext to the frequency of the appearance of a given letter in general usage in a language. See, for example, www.math.nmsu.edu/crypto/public_html/Frequency.html. Frequencies of letters in sample English texts (for example the King James translation of the Book of Psalms),
15 as well as lists of frequently occurring digraphs are found at raphael.math.uic.edu/~jeremy/crypt/freq.html.

Also well known in the art is the so-called Dvorak keyboard, described in US Patent 2,040,248 to Dvorak et al, which provides a typist with an alternative to the standard QWERTY keyboard, optimized to decrease typist errors, increase typist
20 speed, and lessen typist fatigue.

The GSM T9 dictionary for text entry on mobile phones is well known in the art and is described, for example, in a slideshow freely available for download on the World Wide Web at:

www.gsmworld.com/technology/sms/t9text.zip.

Published PCT Patent Application WO 02/21358 of NDS Limited and corresponding US Patent Application 2003/0033213 of Bogot describes an environment including a television and a remote control unit hand held by a user and including at least one directional control, a method for acquisition of goods or services including selecting goods or services by employing only the at least one direction control, and completing a transaction for selected goods or services by employing only the at least one direction control, and other related methods.

A typical system in which the present invention, in preferred embodiments thereof, could be used is described in published PCT application WO 03/047257 of NDS Limited, which describes a system and a method for sending online television recommendations using standard electronic mailing protocols such that content viewers are able to notify one another of desirable programming, including but not limited to instant messaging, sending of single screenshots and adding comments to the content for example.

Another example of a system in which the present invention, in preferred embodiments thereof, could be used is described in US Patent 5,414,773 to Handelsman, which describes a CATV system comprising a CATV network, a multiplicity of subscriber units, apparatus for transmitting over the CATV network individually addressed information individually addressed subscriber unit, wherein each subscriber unit includes: a receiver for receiving the individually addressed information addressed thereto; a memory for storing the individually addressed information; and a display for displaying at least part of the individually addressed information retrieved from the memory, the CATV system further comprising: a keyboard for entering information to be transmitted via a telephone link; a processor

for preparing the information to be transmitted via a telephone link in a format suitable for transmission over the telephone link; and a unit for transmitting over the telephone link at least one of mail, facsimile, electronic-mail and voice-mail information.

5 Still another example of a system in which the present invention, in preferred embodiments thereof, could be used is described in US Patent 5,715,315 to Handelman, which describes a CATV system comprising a CATV network, a transmitter for transmitting over the CATV network individually addressed non-audible information, individually addressed to a subscriber unit, apparatus, associated
10 with the transmitter, for transmitting audio to accompany the individually addressed non-audible information, and a multiplicity of subscriber units, each including: a receiver for receiving the individually addressed non-audible information and the audio accompanying the individually addressed non-audible information addressed thereto; and a display unit which displays the individually addressed non-audible
15 information and plays the audio accompanying the individually addressed non-audible information received at the receiver.

The following US patents are also believed to reflect the state of the arts of: novel arrangements of keyboards / letter sequences; keyboards for stylus / touch screen operation; and letter and word prediction algorithms:

20 6,359,572 to Vale;
 6,348,878 to Tsubai;
 6,246,769 to Kohut;
 6,199,125 to Cortesi;
 6,169,538 to Nowlan et al;

- 6,157,371 to Smeets;
6,016,471 to Kuhn et al;
6,011,554 to King et al;
6,005,549 to Forest;
5 5,926,566 to Wang et al;
5,734,749 to Yamada et al;
5,718,590 to Choatae;
5,584,588 to Harbaugh;
5,574,482 to Niemeier;
10 5,487,616 to Ichbiah;
5,128,672 to Kaehler;
4,891,786 to Goldwasser; and
4,847,799 to Morita et al.

The disclosures of all references mentioned above and throughout the present
15 specification, as well as the disclosures of all references mentioned in those
references, are hereby incorporated herein by reference.

SUMMARY OF THE INVENTION

The present invention seeks to provide an improved method of text entry. In accordance with preferred embodiments of the present invention, the number of directional inputs required to enter words is minimized. Prior art
5 approaches are not optimized to minimize the number of directional inputs required to enter words.

The present invention, in preferred embodiments thereof, provides a solution to the problems in the prior art, the solution being equally applicable to: mobile phones as an alternative to GSM T9 text entry, referred to above; remote
10 control devices; and PDA devices when vibration, such as on a train, renders text entry using a stylus difficult or impossible.

In preferred embodiments of the present invention, the user is presented with an on-screen optimized grid of letters for the user to navigate using direction inputs. The grid layout is optimized based on statistics of the language and words
15 likely to be entered in an application being used by the user. Ideally, common letter sequences should be “intuitively visible” to a user. The term “intuitively visible” is explained below with reference to Figs. 6 and 7A.

As an aid to the user in navigating the grid, after each character is chosen the display optionally highlights the characters in the on-screen grid based on
20 the likelihood that a given character is to be the next character selected.

There is thus provided in accordance with a preferred embodiment of the present invention producing a display of alphanumeric characters arranged in a non-alphabetical, two-dimensional arrangement which is optimized for use with at least one directional navigation actuator on the device, in response to actuation by a

user of the at least one directional navigation actuator on the device, navigating the display of alphanumeric characters, and in response to an entry actuation by a user of the device, entering individual alphanumeric characters.

Further in accordance with a preferred embodiment of the present
5 invention the device includes a hand-held device.

Still further in accordance with a preferred embodiment of the present invention the device uses a wired communication protocol.

Additionally in accordance with a preferred embodiment of the present invention the device uses a wireless communication protocol.

Moreover in accordance with a preferred embodiment of the present
10 invention the display includes producing the display in response to a display actuation by a user of the device.

Further in accordance with a preferred embodiment of the present invention the producing the display includes producing the display on a television.

Still further in accordance with a preferred embodiment of the present
15 invention the producing the display includes producing the display in response to a display actuation by a user of a remote control.

Additionally in accordance with a preferred embodiment of the present invention the display is optimized based on alphanumeric character occurrence
20 frequency and alphanumeric pair transition frequency.

Moreover in accordance with a preferred embodiment of the present invention the display is optimized for an alphabet of a natural language.

Further in accordance with a preferred embodiment of the present invention the natural language is an alphabet language.

Still further in accordance with a preferred embodiment of the present invention the natural language is chosen from a group including English, Hebrew, French, Spanish, Italian, Swedish, Norwegian, Danish, Finnish, Russian, Polish, Portuguese, Turkish, Japanese, Greek, German, and Arabic.

5 Additionally in accordance with a preferred embodiment of the present invention the producing the display includes pre-computing the non-alphabetical, two-dimensional arrangement, and displaying the display.

Moreover in accordance with a preferred embodiment of the present invention the pre-computing is based on alphanumeric character occurrence
10 frequency and alphanumeric pair transition frequency of a particular natural language.

Further in accordance with a preferred embodiment of the present invention emphasizing, in response to the entry actuation, at least one of the alphanumeric characters in the display.

Still further in accordance with a preferred embodiment of the present
15 invention the emphasizing includes highlighting.

Additionally in accordance with a preferred embodiment of the present invention the emphasizing is based, at least in part, on frequency analysis of likelihood of selection of alphanumeric characters.

There is also provided in accordance with another preferred
20 embodiment of the present invention a device having at least one directional navigation actuator, and a display of alphanumeric characters arranged in a non-alphabetical, two-dimensional arrangement which is optimized for use with the at least one directional navigation actuator on the device.

Further in accordance with a preferred embodiment of the present invention the device includes a hand-held device.

Still further in accordance with a preferred embodiment of the present invention the device uses a wired communication protocol.

5 Additionally in accordance with a preferred embodiment of the present invention the device uses a wireless communication protocol.

Moreover in accordance with a preferred embodiment of the present invention the display is produced in response to a display actuation by a user of the device.

10 Further in accordance with a preferred embodiment of the present invention the display of alphanumeric characters includes a display on a television.

Still further in accordance with a preferred embodiment of the present invention the display of alphanumeric characters is produced in response to a display actuation by a user of a remote control.

15 Additionally in accordance with a preferred embodiment of the present invention the display of alphanumeric characters is optimized based on alphanumeric character occurrence frequency and alphanumeric pair transition frequency.

Moreover in accordance with a preferred embodiment of the present invention the display is optimized for an alphabet of a natural language.

20 Further in accordance with a preferred embodiment of the present invention the natural language is an alphabet language.

Still further in accordance with a preferred embodiment of the present invention the natural language is chosen from a group including English, Hebrew,

French, Spanish, Italian, Swedish, Norwegian, Danish, Finnish, Russian, Polish, Portuguese, Turkish, Japanese, Greek, German, and Arabic.

Additionally in accordance with a preferred embodiment of the present invention the display of alphanumeric characters is produced, at least in part, by pre-computing the non-alphabetical, two-dimensional arrangement, and displaying the display.

Moreover in accordance with a preferred embodiment of the present invention the pre-computing is based on alphanumeric character occurrence frequency and alphanumeric pair transition frequency of a particular natural language.

Further in accordance with a preferred embodiment of the present invention at least one of the alphanumeric characters in the display is emphasized in response to an entry actuation on the device.

Still further in accordance with a preferred embodiment of the present invention the emphasizing includes highlighting.

Additionally in accordance with a preferred embodiment of the present invention the emphasizing is based, at least in part, on frequency analysis of likelihood of selection of alphanumeric characters.

There is also provided in accordance with still another preferred embodiment of the present invention a data entry device having at least one directional navigation actuator, and a display of alphanumeric characters arranged in a non-alphabetical, two-dimensional arrangement which is optimized for use with the at least one directional navigation actuator on the data entry device.

Further in accordance with a preferred embodiment of the present invention the display is optimized for an alphabet of a natural language.

Still further in accordance with a preferred embodiment of the present invention the natural language is an alphabet language.

Additionally in accordance with a preferred embodiment of the present invention the natural language is chosen from a group including English, Hebrew,
5 French, Spanish, Italian, Swedish, Norwegian, Danish, Finnish, Russian, Polish, Portuguese, Turkish, Japanese, Greek, German, and Arabic.

Moreover in accordance with a preferred embodiment of the present invention at least one of the alphanumeric characters in the display is emphasized in response to an entry actuation on the data-entry device.

10 Further in accordance with a preferred embodiment of the present invention the emphasizing includes highlighting.

Still further in accordance with a preferred embodiment of the present invention the emphasizing is based, at least in part, on frequency analysis of likelihood of selection of alphanumeric characters.

BRIEF DESCRIPTION OF THE DRAWINGS AND APPENDICES

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

5 Fig. 1 is a simplified pictorial illustration of a system for text entry using direction inputs, constructed and operative in accordance with a preferred embodiment of the present invention;

 Fig. 2 is a simplified pictorial illustration of a preferred implementation of a portion of the system of Fig. 1, comprising an alphabet grid;

10 Fig. 3A is a simplified pictorial illustration of an alphabet grid, constructed using the order of the QWERTY keyboard, given as a contrasting example to the grid of Fig. 2;

 Fig. 3B is a simplified pictorial illustration of an alternative preferred implementation of a portion of the system of Fig. 1, comprising a Hebrew alphabet
15 grid;

 Fig. 4 is a simplified flowchart illustration of a preferred method of comparing and selecting a best-optimized grid from among a plurality of optimized grids for use in the system of Fig. 1;

 Fig. 5 is a simplified flowchart illustration of a preferred method of
20 operation of a portion of the method of Fig. 4;

 Figs. 6 and 7A are simplified pictorial illustration of the alphabet grid of Fig. 2, illustrating the proximity of frequently used combinations of characters to each other;

Figs. 7B and 7C are simplified pictorial illustration of the Hebrew alphabet grid of Fig. 3A, illustrating the proximity of frequently used combinations of Hebrew characters to each other;

Fig. 8 is a simplified pictorial illustration of the alphabet grid of Fig. 2, illustrating characters highlighted based on the likelihood of selection after the character "H" has been selected; and

Fig. 9 is a simplified pictorial illustration of the Hebrew alphabet grid of Fig. 3A, illustrating characters highlighted based on the likelihood of selection after the Hebrew character SAMECH (ס) has been selected.

The following Appendices may be helpful in understanding certain preferred embodiments of the present invention:

Appendix A lists frequency estimates for letters of the English language for the complete works of William Shakespeare;

Appendix B is a table of pair transition frequency estimates for second letters of pairs of letters in the English language for the complete works of William Shakespeare;

Appendix C lists frequency estimates for letters of the Hebrew language for the Five Books of Moses; and

Appendix D is a table of pair transition frequency estimates for second letters of pairs of letters in the Hebrew language for the Five Books of Moses.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to Fig. 1, which is a simplified pictorial illustration of a system for text entry using direction inputs, constructed and operative in accordance with a preferred embodiment of the present invention. The system of Fig. 1 preferably comprises a remote control 30 or comparable device, operative to send signals to a set-top box 40, which is also preferably comprised in the system of Fig. 1. The set-top box 40, preferably implemented in an appropriate combination of hardware and / or software, generates an on-screen display (OSD) 60, which appears on a television 20 operatively associated with the set-top box 40 and also preferably comprised in the system of Fig. 1. Typically, the television 20 is connected to the set-top box 40 with an appropriate cable (not shown), as is well known in the art.

The OSD 60 preferably comprises an alphabet grid 70 and a message 80.

It is appreciated that each of the following subcombinations comprises an alternative preferred embodiment of the present invention, without the other elements shown in Fig. 1:

1. the set-top box 40, the OSD 60 and the television 20; and
2. the set-top box 40, the remote control 30, and the OSD 60.

It is further appreciated that in an alternative preferred embodiment of the present invention wherein the television 20 comprises an integrated set-top box 40, each of the following subcombinations comprises an alternative preferred embodiment of the present invention, without the other elements shown in Fig. 1:

1. the television 20 comprising the set-top box 40 and the OSD 60; and

2. the television 20 comprising the set-top box 40, the remote control 30, and the OSD 60.

The operation of the system of Fig. 1 is now briefly described. A person 10 watches the television 20. The person 10 manipulates the remote control 30. The person 10 actuates the OSD 60 by pressing a designated button on the remote control 30. For example, and without limiting the generality of the foregoing, the person 10 may press the designated button in order to construct a message. Pressing the designated button on the remote control 30 sends a signal to the set-top box 40. In response to the signal, the set-top box 40 displays the OSD 60 on the television 20. The person 10 then presses one of the plurality of arrow keys 50 on the remote control 30. The remote control 30 sends a signal to the set-top box 40. In response to the signal, the set-top box 40 moves a cursor (not shown) around the alphabet grid 70 seen in the OSD 60. Preferred implementations of the alphabet grid 70 are described in greater detail below with reference to Figs. 2, 3A and 3B. Using the arrow keys 50 and a select / enter key (not shown) comprised in the remote control 30, the person constructs a message 80, which appears beneath the alphabet grid 70. Persons skilled in the art will appreciate that button pushing is given as an example of a method of actuating the system of Fig. 1, and that other methods of actuating the system of Fig. 1 are possible.

It is appreciated that the situation illustrated in Fig. 1 is an example of the use of the present invention only and is not meant to limit the generality of the present invention. Without limiting the generality of the present invention, examples of systems wherein the present invention may be of use include those described in

published PCT application WO 03/047257 of NDS Limited; and in US Patents 5,414,773 and 5,715,315, both to Handelsman.

It is appreciated that the present invention is not limited to data entry using devices such as hand-held remote control units. Any input device possessing
5 direction inputs may be appropriate for data entry. It is also appreciated that the present invention is useful for any appropriate device having a display screen and direction inputs. For example, and without limiting the generality of the foregoing, mobile phones and PDA devices would be examples of devices on which the present invention may be implemented.

10 Returning again to the example of hand-held remote control units, it is also appreciated that the communication between the hand-held device and the set-top box may utilize either a wireless or a wired communication protocol.

Reference is now additionally made to Fig. 2, which is a simplified pictorial illustration of a preferred implementation of a portion of the system of Fig. 1,
15 comprising an alphabet grid 200, corresponding to the alphabet grid 70 of Fig. 1. The alphabet grid 200 of Fig. 2 comprises an on-screen character grid layout optimized for the English language. In the center is SPACE 210, the most common character used in English text. Preferably, when using the system of Fig. 1, by default a cursor or highlight would start on the SPACE 210 square. A user of the system of Fig. 1
20 navigates the cursor or highlight using any appropriate input apparatus, such as, for example, direction keys or a joystick on a device. Non-limiting examples of such a device include: a remote control; a mobile phone keyboard; and a PDA. Pressing an appropriate button on the device selects a character. Direction inputs preferably move the cursor or highlight around the grid. Wrap-around is preferably enabled, such that

moving the cursor or highlight off the top of grid will cause the cursor to appear at the bottom; similarly, moving the cursor or highlight off one side of the grid preferably causes the cursor to appear on the other side of the grid. It can be seen that common English language character sequences, such as “and” or “the”, are, as described below
5 with reference to Figs. 6 and 7A, “intuitively visible”.

The term “character” in all of its grammatical forms, as used throughout the present specification and claims, refers to any alphanumeric character in a language. For example, and without limiting the generality of the foregoing, “A”, “h” and “6”, as well as the non-Latin symbols “β”, “Ɔ” and “Ж” are all characters. It
10 is further appreciated that “SPACE” (that is: “ ”) is also a character. It is also appreciated that “letters” of a given alphabet are a subset of characters available for use in that given alphabet.

In the alphabet grid 200 in Fig. 2 a grid size of width six by height five was chosen to accommodate the letters of the English language plus SPACE. It is
15 appreciated that grids of other sizes and shapes may also be used. With wrap-around, each character in the grid 200 is a maximum of five direction inputs away from any other.

Shown on the left side of the grid are three cells 215 whose functions are deliberately not defined. The three cells 215 whose function are deliberately not
20 defined are shown containing “-” in Fig. 2. For example, and without limiting the generality of the foregoing, the three cells 215 could be allocated to:

1. a delete function;
2. accessing a punctuation grid;
3. accessing a number grid;

4. Shift key functions; or
5. any other application specific appropriate function.

The alphabet grid in Fig. 2 was generated to minimize direction inputs required to enter text by optimizing the layout of the grid. Due to a large number of possible layouts of characters in the grid it is believed by the inventors of the present invention that it is infeasible to test every possible layout to find the best possible layout. Persons skilled in the art will realize that, in the art of software engineering, there are many such optimization problems, where it is infeasible to test every possible solution to find the best, and there are many known ways of performing such optimizations.

Optimization of the alphabet grid layout shown in Fig. 2 is preferably performed as follows. First a weighting function is defined to provide a measure of effectiveness of a chosen layout. A preferred weighting function is as follows:

Let n = number of inputs to navigate from letter₁ to letter₂
 And let L = letter₂ when preceded by letter₁ (for example, N in AN)
 Then the preferred weighting function is :

$$\sum_{\text{letter}_1 = \text{character}_1}^{\text{character}_{27}} \left(\text{frequency}(\text{letter}_1) \times \sum_{\text{letter}_2 = \text{character}_1}^{\text{character}_{27}} n \times \text{frequency}(L) \right)$$

The weighting function recognizes 27 characters, those characters consisting of the 26 letters of the English alphabet and space.

In order to give an example of a typical computation of the value of the weighting function, reference is now made to Appendices A and B. Appendix A lists frequency estimates for letters of the English Language for the complete works of

William Shakespeare. The frequency estimates in Appendix A are based on those found at:

www-stat.stanford.edu/~jtaylor/cipher/frequency.dat

Appendix B is a table of pair transition frequency estimates for second
 5 letters of pairs of letters in the English Language for the complete works of William Shakespeare. The frequency estimates in Appendix B are based on those found at:

www-stat.stanford.edu/~jtaylor/cipher/transition.dat

The table presented in Appendix B is a 27 x 27 matrix, with the i-th
 row representing the relative frequency of the next character being the j-th character,
 10 given that the current letter is the i-th character.

Taking the grid of Fig. 2 for an example of a typical computation of a weighting function, allowing letter₁ to be A and letter₂ to be N, then:

Referring to Appendix A, the frequency of A is 0.06302.

The number of inputs to navigate from A to N is 1.

15 Referring to Appendix B, the pair transition frequency of N when preceded by A (i.e. AN) is 0.22065.

Inserting the values above into the weighting function therefore gives:

$frequency(letter_1) \times number\ of\ inputs\ to\ navigate\ from\ letter_1\ to\ letter_2 \times$
 $frequency(letter_2\ when\ preceded\ by\ letter_1) = 0.06302 \times 1 \times 0.22065 = 0.013905.$

20 The computation is preferably repeated for each of the 27 X 27 possible character combinations; the result of each individual computation is summed to give the resulting value of the weighting function.

By contrast, as an example of a less optimized grid, reference is now made to Fig. 3A, which is a simplified pictorial illustration of an alphabet grid,

constructed using the order of the QWERTY keyboard, given as a contrasting example to the grid of Fig. 2.

To compute the weighting function of the grid of Fig. 3, allowing letter₁ to be A and letter₂ to be N, as in the example given for Fig. 2, then:

5 Referring to Appendix A, the frequency of A is 0.06302.

The number of inputs to navigate from A to N is 4 (right - right - up-up, in any order, using grid wrap around).

Referring to Appendix B, the pair transition frequency of N when preceded by A (i.e. AN) is 0.22065.

10 Inserting the values above into the weighting function therefore gives:

frequency(letter₁) X number of inputs to navigate from letter₁ to letter₂ X frequency(letter₂ when preceded by letter₁) = 0.06302 X 4 X 0.22065 = 0.055621.

The computation is repeated for each of the 27 X 27 possible character combinations; the result of each individual computation is summed to give the
15 resulting value of the weighting function.

Returning to the discussion of Fig. 2 and the weighting function, as mentioned above, the weighting function recognizes 27 characters, namely the 26 letters of the English alphabet and space. It is appreciated that the weighting function may be generalized for the alphabet of any natural language, where a natural language
20 is understood to mean a human language, such as, for example, any of English, Greek and Russian, as opposed to a computer language. It is further appreciated that the weighting function is generalized for an "alphabet language", the term alphabet language being understood to mean a language which, in its written form, is written using characters of an alphabet, as opposed to a language relying on ideograms. For

example, and without limiting the generality of the foregoing, English, Hebrew, French, Spanish, Italian, Swedish, Norwegian, Danish, Finnish, Russian, Polish, Portuguese, Turkish, Greek, German and Arabic are alphabet languages, while Chinese and Korean are not. It is appreciated that some ideogrammatic languages have alphabetic forms, for example, and without limiting the generality of the foregoing, Japanese kanji.

The weighting function is therefore generalized for alphabets having other than 26 letters as:

Let n = number of inputs to navigate from letter₁ to letter₂

And L = letter₂ when preceded by letter₁

And let C = number of letters in the alphabet +1

Then the preferred weighting function is :

$$\sum_{\text{letter}_1 = \text{character}_1}^{\text{character}_C} \left(\text{frequency}(\text{letter}_1) \times \sum_{\text{letter}_2 = \text{character}_1}^{\text{character}_C} n \times \text{frequency}(L) \right)$$

Reference is now made to Fig. 3B, which is a simplified pictorial illustration of an alternative preferred implementation of a portion of the system of Fig. 1, comprising a Hebrew alphabet grid 270. The grid of Fig. 3B was prepared using the table of pair transition frequency estimates for second letters of pairs of letters in the Hebrew language for the Five Books of Moses.

Reference is now made to Appendices C and D. Appendix C lists frequency estimates for letters of the Hebrew Language for the Five Books of Moses.

Appendix D is a table of pair transition frequency estimates for second letters of pairs of letters in the Hebrew Language for the Five Books of Moses. The table presented in Appendix D is a 23 x 23 matrix, with the i -th row representing the

relative frequency of the next character being the j-th character, given that the current letter is the i-th character.

It is appreciated that the weighting function, both in the 26-letter alphabet form and in the generalized form, is one preferred embodiment of several possible weighting functions. The weighting functions presented above are presented as examples of possible weighting functions, and are not meant to be limiting.

Returning to the discussion of Fig. 3B, optimization of the position of the Hebrew letters of the grid 270 of Fig. 3B was performed using the weighting function generalized for alphabets having other than 26 letters in accordance with the method explained below with reference to Figs. 4 and 5.

The statistics relied upon to generate the grid 270 of Fig. 3B do not relate to five Hebrew letters which have final forms (Mem, Nun, Tsadi, Pei, and Kaf). For example, Final Mem and Mem are evaluated in the statistics as if they were the same letter. Therefore, the grid 270 of Fig. 3B does not have the five final forms. It is appreciated, however, that only a space character may follow one of the final forms. A variety of possible solutions to this problem exist. For example, and without limiting the generality of the foregoing, software may preferably detect when one of the five letters with final forms is followed by a space, and preferably automatically replace the selected letter in the OSD 60 (shown in Fig. 1) with the appropriate final form.

An alternative solution would be to preferably place the five final letters in a secondary menu, preferably accessible from one of the spaces 280 whose functions are deliberately not defined, as described above with respect to the three cells 215 in Fig. 2. A third alternative would be to generate a grid using statistics in

which final forms are separated out from non-final forms. Yet another alternative would be to completely ignore the existence of final forms.

Reference is now made to Fig. 4, which is a simplified flowchart illustration of a preferred method of comparing and selecting a best-optimized grid from among a plurality of optimized grids for use in the system of Fig. 1. An individual grid is optimized (step 300), preferably as described below with reference to Fig. 5. The weighting function for the grid is preferably computed (step 310) as explained above with respect to Fig. 2. The weighting function for the grid is preferably compared with the weighting function of a stored old grid, should such a grid exist (step 320). The grid with a higher weighting function is discarded, and the grid with a lower weighting function stored (step 330). The full process, starting from a new random layout as described below with reference to Fig. 5, is preferably carried out a multiplicity of times, such as, for example 750,000 times (step 340) and a solution with the lowest weighting function is selected (step 350). It is appreciated that the selection of a best-optimized grid is preferably carried out in advance of use of the system of Fig. 1, and the set-top box 40 (Fig. 1) displays a pre-selected alphabet grid 70 (Fig. 1) comprised in the OSD 60 (Fig. 1).

The stored optimized grid of step 350 is preferably stored in software on a device, such as, for example, and without limiting the generality of the foregoing, the set-top box 40 of Fig. 1. Upon invocation, the device displays the stored optimized grid, such as, for example, and without limiting the generality of the foregoing, the alphabet grid 70 of Fig. 1.

Reference is now made to Fig. 5, which is a simplified flowchart illustration of a preferred method of operation of step 300 of the method of Fig. 4.

The optimization process preferably begins by creating a random layout of letters over a grid (step 400). The weighting function is computed for the random layout (step 410), preferably as described above with respect to Fig. 2. A random pair of letters is then preferably selected (step 420) and swapped (step 430), generating a new
5 layout, and the weighting function preferably computed for the new layout (step 440). If the result of the weighting function for the new layout is less than for the original layout then the new layout is kept. If the result of the weighting function for the new layout is not less than the result of the weighting function for the original layout, then the swap is discarded (step 450). The swapping process preferably occurs a large
10 number of times, such as, for example, five thousand times before the layout is considered stable (step 460). The optimized grid is then stored (step 470).

Due to the wrapping nature of the alphabet grid chosen, character layout can be shifted left, right, up and down and reflected in horizontal or vertical directions without altering optimization of the alphabet grid layout. Hence, best
15 candidate character layouts found by the optimization process can be altered to be visually more intuitive for a human user. Thus, the alphabet grid of Fig. 2 is presented with SPACE at the center of the grid and with the common words of “the” and “and” oriented to the left and down.

Reference is now made to Figs. 6 and 7A, which are simplified
20 pictorial illustrations of the alphabet grid of Fig. 2, illustrating proximity of frequently used combinations of characters to each other. Figs. 6 and 7A demonstrate what is meant by “intuitively visible”. The user will see the letters of common English language character sequences, such as A-N-D 610 or T-H-E 710 in close proximity to each other in the alphabet grid. For example, and without limiting the generality of

the foregoing, in Fig. 6 the proximity of the letters A-N-D 610 are shown with the letters A, N and D in an outline font. Similarly, in Fig. 7A, the proximity of the letters T-H-E 710 are shown with the letters T, H and E in an outline font. It is appreciated that the use of the outline font in Figs. 6 and 7A is strictly for illustrative purposes.

Reference is now made to Figs. 7B and 7C, which are simplified pictorial illustrations of the Hebrew alphabet grid 270 of Fig. 3B, illustrating the proximity of frequently used combinations of Hebrew characters to each other. Figs. 7B and 7C demonstrate what is meant by “intuitively visible” in the context of the Hebrew grid 270 of Fig. 3B. The user will see the letters of common Hebrew language character sequences, such as ALEPH (א) - TAV (ט) - MEM (מ) 730 or LAMED (ל) - BET (ב) - DALED (ד) 750 in close proximity to each other in the alphabet grid. For example, and without limiting the generality of the foregoing, in Fig. 7B the proximity of the letters ALEPH (א) - TAV (ט) - MEM (מ) 730 are shown with the letters ALEPH (א), TAV (ט) and MEM (מ) in an outline font. Similarly, in Fig. 7C, the proximity of the letters LAMED (ל) - BET (ב) - DALED (ד) 750 are shown with the letters LAMED (ל), BET (ב) and DALED (ד) in an outline font. It is appreciated that the use of the outline font in Figs. 7B and 7C is strictly for illustrative purposes.

Reference is now made to Fig. 8, which is a simplified pictorial illustration of the alphabet grid of Fig. 2, illustrating characters highlighted based on the likelihood of selection after the character “H” has been selected. Highlighting in the example of Fig. 8 is based on frequency analysis, computed from a sample English text. Consulting Appendix B, the estimated pair transition frequency, in the

English language, of any given character appearing after an H can be seen. Only five characters (including SPACE) have a pair transition frequency greater than 0.1. The five characters (given in pair transition frequency order), and their respective pair transition frequencies are:

5	E	0.3507
	A	0.18627
	I	0.13836
	SPACE	0.11884
	O	0.10938

10 The letter with the next highest frequency after O is Y, with frequency 0.02892.

In the example of Fig. 8, the E 810 has a very darkly shaded background, to indicate that E is the letter most likely to appear after H. The A 820 has a somewhat dark background, less so than the E 810, to show that A 820 is the second most likely letter to appear after H. The I, SPACE and O characters 830
 15 appearing in the on-screen alphabet grid have an even less dark background to show that they are the third most likely characters to appear after H. It is appreciated that shading the background of various letters is given by way of example only, and other methods of indicating expected letters might be used in preferred embodiments of the present invention.

20 Highlighting could, alternatively, be based on more than just a previous character selected. For example, statistics could be based on two previous consecutive selected letters, or words from a dictionary could be used, similar to the approach of the GSM T9 dictionary used for SMS entry. The choice of basing the

highlighting on statistics or on a dictionary allows designs to be realized with different memory requirements.

Implementation of highlighting is preferably performed differently depending on the availability of memory on different hardware platforms running the
5 system of Fig. 1. More specifically:

1. using a stored table of conditional statistics based on the last letter entered requires the least memory;
2. using a larger table of statistics covering the last two letters entered requires more memory;
- 10 3. using a limited dictionary of common words requires still more memory; and
4. using a full dictionary of words requires yet more memory.

In software for preferred embodiments of the present invention where a stored table of conditional statistics based on the last letter entered is used as
15 described above, the pair transition frequency of occurrence for each letter, given knowledge of a preceding letter, is preferably stored in a two-dimensional data array. (Appendices B and D, described in more detail above, comprise particularly detailed examples of such arrays. The examples of Appendices B and D are not meant to be limiting.) When a new character is entered the software preferably accesses the
20 stored frequency data for each character on the alphabet grid and each character is preferably redrawn or has a palette defining background color changed. Upon initialization the grid is preferably shown as if the last character entered was SPACE. Resolution of the stored data need not be greater than a number of different presentation variations possible; for example, and without limiting the generality of

the foregoing, if only eight different background brightness levels are to be used then frequency data need only be stored as integers in the range 0 - 7.

The statistics used in designing the layout of the on-screen character grid in Figs. 2 and 8 are based on English language usage frequencies. It is appreciated that alternative optimized keyboards for use in the present invention could be generated for different languages or subsets of language likely to be used in specific applications (such as e-mail), using appropriate statistics for that language or subset of language.

Reference is now made to Fig. 9, which is a simplified pictorial illustration of the Hebrew alphabet grid of Fig. 3B, illustrating characters highlighted based on the likelihood of selection after the Hebrew character SAMECH (ס) has been selected. Highlighting in the example of Fig. 9 is based on frequency analysis, computed from the Five Books of Moses. Consulting Appendix D, the estimated pair transition frequency, in the Hebrew language, of any given character appearing after a SAMECH (ס) can be seen. Only six characters (including SPACE) have a pair transition frequency greater than 0.08. The six characters (given in pair transition frequency order), and their respective pair transition frequencies are:

	SPACE	0.168224
	VAV (ו)	0.136682
20	KAF (כ)	0.130841
	YUD (י)	0.126168
	MEM (מ)	0.089369
	NUN (נ)	0.084696

The letter with the next highest frequency after NUN (נ) is ALEPH (א), with frequency 0.057827.

In the example of Fig. 9, the SPACE 910 has a very darkly shaded background, to indicate that SPACE 910 is the character most likely to appear after
5 SAMECH (ס). The KAF (כ), YUD (י) and VAV (ו) 920 have a somewhat dark background, less so than the SPACE 910, to show that KAF (כ), YUD (י) and VAV (ו) 920 are the second most likely characters to appear after SAMECH (ס). The NUN (נ) and MEM (מ) characters 930 appearing in the on-screen alphabet grid have an even less dark background to show that they are the third most likely characters to
10 appear after SAMECH (ס). It is appreciated that shading the background of various letters is given by way of example only, and other methods of indicating expected letters might be used in preferred embodiments of the present invention.

It is appreciated that various features of the invention which are, for clarity, described in the contexts of separate embodiments may also be provided in
15 combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described
20 hereinabove. Rather the scope of the invention is defined only by the claims which follow:

APPENDIX A

SPACE	0.17275
A	0.06302
B	0.01375
C	0.01983
D	0.03338
E	0.08981
F	0.01863
G	0.01590
H	0.05219
I	0.05461
J	0.00133
K	0.00871
L	0.03925
M	0.02507
N	0.05307
O	0.06770
P	0.01280
Q	0.00110
R	0.05323
S	0.05353
T	0.06773
U	0.02960
V	0.00894
W	0.02052
X	0.00135
Y	0.02161
Z	0.00059

APPENDIX B

Space	A	B	C	D	E	F	G	H	I	J	K	L	M	
Space	0.0002	0.08831	0.04999	0.04019	0.03666	0.02011	0.04383	0.02521	0.07152	0.05288	0.0047	0.01223	0.03838	0.06028
A	0.05616	0.00055	0.0118	0.03075	0.0367	0.00226	0.01023	0.01778	0.00146	0.03951	0.00156	0.02515	0.08485	0.03387
B	0.0113	0.08443	0.00677	0.00019	0.00074	0.32481	0.00019	0.00021	0.0014	0.03671	0.00432	0.0002	0.10129	0.00077
C	0.00698	0.11858	0.00367	0.0093	0.00156	0.19816	0.00019	0.00019	0.18214	0.03171	0.00019	0.07192	0.04953	0.00019
D	0.58531	0.034	0.00023	0.00033	0.00541	0.10168	0.00151	0.00665	0.00032	0.06364	0.00028	0.00027	0.00722	0.00373
E	0.36269	0.06464	0.00172	0.01225	0.04156	0.0419	0.00871	0.00439	0.00162	0.01273	0.0003	0.00167	0.04122	0.0164
F	0.26006	0.1102	0.00019	0.00019	0.00019	0.08981	0.05976	0.00019	0.00019	0.07582	0.00019	0.00019	0.02483	0.00019
G	0.25903	0.05784	0.00373	0.00019	0.00221	0.14665	0.00035	0.008	0.14242	0.04538	0.00019	0.00019	0.04483	0.00431
H	0.11884	0.18627	0.00103	0.00026	0.00043	0.3507	0.00089	0.00019	0.00027	0.13836	0.00019	0.00019	0.00107	0.00208
I	0.07539	0.01858	0.00386	0.04113	0.02808	0.04215	0.02361	0.02818	0.00031	0.0065	0.00019	0.01116	0.06534	0.04351
J	0.0006	0.11816	0.00019	0.00019	0.00019	0.21557	0.00019	0.00019	0.00019	0.00227	0.00019	0.00019	0.00019	0.00019
K	0.32916	0.00914	0.00052	0.00024	0.00021	0.30616	0.00181	0.00019	0.00043	0.17683	0.00019	0.00019	0.01716	0.00052
L	0.19692	0.08132	0.00281	0.0045	0.06387	0.14234	0.01506	0.00058	0.00019	0.08458	0.00019	0.00741	0.1817	0.0035
M	0.16889	0.18443	0.02279	0.00019	0.00019	0.24357	0.00267	0.00021	0.00021	0.07381	0.00019	0.00019	0.00544	0.01139
N	0.23136	0.02457	0.00095	0.0405	0.19523	0.08064	0.00488	0.10494	0.00123	0.02502	0.00151	0.01294	0.00444	0.00115

	Space	A	B	C	D	E	F	G	H	I	J	K	L	M
O	0.11833	0.00524	0.00743	0.00776	0.02566	0.00417	0.04861	0.00425	0.00271	0.00784	0.00043	0.00935	0.03467	0.05508
P	0.08304	0.13833	0.00063	0.00105	0.00026	0.179	0.00048	0.00019	0.03466	0.05527	0.00019	0.00065	0.08006	0.00035
Q	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019
R	0.29623	0.05957	0.00296	0.01204	0.05573	0.17863	0.00333	0.00756	0.00089	0.0729	0.00035	0.01001	0.01156	0.01093
S	0.39655	0.03491	0.00403	0.01471	0.00135	0.10341	0.00081	0.00093	0.07052	0.05433	0.00021	0.0033	0.00895	0.00372
T	0.29198	0.034	0.00027	0.00523	0.0002	0.07468	0.00074	0.00022	0.3556	0.04778	0.00019	0.00019	0.01241	0.00093
U	0.15911	0.00958	0.0106	0.05346	0.01763	0.0385	0.0085	0.0344	0.00019	0.01757	0.0002	0.01009	0.08236	0.02029
V	0.00991	0.06142	0.00019	0.00019	0.00019	0.71096	0.00019	0.00019	0.00024	0.15514	0.00019	0.00019	0.0003	0.00019
W	0.13986	0.10573	0.00066	0.00022	0.00264	0.14368	0.00125	0.00027	0.19552	0.22528	0.00019	0.00059	0.00411	0.00029
X	0.12249	0.04305	0.00019	0.10473	0.00019	0.24862	0.0088	0.00019	0.00626	0.26128	0.00019	0.00019	0.00086	0.00034
Y	0.62775	0.00528	0.00214	0.00056	0.00043	0.04366	0.00079	0.00037	0.00033	0.00671	0.00019	0.00022	0.00222	0.00452
Z	0.08478	0.26455	0.00019	0.00019	0.00019	0.45908	0.00019	0.00019	0.00019	0.02732	0.00019	0.00019	0.01575	0.00019

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Space	0.0297	0.03789	0.03223	0.00343	0.01695	0.08114	0.13602	0.00969	0.00714	0.06971	0.00022	0.03112	0.00029
A	0.22065	0.00041	0.01253	0.00081	0.12741	0.0636	0.11566	0.016	0.03906	0.00916	0.00108	0.03974	0.00125
B	0.0003	0.09632	0.00019	0.00019	0.08986	0.01	0.00709	0.16545	0.00024	0.00021	0.00019	0.0565	0.00019
C	0.0002	0.19746	0.00019	0.00193	0.03424	0.00063	0.04302	0.03753	0.00019	0.00019	0.00019	0.00977	0.00019
D	0.00265	0.07402	0.00027	0.00019	0.02539	0.03966	0.00031	0.01983	0.00293	0.00457	0.00019	0.01923	0.00019
E	0.08908	0.00489	0.00877	0.00102	0.13234	0.07268	0.03629	0.0045	0.01092	0.00628	0.00881	0.0123	0.00031
F	0.00025	0.23693	0.00028	0.00019	0.07774	0.00196	0.02492	0.03255	0.00019	0.0002	0.00019	0.00247	0.00019
G	0.01494	0.12688	0.00023	0.00019	0.07637	0.02535	0.00329	0.03489	0.00019	0.00028	0.00019	0.00172	0.00019
H	0.00411	0.10938	0.0002	0.00023	0.00924	0.00323	0.02704	0.01575	0.00019	0.00058	0.00019	0.02892	0.00019
I	0.21661	0.04068	0.00771	0.00045	0.05358	0.14092	0.11164	0.00984	0.02488	0.00033	0.00175	0.00019	0.00343
J	0.00019	0.32646	0.00019	0.00019	0.00019	0.00019	0.00019	0.33306	0.00019	0.00019	0.00019	0.00019	0.00019
K	0.10313	0.00341	0.00019	0.00019	0.00088	0.04389	0.00032	0.00076	0.00019	0.001	0.00019	0.00293	0.00019
L	0.00062	0.11029	0.0046	0.00019	0.00113	0.02167	0.01517	0.01642	0.00489	0.00055	0.00019	0.03912	0.0002
M	0.00491	0.08958	0.03181	0.00019	0.00028	0.01608	0.00039	0.03955	0.00023	0.00072	0.00019	0.01078	0.00019
N	0.01003	0.10617	0.00061	0.00161	0.00669	0.03347	0.08708	0.00614	0.00302	0.00176	0.00019	0.01292	0.00094

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
O	0.1015	0.0435	0.00978	0.00024	0.13568	0.02746	0.06258	0.20191	0.0192	0.05928	0.00104	0.0055	0.00079
P	0.00026	0.13045	0.03663	0.00019	0.16255	0.01705	0.02506	0.0457	0.00019	0.00073	0.00019	0.00667	0.00019
Q	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.99519	0.00019	0.00019	0.00019	0.00019	0.00019
R	0.01627	0.08086	0.00302	0.00033	0.01766	0.05088	0.04713	0.0215	0.00752	0.00261	0.00019	0.02914	0.0002
S	0.00102	0.05092	0.02458	0.00062	0.00034	0.04138	0.13822	0.02784	0.00019	0.0136	0.00019	0.00318	0.00019
T	0.00139	0.07504	0.00022	0.00019	0.03473	0.0151	0.01361	0.01431	0.00019	0.00702	0.00019	0.01317	0.00043
U	0.09024	0.00287	0.02773	0.00019	0.18418	0.13492	0.09471	0.00024	0.00035	0.00019	0.00051	0.00097	0.00045
V	0.00019	0.04668	0.00019	0.00019	0.0003	0.00019	0.00019	0.00169	0.00019	0.00019	0.00019	0.01019	0.00019
W	0.03735	0.10694	0.00021	0.00019	0.01526	0.01759	0.00061	0.00023	0.00019	0.00019	0.00019	0.00058	0.00021
X	0.00019	0.00221	0.06523	0.00266	0.00019	0.00056	0.12609	0.00356	0.00034	0.00019	0.00019	0.00108	0.00019
Y	0.00072	0.2686	0.00129	0.00019	0.00626	0.02508	0.00084	0.00019	0.00029	0.00042	0.00023	0.00019	0.00055
Z	0.00019	0.08698	0.00019	0.00019	0.00019	0.00019	0.00019	0.00537	0.00198	0.00138	0.00019	0.01994	0.02991

APPENDIX C

Space	0.206493
Aleph	0.069642
Bet	0.042117
Gimel	0.005525
Dalet	0.018239
Hei	0.074361
Vav	0.078614
Zayin	0.006033
Chet	0.018707
Tet	0.004847
Yud	0.081106
Kaf	0.031047
Lamed	0.056365
Mem	0.065253
Nun	0.036408
Samech	0.004777
Ayin	0.029099
Pei	0.012345
Tsadi	0.010141
Kuf	0.012005
Resh	0.047070
Shin	0.040875
Tav	0.047034

APPENDIX D

	Space	Aleph	Bet	Gimel	Dalet	Hei	Vav	Zayin	Chet	Tet	Yud	Kaf	Lamed	Mem
Space	0.000000	0.044433	0.021068	0.001243	0.024433	0.142610	0.093596	0.001000	0.014879	0.003432	0.085569	0.041487	0.081623	0.132011
Aleph	0.485595	0.000040	0.040029	0.002244	0.000321	0.050487	0.112994	0.006972	0.000000	0.009456	0.046159	0.009176	0.091237	0.030665
Bet	0.380574	0.054860	0.015835	0.011330	0.054462	0.038693	0.063606	0.026105	0.006692	0.007288	0.046710	0.023852	0.044193	0.011665
Gimel	0.246970	0.006566	0.085354	0.011616	0.016667	0.120707	0.057071	0.000505	0.025253	0.000000	0.076263	0.005556	0.048485	0.033333
Dalet	0.078488	0.071297	0.097613	0.054009	0.004131	0.033660	0.050337	0.000765	0.066095	0.000765	0.125000	0.006732	0.046818	0.052781
Hei	0.308916	0.034224	0.022516	0.001313	0.014185	0.014185	0.124325	0.018951	0.007243	0.011933	0.134194	0.021765	0.077004	0.029871
Vav	0.446223	0.036668	0.022895	0.005963	0.014695	0.103685	0.001171	0.001775	0.011998	0.005608	0.073229	0.009726	0.034147	0.032721
Zayin	0.275208	0.080481	0.022664	0.008326	0.000000	0.155874	0.049954	0.003238	0.057354	0.000000	0.019426	0.003700	0.036078	0.142921
Chet	0.148717	0.149314	0.077416	0.001492	0.001342	0.052357	0.047285	0.000447	0.005519	0.002387	0.061605	0.008801	0.085471	0.050561
Tet	0.135866	0.001727	0.051238	0.000000	0.000000	0.055268	0.082902	0.000000	0.166379	0.000576	0.078296	0.002303	0.036269	0.129534
Yud	0.182247	0.034474	0.056288	0.001617	0.023258	0.077826	0.128746	0.003647	0.021159	0.005539	0.007569	0.042869	0.061724	0.043381
Kaf	0.286536	0.048805	0.042603	0.000360	0.013572	0.047277	0.064264	0.011774	0.004404	0.000629	0.131134	0.013122	0.109473	0.039811
Lamed	0.317689	0.188574	0.020546	0.010050	0.006188	0.026437	0.069657	0.001733	0.023615	0.000396	0.025150	0.106144	0.008812	0.028961
Mem	0.219979	0.078772	0.019843	0.008638	0.020954	0.082877	0.057261	0.000898	0.021938	0.009237	0.184271	0.052857	0.038531	0.016031
Nun	0.103779	0.045834	0.152142	0.004292	0.020924	0.074500	0.082471	0.005135	0.027439	0.003679	0.079559	0.037786	0.018472	0.071351

	Space	Aleph	Bet	Gimel	Dalet	Hei	Vav	Zayin	Chet	Tet	Yud	Kaf	Lamed	Mem
Samech	0.168224	0.057827	0.044393	0.000000	0.000000	0.037383	0.136682	0.000000	0.022196	0.000000	0.126168	0.130841	0.009930	0.089369
Ayin	0.354814	0.004315	0.091964	0.013905	0.018700	0.079498	0.079785	0.000767	0.000000	0.001822	0.066360	0.002301	0.052647	0.074607
Pei	0.215868	0.042269	0.013788	0.009042	0.009946	0.039331	0.053571	0.000678	0.009268	0.007685	0.041365	0.048373	0.139014	0.025769
Tsadi	0.133187	0.014584	0.025867	0.000000	0.000000	0.033847	0.075124	0.000000	0.050908	0.000000	0.106219	0.002752	0.018437	0.186571
Kuf	0.177359	0.006509	0.092283	0.000000	0.009066	0.095769	0.034170	0.026964	0.047420	0.000000	0.112971	0.000930	0.076244	0.090421
Resh	0.045649	0.079737	0.097996	0.015592	0.016184	0.054363	0.051873	0.021046	0.031183	0.007173	0.058987	0.024129	0.008003	0.102261
Shin	0.168419	0.177089	0.043487	0.004437	0.030857	0.047856	0.050382	0.000000	0.014951	0.000273	0.123771	0.003823	0.032086	0.112161
Tav	0.122812	0.306081	0.042836	0.001187	0.018214	0.013764	0.087274	0.001958	0.047820	0.001127	0.075289	0.015722	0.033403	0.035181

	Nun	Samech	Ayin	Pei	Tsadi	Kuf	Resh	Shin	Tav
Space	0.052676	0.001905	0.011054	0.008973	0.012419	0.006081	0.085461	0.022338	0.111704
Aleph	0.008214	0.000160	0.000641	0.002765	0.018712	0.000160	0.063028	0.011019	0.009937
Bet	0.007619	0.006957	0.040019	0.000000	0.012655	0.016100	0.055854	0.061022	0.013914
Gimel	0.090909	0.018182	0.014141	0.013636	0.002020	0.000000	0.078283	0.018182	0.030303
Daled	0.016524	0.006120	0.110924	0.012546	0.008262	0.087821	0.035802	0.022338	0.011169
Hei	0.038615	0.002439	0.014823	0.004391	0.004691	0.006229	0.019026	0.057753	0.031409
Vav	0.044690	0.003976	0.023250	0.004969	0.018352	0.010720	0.027048	0.023747	0.042737
Zayin	0.022202	0.000000	0.076781	0.004625	0.000000	0.000000	0.016189	0.009713	0.015264
Chet	0.067721	0.004624	0.000000	0.034159	0.018795	0.055489	0.043705	0.023568	0.059218
Tet	0.029937	0.000000	0.021877	0.073690	0.000576	0.075417	0.009787	0.035118	0.013241
Yud	0.109788	0.004748	0.024703	0.009909	0.007810	0.006021	0.063650	0.035541	0.047480
Kaf	0.028582	0.009168	0.007909	0.006831	0.003865	0.000809	0.044131	0.038918	0.046018
Lamed	0.001386	0.005545	0.097332	0.006485	0.003911	0.010100	0.001733	0.032526	0.007030
Mem	0.003635	0.002309	0.043919	0.000641	0.002822	0.005346	0.011760	0.064403	0.053070
Nun	0.012570	0.001303	0.028972	0.056795	0.003219	0.016402	0.038016	0.063003	0.052349

	Nun	Samech	Ayin	Pei	Tsadi	Kuf	Resh	Shin	Tav
Samech	0.084696	0.002921	0.001752	0.034463	0.000000	0.002921	0.025701	0.005841	0.018692
Ayin	0.021481	0.013425	0.000000	0.005562	0.004699	0.004219	0.059359	0.022727	0.027043
Pei	0.070750	0.094937	0.008816	0.000452	0.027125	0.001808	0.027577	0.091998	0.020570
Tsadi	0.010732	0.000000	0.047331	0.005779	0.002201	0.038250	0.237755	0.000000	0.010457
Kuf	0.023245	0.002789	0.045793	0.034403	0.005114	0.000697	0.031613	0.045328	0.040911
Resh	0.004328	0.005276	0.035748	0.050213	0.031243	0.056735	0.003201	0.181824	0.017252
Shin	0.029765	0.000000	0.085199	0.017477	0.000000	0.005666	0.021914	0.011264	0.019115
Tav	0.034055	0.002670	0.031267	0.018451	0.002729	0.005696	0.045328	0.037140	0.019994

What is claimed is:

CLAIMS

1. A method for alphanumeric data entry using a device, the method comprising:
 - 5 producing a display of alphanumeric characters arranged in a non-alphabetical, two-dimensional arrangement which is optimized for use with at least one directional navigation actuator on the device;
in response to actuation by a user of the at least one directional navigation actuator on the device, navigating the display of alphanumeric characters;
 - 10 and
in response to an entry actuation by a user of the device, entering individual alphanumeric characters.
2. The method for alphanumeric data entry according to claim 1 and
15 wherein the device comprises a hand-held device.
3. The method for alphanumeric data entry according to either claim 1 or claim 2 and wherein the device uses a wired communication protocol.
- 20 4. The method for alphanumeric data entry according to either claim 1 or claim 2 and wherein the device uses a wireless communication protocol.

5. The method for alphanumeric data entry according to any of claims 1 - 4 and wherein the producing the display comprises producing the display in response to a display actuation by a user of the device.
- 5 6. The method for alphanumeric data entry according to any of claims 1 - 5 and wherein the producing the display comprises producing the display on a television.
7. The method for alphanumeric data entry according to any of claims 1 - 10 6 and wherein the producing the display comprises producing the display in response to a display actuation by a user of a remote control.
8. The method for alphanumeric data entry according to any of claims 1 - 15 7 and wherein the display is optimized based on alphanumeric character occurrence frequency and alphanumeric pair transition frequency.
9. The method for alphanumeric data entry according to any of claims 1 - 8 and wherein the display is optimized for an alphabet of a natural language.
- 20 10. The method for alphanumeric data entry according to any of claims 1 - 9 and wherein the natural language is an alphabet language.
11. The method for alphanumeric data entry according to any of claims 1 - 10 and wherein the natural language is chosen from a group comprising:

English;
Hebrew;
French;
Spanish;
5 Italian;
Swedish;
Norwegian;
Danish;
Finnish;
10 Russian;
Polish;
Portuguese;
Turkish;
Japanese;
15 Greek;
German; and
Arabic.

12. The method for alphanumeric data entry according to any of claims 1 -
20 11 and wherein the producing the display comprises:
pre-computing the non-alphabetical, two-dimensional arrangement; and
displaying the display.

13. The method for alphanumeric data entry according to claim 12 and wherein the pre-computing is based on alphanumeric character occurrence frequency and alphanumeric pair transition frequency of a particular natural language.
- 5 14. The method for alphanumeric data entry according to any of claims 1 - 13 and also comprising:
- emphasizing, in response to the entry actuation, at least one of the alphanumeric characters in the display.
- 10 15. The method according to claim 14 and wherein the emphasizing comprises highlighting.
16. The method according to either claim 14 or claim 15 and wherein the emphasizing is based, at least in part, on frequency analysis of likelihood of selection
- 15 of alphanumeric characters.
17. A system comprising:
- a device having at least one directional navigation actuator; and
- a display of alphanumeric characters arranged in a non-alphabetical,
- 20 two-dimensional arrangement which is optimized for use with the at least one directional navigation actuator on the device.
18. The system according to claim 17 and wherein the device comprises a hand-held device.

19. The system according to either claim 17 or claim 18 and wherein the device uses a wired communication protocol.
- 5 20. The system according to either of claim 17 or claim 18 and wherein the device uses a wireless communication protocol.
21. The system according to any of claims 17 - 20 and wherein the display is produced in response to a display actuation by a user of the device.
- 10 22. The system according to any according to any of claims 17 - 21 and wherein the display of alphanumeric characters comprises a display on a television.
23. The system according to any of claims 17 - 22 and wherein the display
15 of alphanumeric characters is produced in response to a display actuation by a user of a remote control.
24. The system according to any of claims 17 - 23 and wherein the display of alphanumeric characters is optimized based on alphanumeric character occurrence
20 frequency and alphanumeric pair transition frequency.
25. The system according to any of claims 17 - 24 and wherein the display is optimized for an alphabet of a natural language.

26. The system according to any of claims 17 - 25 and wherein the natural language is an alphabet language.

27. The system according to any of claims 17 - 26 and wherein the natural
5 language is chosen from a group comprising:

English;
Hebrew;
French;
Spanish;
10 Italian;
Swedish;
Norwegian;
Danish;
Finnish;
15 Russian;
Polish;
Portuguese;
Turkish;
Japanese;
20 Greek;
German; and
Arabic.

28. The system according to any of claims 17 - 27 and wherein the display of alphanumeric characters is produced, at least in part, by:

pre-computing the non-alphabetical, two-dimensional arrangement; and displaying the display.

5

29. The system according to claim 28 and wherein the pre-computing is based on alphanumeric character occurrence frequency and alphanumeric pair transition frequency of a particular natural language.

10 30. The system according to any of claims 17 - 27 and wherein at least one of the alphanumeric characters in the display is emphasized in response to an entry actuation on the device.

31. The system according to claim 30 and wherein the emphasizing
15 comprises highlighting.

32. The system according to either claim 30 or claim 31 and wherein the emphasizing is based, at least in part, on frequency analysis of likelihood of selection of alphanumeric characters.

20

33. A data entry system comprising:
a data entry device having at least one directional navigation actuator;
and

a display of alphanumeric characters arranged in a non-alphabetical, two-dimensional arrangement which is optimized for use with the at least one directional navigation actuator on the data entry device.

5 34. The data entry system according to claim 33 and wherein the display is optimized for an alphabet of a natural language.

35. The data entry system according to claim 34 and wherein the natural language is an alphabet language.

10

36. The data entry system according to any of claims 33 - 35 and wherein the natural language is chosen from a group comprising:

English;
Hebrew;
15 French;
Spanish;
Italian;
Swedish;
Norwegian;
20 Danish;
Finnish;
Russian;
Polish;
Portuguese;

Turkish;
Japanese;
Greek;
German; and
Arabic.

5

37. The data entry system according to any of claims 33 - 36 and wherein at least one of the alphanumeric characters in the display is emphasized in response to an entry actuation on the data-entry device.

10

38. The data entry system according to claim 37 and wherein the emphasizing comprises highlighting.

39. The data entry system according to claim 37 or claim 38 and wherein
15 the emphasizing is based, at least in part, on frequency analysis of likelihood of selection of alphanumeric characters.

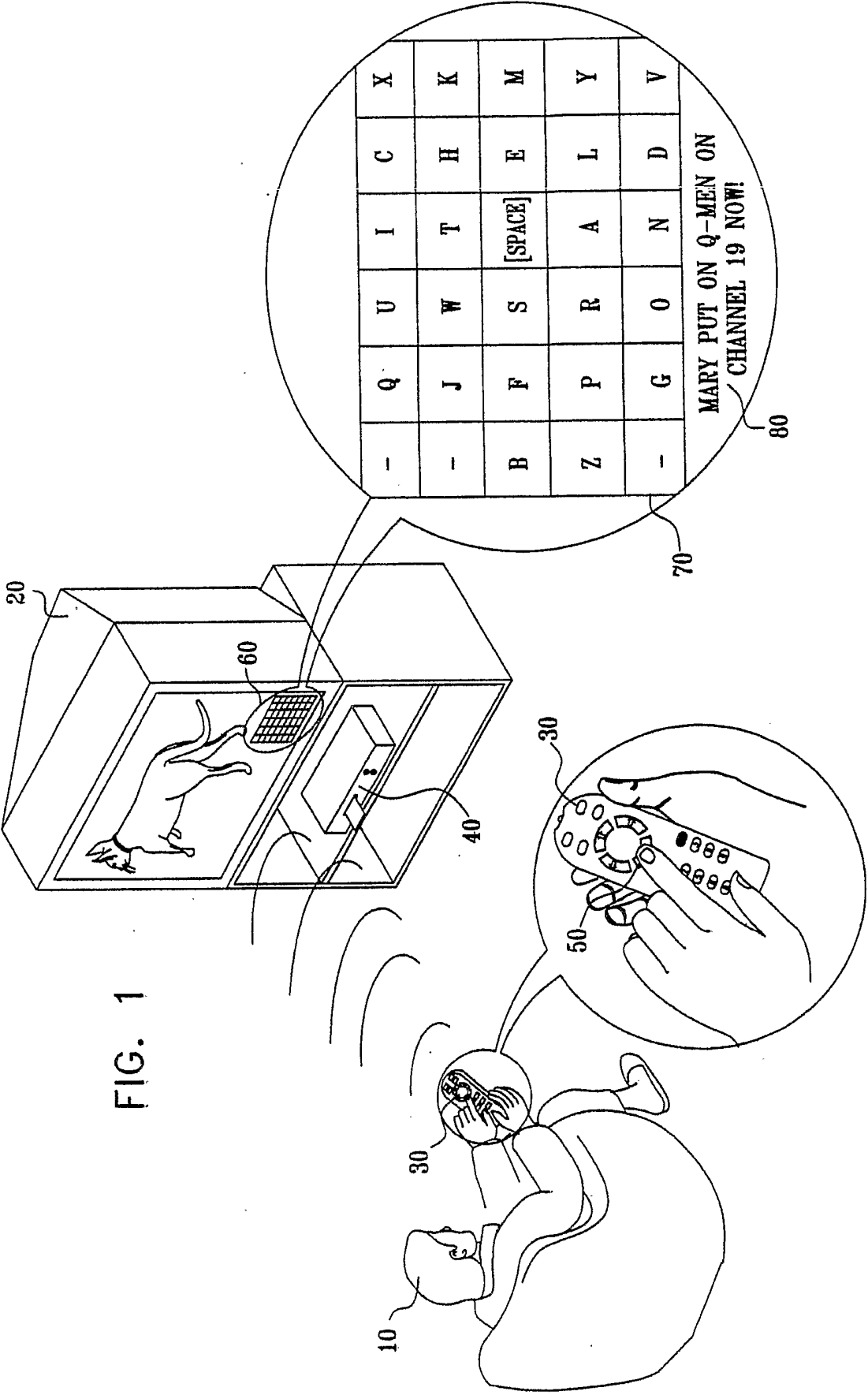


FIG. 2

Diagram illustrating a 5x6 grid structure, labeled FIG. 2. The grid is composed of cells containing characters or symbols. The grid is labeled with reference numerals: 200 points to the top-right corner, 210 points to the bottom-right corner, and 215 points to the left side of the grid.

-	Q	U	I	C	X
-	J	W	T	H	K
B	F	S	[SPACE]	E	M
Z	P	R	A	L	Y
-	G	O	N	D	V

FIG. 3A

Q	W	E	R	T	Y
U	I	O	P	A	S
D	F	G	H	J	K
L	Z	X	C	V	B
N	M	[SPACE]	-	-	-

FIG. 3B

270 →

Y	∑	τ	ρ	-
ϣ	∏	N	π	μ
ϑ	ι	[SPACE]	λ	κ
∫	γ	η	⊥	λ
∠	∏	∪	τ	-

280

FIG. 4

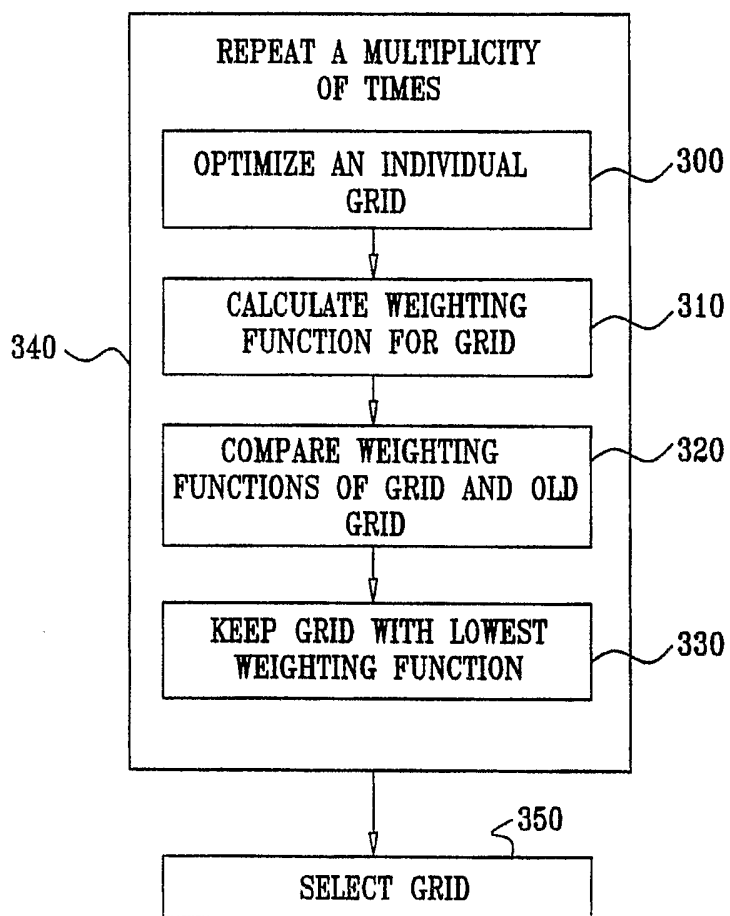


FIG. 5

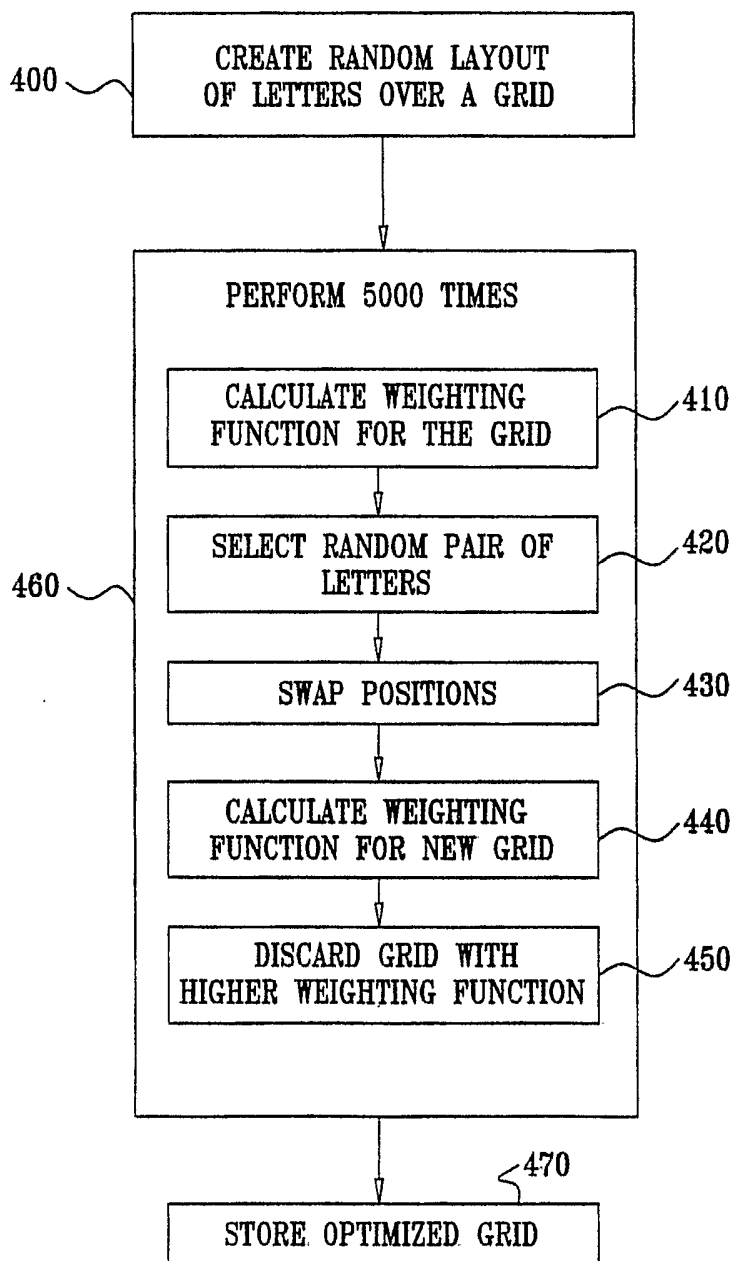


FIG. 6

-	Q	U	I	C	X
-	J	W	T	H	K
B	F	S	[SPACE]	E	M
Z	P	R	A	L	Y
-	G	O	N	D	V

610

FIG. 7A

-	Q	U	I	C	X
-	J	W	T	H	K
B	F	S	[SPACE]	E	M
Z	P	R	A	L	Y
-	G	O	N	D	V

710

FIG. 7B

730

Y	ן	ז	ק	—
פ	ת	נ	ח	ט
צ	ל	[SPACE]	כ	ב
ג	י	ה	ו	א
ך	ש	ע	ד	—

FIG. 7C

Y	ן	ז	ק	—
פ	ת	נ	ח	ט
צ	ל	[SPACE]	כ	ב
ג	י	ה	ו	א
ך	ש	ע	ד	—

750

FIG.8

-	Q	U	I	C	X
-	J	W	T	H	K
B	F	S	[SPACE]	E	M
Z	P	R	A	L	Y
-	G	O	N	D	V

830

810

830

820

FIG.9

Y	Σ	τ	ρ	-
ϣ	Π	N	Π	υ
υ	ι	[SPACE]	λ	⊔
⊔	τ	π	⊥	λ
τ	Ш	Λ	τ	-

930

910

930

920

INTERNATIONAL SEARCH REPORT

PCT/GB2004/000873

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G06F3/023

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 G06F H04N

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 and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 487 616 A (ICHBIAH JEAN D) 30 January 1996 (1996-01-30)	1-4, 8-13, 17-20, 24-29, 33-36
Y	column 1, line 61 - column 2, line 16 column 3, line 31 - column 4, line 12 column 4, line 44 - column 4, line 57 column 5, line 13 - column 5, line 16; figures 1-5 ----- -/--	1,17,33



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

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INTERNATIONAL SEARCH REPORT

PCT/GB2004/000873

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	paragraph '0008! - paragraph '0009! paragraph '0016! paragraph '0021! paragraph '0025! paragraph '0026! - paragraph '0027! paragraph '0029! - paragraph '0037! paragraph '0043! - paragraph '0044!; figure 1	1,17,33
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