[0046] **FIG. 5** illustrates an exemplary display on a graphical interface and a discrete graphical choice in accordance with one embodiment of the invention.

[0047] **FIG. 6** illustrates an exemplary memory cue presented in response to a portion of a graphical interface being highlighted in accordance with one embodiment of the invention.

[0048] **FIG. 7** illustrates an exemplary display on a graphical interface and two discrete graphical choices in accordance with one embodiment of the invention.

[0049] **FIG. 8** is a block diagram showing an error-correcting code, a portion of which is used in aspects of the invention.

[0050] **FIG. 9** is a geometric analogy to decoding with unconstrained codewords in accordance with one embodiment of the invention.

[0051] **FIG. 10** is a geometric analogy to decoding with constrained codewords in accordance with one embodiment of the invention.

[0052] **FIGS. 11A and 11B** illustrate a comparison of the security levels associated with different numbers of codewords.

[0053] **FIG. 12** illustrates an exemplary display on a graphical interface, two discrete graphical choices, and a line between the two discreet graphical choices in accordance with one embodiment of the invention.

[0054] **FIG. 13** illustrates a flowchart of an enrollment process in accordance with one embodiment of the invention.

[0055] **FIG. 14** is a block diagram showing an enrollment system in accordance with one embodiment of the invention.

[0056] **FIG. 15** is a flowchart of an authentication process in accordance with one embodiment of the invention.

[0057] **FIG. 16** is a geometric analogy to decoding with constrained codewords and an offset in accordance with one embodiment of the invention.

DETAILED DESCRIPTION

[0058] **FIG. 1** illustrates a functional block diagram of an enrollment system **110** and a user **126**. The user **126** provides a secret pattern made up of a sequence of discrete graphical choices to a graphical interface **112**, which is a component of the enrollment system **110**. The display parameter **124**, which in one embodiment is an image file, may help the user **126** to select or recall the secret pattern. The secret pattern is processed by components of the enrollment system **110** including a converter **114**, a codeword generator **116**, a security calculator **118**, and, in conjunction with a threshold value **122**, a comparator **120**, to determine the secret level that characterizes the secret pattern. In one embodiment, if the secret pattern has a security value that meets or exceeds the threshold value, the secret pattern will be accepted for use in authenticating the user, as will be discussed in more detail later.

[0059] In one embodiment, the graphical interface **112** is one or more hardware devices that provide a graphical display, which can be viewed by the user **126**, and that receives input from the user **126**. In one embodiment, the graphical interface **112** is a CRT (cathode ray tube) with a mouse used for input. In another embodiment, the graphical interface **112** is a flat screen device, such as a liquid crystal display (LCD) or an active-matrix display device with input or touch-screen capability, or with an input or touch-screen overlaid on the display. In one embodiment, the graphical interface **112** is rectangular. In other embodiments, the graphical interface is another geometric form or shape. In one embodiment, the graphical interface **112** is a separate device that is electronically, optically, or otherwise in communication with the converter **114**. In another embodiment, the graphical interface **112** is integrated into another device, such as a computer system, laptop computer, palmtop computer, other portable computer, or portable cellular telephone.

[0060] In one embodiment, the display parameter **124**, the converter **114**, the codeword generator **116**, the security calculator **118**, the threshold value **122**, and the comparator **120** are implemented as a single software application program executing on a general purpose computer system. In alternate embodiments, the converter **114**, the codeword generator **116**, the security calculator **118**, and the comparator **120** are variously implemented as individual software modules, programs, or objects, such as objects implemented in the C++ programming language. In another embodiment, one or more of the display parameter **124**, the converter **114**, the codeword generator **116**, the security calculator **118**, the threshold value **122**, and the comparator **120** are combined in a hardware device or integrated chip, such as an ASIC (application-specific integrated circuit).

[0061] In another embodiment, the graphical interface **112**, the display parameter **124**, the converter **114**, the codeword generator **116**, the security calculator **118**, the comparator **120**, and the threshold value **122** are all part of the same computer system, laptop computer, palmtop computer, or other portable computer. In another embodiment, two or more of the graphical interface **112**, the converter **114**, the codeword generator **116**, the security calculator **118**, and the comparator **120** are separate computers or devices connected in a network, which may be a local network, or a global network, such as the Internet. The threshold value **122** and the display parameter **124** in some embodiments are contained in one or more memory elements, such as ROM or RAM. The threshold value **122** and/or the display parameter **124** in various embodiments are stored on a CD-ROM, a network, a smartcard, a personal digital assistant (PDA), a magnetic strip which may be attached to a card the approximate size of a credit card, or a bar code.

[0062] The converter **114**, the codeword generator **116**, the security calculator **118**, and the comparator **120**, in conjunction with a threshold value **122**, are all used by the enrollment system **110** to perform the enrollment process. Their individual functions are described in more detail with respect to the steps, illustrated in **FIG. 2**, which are part of the enrollment process.

[0063] **FIG. 2** illustrates a flowchart of the enrollment process according to one embodiment of the invention. The objective of the enrollment process and the use of the enrollment system **110** is to establish a robust visual password that can be used to authenticate the user. The visual password is derived from a secret pattern entered by the user, for example, on the graphical interface **112** (**FIG. 1**). The