may provide a haptic sensation directly to the user, as shown by the phantom arrow in **FIG. 1**.

[**0040**] The actuator **135** may provide the haptic sensation actively or passively. For example, the actuator **135** may comprise one or more motors coupled to the user object **130** to apply a force to the user or to the user object **130** in one or more degrees of freedom. Alternatively or additionally, the actuator **135** may comprise one or more braking mechanisms coupled to the user object to inhibit movement of the user or the user object **130** in one or more degrees of freedom. By haptic sensation it is meant any sensation provided to the user that is related to the user's sense of touch. For example, the haptic sensation may comprise kinesthetic force feedback and/or tactile feedback. By kinesthetic force feedback it is meant any active or passive force applied to the user to simulate a force that would be experienced in the graphical environment **110**, such as a grounded force applied to the user or the user object **130** to simulate a force experienced by at least a portion of the graphical image **115**. For example, if the graphical image **115** is positioned against a surface, a barrier or an obstruction, the actuator **135** may output a force against the user object **130** preventing or retarding movement of the user or the user object **130** in the direction of the barrier or obstruction. By tactile feedback it is meant any active or passive force applied to the user to provide the user with a tactile indication of a predetermined occurrence within the graphical environment **110**. For example, a vibration, click, pop, or the like may be output to the user when the graphical image **115** interacts with a graphical object **120**. Additionally, tactile feedback may comprise a tactile sensation applied to approximate or give the illusion of a kinesthetic force. For example, by varying the frequency and/or the amplitude of an applied vibration, variations in surface textures of different graphical objects can be simulated or by providing a series of clicks when a graphical image penetrates an object, resistance to the penetration can be simulated. For example, in one version a kinesthetic force sensation, such as a spring force, may be applied to the user whenever the graphical image **115** engages the graphical object **120** to simulate a selectively deformable surface. Alternatively or additionally, a tactile sensation, such as a pop, may be applied to the user when the graphical image **115** is moved across a surface of the graphical object **120** to simulate a texture of the graphical object **120**.

[**0041**] The controller **125** may be a computer **150**, or the like, such as the computer shown in **FIG. 2**. In one version, the computer **150** may comprise a processor and may be able to execute program code. For example, the computer may be a personal computer or workstation, such as a PC compatible computer or Macintosh personal computer, or a Sun or Silicon Graphics workstation. The computer **150** may be operable under the Windows™, MacOS, Unix, or MS-DOS operating system or similar. Alternatively, the computer **150** can be one of a variety of home video game console systems commonly connected to a television set or other display, such as systems available from Nintendo, Sega, or Sony. In other embodiments, the computer **150** can be a "set top box" which can be used, for example, to provide interactive television functions to users, or a "network-" or "internet-computer" which allows users to interact with a local or global network using standard connections and protocols such as used for the Internet and World Wide Web. The computer **150** may include a host microprocessor, random access memory (RAM), read only memory (ROM), input/output (I/O) circuitry, and/or other components of computers well-known to those skilled in the art. The computer **150** may implement an application program with which a user is interacting via peripherals, such as haptic interface device **140** and/or user object **130**. For example, the application program can be a simulation program, such as an interactive digital mockup of a designed feature, a medical procedure simulation program, a game, etc. Specifically, the application program may be a computer aided design or other graphic design program, an operating system, a video game, a word processor or spreadsheet, a Web page or browser that implements, for example, HTML or VRML instructions, a scientific analysis program, or other application program that may or may not utilize haptic feedback. Herein, for simplicity, operating systems such as Windows™, MS-DOS, MacOS, Linux, Be, etc. are also referred to as "application programs." The application program may comprise an interactive graphical environment, such as a graphical user interface (GUI) to allow the user to input information to the program. Typically, the application provides images to be displayed on a display screen **155** and/or outputs other feedback, such as auditory signals. The computer **150** is capable of generating a graphical environment **110**, which can be a graphical user interface, game, simulation, such as those described above, or other visual environment. The computer **150** displays graphical objects **120**, such as graphical representations and graphical images, or "computer objects," which are not physical objects, but are logical software unit collections of data and/or procedures that may be displayed as images by the computer on display screen **155**, as is well known to those skilled in the art. The application program checks for input signals received from the electronics and sensors of the user object **130**, and outputs force values and/or commands to be converted into haptic output for the actuator **135**. Suitable software drivers which interface such simulation software with computer input/output (**110**) devices are available from Immersion Corporation of San Jose, Calif. Display screen **155** can be included in the computer and can be a standard display screen (LCD, CRT, flat panel, etc.), 3-D goggles, or any other visual output device.

[**0042**] In one version of the simulation system **100**, the user object **130** comprises an instrumented glove **160**. Within or on the instrumented glove **160** are one or more sensors that are capable of detecting a manipulation of the glove. A signal indicative of the detected manipulation is provided to the computer **150**, optionally through glove sensor interface **165**, to control the position, orientation, and/or shape of the graphical image **115**, which may be for example a graphical hand **170** as shown in the version of **FIG. 2. 10**

[**0043**] The position of the instrumented glove **160** may be used to control the position of the graphical hand **170** in the graphical environment **110**. The position of the instrumented glove **160** may be detected by one or more position sensors adapted to detect the position of the instrumented glove **160** in one, two, or three dimensions. The position sensor may include a grounded link connected to the instrumented glove **160**. Alternatively, the position sensor may detect the position of the instrumented glove **160** in space, without being physically connected to a reference. For example in one version, the instrumented glove **160** comprises a Polhemus™ or Ascension™ electromagnetic position sensor to