

patent application Ser. No. 09/153,781 filed on Sep. 16, 1998, which is incorporated herein by reference in its entirety. In this version, a user may download an application program, such as a virtual reality simulation program, or a file of haptic sensations from a remote location. Also, a user may interact with a simulation running at a remote location. In another version, the haptic interface may be used as a master device to control a remote slave device. The slave device may be representative of the user's hand or fingers for example, and the user may control the slave to, for example, perform a procedure at a remote location. In an advanced version, the slave device may be equipped with sensors to detect conditions of the slave device, such as pressures or forces. The sensed conditions may then be used to provide haptic sensations to the user via the master device, the haptic sensations being related to the sensed conditions of the slave device.

[0150] While this invention has been described in terms of several preferred embodiments, it is contemplated that alterations, permutations and equivalents thereof will become apparent to those skilled in the art upon a reading of the specification and study of the drawings. For example, many different types of haptic sensations can be provided with the haptic interface of the present invention and many different types actuators and user objects can be used, including the use of two user objects to detect manipulation of both hand of a user. In addition, the haptic interface can be replaced by a non-haptic interface, for example, when the mapping of the graphical image is broken. Furthermore, certain terminology, such as terms like x, y, z, left, right, up, down, etc., has been used for the purposes of descriptive clarity, and not to limit the present invention. Therefore, the appended claims should not be limited to the description of the preferred versions contained herein and should include all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

What is claimed is:

1. An interface device for interfacing a user with a computer, the computer running an application program and generating a graphical image and a graphical object, the interface device comprising:

a user manipulatable object in communication with the computer;

a sensor to detect a manipulation of the object, the sensor providing a signal to the computer to control the graphical image; and

an actuator adapted to provide a haptic sensation to the palm of the user in relation to an interaction between the graphical image and the graphical object, the actuator comprising a member that is deformable to provide the haptic sensation.

2. An interface device according to claim 1 wherein the member is bowed to provide the haptic sensation.

3. An interface device according to claim 1 wherein the member is biased away from the palm of the user.

4. An interface device according to claim 1 wherein the graphical image is a graphical hand and wherein the haptic sensation is provided to the user when the graphical hand grasps the graphical object.

5. An interface device according to claim 1 wherein the user manipulatable object comprises an instrumented glove.

6. An actuator for providing a haptic sensation to a user interfacing with a computer running an application program, the actuator comprising:

a deformable member having a first end, a second end, and an intermediate portion; and

a tendon capable of displacing the first end relative to the second end in response to the computer to cause the intermediate portion to contact the user and thereby provide a haptic sensation to the user.

7. An actuator according to claim 6 wherein the deformable member is a leaf spring.

8. An actuator according to claim 6 wherein the tendon passes through a guide member fixed to the first or second end of the deformable member.

9. An actuator according to claim 6 wherein the deformable member is capable of providing a controllable kinesthetic force to the user.

10. An actuator according to claim 6 wherein the deformable member is capable of providing a tactile sensation to the user.

11. A mouse for interfacing a user with a computer generating a graphical environment comprising a graphical hand, the mouse comprising:

a housing;

a position detector to detect a position of the mouse, the position detector capable of providing a first position signal to the computer to control the position of the graphical hand in the graphical environment; and

a finger position detector to detect a position of a finger of the user, the finger position detector capable of providing a second position signal to the computer to control a graphical finger on the graphical hand in relation to the position of the finger of the user.

12. A mouse according to claim 11 further comprising an actuator capable of providing a haptic sensation to the finger of the user.

13. A mouse according to claim 12 wherein the actuator comprises a deformable member.

14. A mouse according to claim 11 further comprising a position detector for each finger on the hand of the user.

15. A mouse according to claim 11 wherein the finger position detector comprises a button on the mouse.

16. A mouse according to claim 15 wherein the button comprises first and second sensing portions.

17. A mouse for interfacing a user with a computer, the mouse comprising:

a housing;

a position detector to detect a position of the mouse;

a member adapted to contact a finger of the user, the member being capable of being moved by the finger in two directions; and

a member position detector to detect a position of the member.

18. A mouse according to claim 17 wherein the member position detector is an analog sensor.

19. A mouse according to claim 17 further comprising a second member adapted to contact a second finger and a second member position detector.