MULTI-DIMENSIONAL ELECTRICAL CONTROL DEVICE

A hand manipulable electrical control input device (120) including a finger engageable control element (125, 130) providing at least four mutually orthogonal parameter inputs and including at least one force sensor (130) providing at least one of said at least four mutually orthogonal parameter inputs.
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MULTI-DIMENSIONAL ELECTRICAL CONTROL DEVICE

FIELD OF THE INVENTION

The present invention relates to hand manipulable input and control devices generally, and more specifically to such devices for use with computers, games, televisions, and other electronically controlled devices.

BACKGROUND OF THE INVENTION

Hand-manipulated input devices are well-known in the art. Hand-manipulated input devices include mice, joysticks, light pens, trackballs and digitizers. Unlike keyboard based input such as computer keyboards, telephones, and conventional television remote control devices, hand-manipulated input devices generally provide a continuous scale of input.

Various hand-manipulated input devices are used in different applications. For computer input, the most widely used of these devices is the mouse.

Conventional mice are hand manipulable devices designed to control displacement in two dimensions, as the hand manipulating the mouse moves about a generally flat surface. Displacement may be effected by the rotation of a ball located on the underside of the mouse in contact with the flat surface, or alternatively by optical means or otherwise. Conventional mice also include a switch having a pressed position and a released position. The user of the mouse typically presses and/or releases the switch to indicate selection of an object, of an option, or of some desired action.

Some mice are additionally capable of controlling displacement in a third spatial dimension. Of these mice, some use transmitters and receivers located in the
mouse and in the environment around the mouse, as for example ultrasonic or infrared transmitters and receivers. Other mice determine three-dimensional displacement with the aid of accelerometers, such as the mouse described in Applicant's copending Israel patent application 108565.

Some mice control the conventional two dimensions along a flat surface and additionally control another variable indicating user input via hand motion. These mice may be considered three dimensional in the sense that they control three independent variables indicating user input via hand motions.

US Patent 4,961,138 to Gorniak describes a mouse whose third dimension is the pressure of the entire mouse against the flat surface.

US Patent 5,063,376 to Chang describes a mouse with a numeric keyboard, one of whose buttons is an analog switch. The analog switch described by Chang controls the position of the switch, that is the degree to which the switch is depressed, from undepressed through fully depressed.

A non-mouse device using pressure sensors for input of two-dimensional information from the user's hand is described in US Patent 4,313,113 to Thornburg.
SUMMARY OF THE INVENTION

The present invention seeks to provide an improved hand manipulable input and control device.

Existing hand manipulable input and control devices, such as mice, are sometimes inadequate to input the necessary information to a computer because existing devices can input at most three dimensions of information plus on/off information. Input of four or more dimensions of information with existing devices requires the use of a second input device such as a keyboard in addition to the hand manipulable input device.

In CAD/CAM applications, for example, it may be necessary to position an object in three dimensions and also to zoom at the same time; to position an object in three dimensions and also to rotate the object about an arbitrary axis at the same time; or to position an object in three dimensions and to specify object attributes at the same time.

In another example, computer games may additionally require the input of three-dimensional position information and also of information on the speed of action of the game at the same time.

There are many other examples requiring more than three dimensions of information. Typically, it is preferred for the multiple dimensions to be input simultaneously.

There is thus provided in accordance with a preferred embodiment of the present invention a hand manipulable electrical control input device including a finger engageable control element providing at least four mutually orthogonal parameter inputs and including at least one force sensor providing at least one of the at least four mutually orthogonal parameter inputs.
Further in accordance with a preferred embodiment of the present invention the control element includes a mouse.

Still further in accordance with a preferred embodiment of the present invention the control element includes a computer input device.

Additionally in accordance with a preferred embodiment of the present invention the control element is displaceable in at least two dimensions.

Further in accordance with a preferred embodiment of the present invention the control element is displaceable in at least three dimensions.

Still further in accordance with a preferred embodiment of the present invention the mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed, amplitude, frequency and texture.

Additionally in accordance with a preferred embodiment of the present invention each force sensor is associated with a displaceable switch.

Further in accordance with a preferred embodiment of the present invention the at least one force sensor includes a plurality of force sensors.

Still further in accordance with a preferred embodiment of the present invention each force sensor is individual finger actuable.

Additionally in accordance with a preferred embodiment of the present invention each force sensor is separately actuable.

Further in accordance with a preferred embodiment of the present invention the control element includes a mouse.

Still further in accordance with a preferred embodiment of the present invention the control element includes a computer input device.
Additionally in accordance with a preferred embodiment of the present invention the control element is displaceable in at least two dimensions.

Further in accordance with a preferred embodiment of the present invention the control element is displaceable in at least three dimensions.

Still further in accordance with a preferred embodiment of the present invention the mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed, amplitude, frequency and texture.

Additionally in accordance with a preferred embodiment of the present invention each force sensor is associated with a displaceable switch.

There is also provided in accordance with another preferred embodiment of the present invention a hand manipulable electrical control input device including a finger engageable control element providing at least three mutually orthogonal parameter inputs and including at least two force sensors providing at least two of the at least three mutually orthogonal parameter inputs.

Further in accordance with a preferred embodiment of the present invention each force sensor is individual finger actuable.

Still further in accordance with a preferred embodiment of the present invention each force sensor is separately actuable.

Additionally in accordance with a preferred embodiment of the present invention the control element includes a mouse.

Further in accordance with a preferred embodiment of the present invention the control element includes a computer input device.

Still further in accordance with a preferred
embodiment of the present invention the control element is displaceable in at least two dimensions.

Additionally in accordance with a preferred embodiment of the present invention the control element is displaceable in at least three dimensions.

Further in accordance with a preferred embodiment of the present invention the mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed, amplitude, frequency and texture.

Still further in accordance with a preferred embodiment of the present invention each force sensor is associated with a displaceable switch.
BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1A is a simplified pictorial illustration of a computer system including a hand manipulable computer input device constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 1B is a sectional illustration of a portion of the device of Fig. 1A at section lines 1B-1B;

Figs. 2A, 2B, 3A, and 3B are simplified pictorial illustrations showing the operation of the device of Fig. 1A;

Figs. 4A - 4D are simplified pictorial illustrations showing the operation of the device of Fig. 1A;

Fig. 5 is an enlarged view of a portion of the device of Fig. 4A at section lines V-V;

Figs. 6A - 6D are simplified pictorial illustrations showing the operation of the device of Fig. 1;

Fig. 7 is an enlarged view of a portion of the device of Fig. 6A at section lines VII-VII;

Figs. 8A - 8D are simplified pictorial illustrations showing the operation of the device of Fig. 1;

Fig. 9 is an enlarged view of a portion of the device of Fig. 8A at section lines IX-IX;

Figs. 10A - 10D are simplified pictorial illustrations showing the operation of the device of Fig. 1;

Fig. 11 is an enlarged view of a portion of the device of Fig. 6A at section lines XI-XI;

Figs. 12A and 12B are simplified pictorial illustrations showing the operation of the device of Fig. 1;

Fig. 13 is an enlarged view of a portion of the device of Fig. 10A at section lines XIII-XIII;
Figs. 14A and 14B are simplified pictorial illustrations showing the operation of the device of Fig. 1;

Fig. 15 is an enlarged view of a portion of the device of Fig. 6A at section lines XV-XV; and

Figs. 16A and 16B are simplified pictorial illustrations showing the operation of the device of Fig. 1.
DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1A which illustrates a computer system including a hand manipulable computer input device which is constructed and operative in accordance with a preferred embodiment of the present invention. The apparatus of Fig. 1A comprises a computer 100 including a CPU 105 and a display screen 110. Computer 105 may be any appropriate computer system such as an IBM-compatible PC system, a workstation system, or another appropriate system.

It is appreciated that the system of Fig. 1A includes computer 105 merely as an example, and that the scope of the present invention is not limited to use with computers, but rather may include use with other devices such as video games, interactive television, or any other electronically controlled device.

A screen object 115 is shown in Fig. 1A displayed on the screen 110. The screen object 115 is depicted in Fig. 1A as a screen representation of a three dimensional object. It is appreciated that the screen object 115 may be an object such as a representation of an object which is part of a computer game, a cursor representing position in three dimensional space, or another object.

The system of Fig. 1A also includes a hand manipulable computer input device 120. The hand manipulable computer input device 120 is depicted in Fig. 1A as a mouse. It is appreciated that the input device 120 is not necessarily a mouse, but may in fact include any two or three-dimensional hand manipulable computer input device, for example a trackball, a digitizer, or a light pen.

In Fig. 1A the input device 120 is shown connected to the CPU 105 by a cable. Alternatively, the input device 120 may be connected by a plurality of cables, by a wireless connection, or by other appropriate
means.

The input device 120 comprises a select button 125. Except as described below, the select button 125 and the remaining components of the input device 120 may be conventional components such as are found in commercially available hand manipulable computer input devices, for example, a mouse such as a Microsoft mouse available from Microsoft Corporation, USA.

The input device 120 also comprises a plurality of force sensors 130. Each of the force sensors 130 is operative to sense the force applied to the force sensor 130 by the user, typically by the user's finger. In Fig. 1A, a first force sensor 131 and a second force sensor 132 are depicted. It will be appreciated that the plurality of force sensors 130 may comprise more than two force sensors.

 Preferably, each of the force sensors 130 is individually finger actuable; that is, each of the force sensors 130 may, if so desired by the user, be actuated by a single finger. Additionally, each of the force sensors 130 is preferably separately actuable; that is, each of the force sensors 130 may, if so desired by the user, be actuated without actuating any of the other force sensors. Preferably, each of the force sensors 130 may be actuated by the user by applying force either in the forward or the backward direction; alternatively, actuation may occur by applying force in other directions.

The force sensors 130 produce continuous signals representing the force applied to each force sensor 130. The continuous signals are converted to digital signals by conventional means, such as by analog-to-digital conversion or within an embedded microprocessor, as typically employed in hand manipulable computer input devices. The processed digitized signals are then transmitted to the computer 100 via the cable or other connecting means.
Alternatively, the analog signals may be sent via the cable or other connecting means to the computer 100 through an analog connection such as a game port. In this case, the computer 100 is operative to convert the analog signals to digital signals.

In the case where analog-to-digital conversion occurs within the input device 120, the signals representing force applied to the force sensors 130 are received by the computer 100 in synchronization with conventional signals sent by the input device 120. In the case where analog-to-digital conversion occurs within the computer 100, the computer 100 is also operative to synchronize the force signals with the conventional signals.

Reference is now made to Fig. 1B which is a sectional illustration of a portion of the device of Fig. 1A at section lines 18-18B. The apparatus of Fig. 1B comprises one of the force sensors 130.

The force sensor 130 shown in Fig. 1B comprises an actuator 135. Preferably, the actuator 135 comprises a bidirectional actuator such as a rocker switch. It is appreciated that the actuator 135 may be any appropriate actuator such as an on-off switch or another appropriate switch. The actuator 135 is operative to provide an indication of the direction in which force is applied to the force sensor 130. Preferably, the actuator 135 may be actuated by the user without necessitating movement of the user's hand or finger from its point of contact with the actuator 135.

Force sensor 130 also comprises a force sensitive element 140. The actuator 135 is positioned relative to the force sensitive element 140 such that, when the user presses the actuator 135, the actuator 135 presses on the force sensitive element 140. The force sensitive element 140 is operative to produce an analog signal indicating the degree of force applied thereto.
The force sensitive element 140 may be any appropriate force sensitive element or transducer as, for example, a force sensitive resistor such as the FSR commercially available from Interlink Electronics Europe, B.P. 8, Zone Industrielle, L-6401 Echternach, Luxembourg.

The operation of the apparatus of Fig. 1A is now briefly described. The depiction of the screen object 115 on the screen 110 is controlled by the CPU 105, which may be executing a CAD/CAM package, a simulation, a computer game, or another appropriate computer task. In response to signals from the input device 120, the computer 100 is operative to alter the depiction of the screen object 115 on the screen 110.

Preferably, the user of the system of Fig. 1A may use the input device 120 to direct the CPU 105 to manipulate the screen object 115 in more than three mutually orthogonal dimensions. For example, the user may, utilizing the conventional input capabilities of the input device 120, direct the CPU 105 to move the screen object 115 in two or three orthogonal directions. Typically at the same time, the user may actuate one or more of the force sensors 130 to direct the CPU 105 to perform other manipulations, such as one or more of the following:

- to zoom the screen object 115 in or out;
- to rotate the screen object 115 about one or more axes;
- to change the speed of an action occurring to the screen object 115;
- to change attributes of the screen object 115 such as the color, texture, size, or other visible attributes of the screen object 115;
- to move the screen object 115 in two or three orthogonal directions, instead of or in addition to the movement indicated using the conventional input capabilities of the input device 120 as described above;
to change the amplitude or frequency of one or more characteristics of motion of the screen object 115; or to perform another manipulation.

It is appreciated that the manipulations described above may alternatively or additionally affect some other attribute such as the frequency or volume of a sound, which other attribute is typically associated in some way with the screen object 115.

In the case where the screen object 115 comprises text, such as a menu or a representation of a printed document, the user may actuate one or more of the force sensors 130 to direct the CPU 105 to change the speed of some action, such as paging through text or scrolling, in addition to manipulations performed utilizing the conventional input capabilities of the input device 120.

In the case where the actuator 135 comprises a bidirectional actuator such as a rocker switch, the position of the actuator 135 may be used to control the direction of the action indicated by use of the force sensors 130, as, for example, whether a zoom is to take place in the inward or the outward direction.

Reference is now made to Figs. 2A, 2B, 3A, and 3B which are simplified pictorial illustrations showing the operation of the device of Fig. 1A. In Figs. 2A and 2B, the user is shown manipulating the input device 120 by moving the input device 120 in a given direction, thus controlling motion of the screen object 115 in a single dimension, motion in the vertical direction.

In Figs. 3A and 3B, the user is shown manipulating the input device 120 by moving the input device 120 in another given direction, thus controlling motion of the screen object 115 in a second dimension orthogonal to the first, motion in the horizontal direction.

Reference is now made to Figs. 4A - 4D which are simplified pictorial illustrations showing the opera-
tion of the device of Fig. 1A. In Figs. 4A – 4D, the user is shown pressing on the first force sensor 131.

Reference is now additionally made to Fig. 5 which is an enlarged view of a portion of the device of Fig. 4A at section lines V-V. As is shown in Fig. 5, the user presses down with one finger on the first force sensor 131 at one end thereof, shown in Fig. 5 as the front end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied.

As is shown in Figs. 4A – 4D, the computer 100 responds to the force exerted by the user on the first force sensor 131 by zooming the depiction of the screen object 115 inward. Thus, the manipulation of the first force sensor 131 of the input device 120 by the user controls motion of the screen object 115 in a third dimension orthogonal to the first two dimensions.

Reference is now made to Figs. 6A – 6D which are simplified pictorial illustrations showing the operation of the device of Fig. 1. In Figs. 6A – 6D, the user is shown pressing on the first force sensor 131.

Reference is now additionally made to Fig. 7 which is an enlarged view of a portion of the device of Fig. 6A at section lines VII-VII. As is shown in Fig. 7, the user presses down with one finger on the first force sensor 131 at an end thereof different from the end shown in Fig. 5, which different end is shown in Fig. 7 as the back end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied.

As is shown in Figs. 6A – 6D, the computer 100 responds to the force exerted by the user on the first force sensor 131 by zooming the depiction of the screen object 115 outward. Thus, taking Figs. 4A – 4D, 5, 6A – 6D and 7 together, it will be appreciated that the manipulation of the first force sensor 131 of the input device
120 by the user controls motion of the screen object 115 in two different directions in a third dimension orthogonal to the first two dimensions.

Reference is now made to Figs. 8A - 8D which are simplified pictorial illustrations showing the operation of the device of Fig. 1. In Figs. 8A - 8D, the user is shown pressing on the first force sensor 131.

Reference is now additionally made to Fig. 9 which is an enlarged view of a portion of the device of Fig. 8A at section lines IX-IX. As is shown in Fig. 9, the user presses down with one finger on the first force sensor 131 at one end thereof, shown in Fig. 9 as the front end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied. The force depicted in Figs. 8A - 8D and in Fig. 9 is greater than the force depicted above in Figs. 4A - 4D, 5, 6A - 6D, and 7.

As is shown in Figs. 8A - 8D, the computer 100 responds to the force exerted by the user on the first force sensor 131 by zooming the depiction of the screen object 115 inward. The zoom is seen in Figs. 8A - 8D to occur at a higher rate than the zoom depicted in Figs. 4A - 4D, in response to the greater force applied by the user to the first force sensor 131. Thus, the manipulation of the first force sensor 131 of the input device 120 by the user controls motion as well as rate of motion of the screen object 115 in a third dimension orthogonal to the first two dimensions.

Reference is now made to Figs. 10A - 10D which are simplified pictorial illustrations showing the operation of the device of Fig. 1. In Figs. 10A - 10D, the user is shown pressing on the first force sensor 131.

Reference is now additionally made to Fig. 11 which is an enlarged view of a portion of the device of Fig. 8A at section lines XI-XI. As is shown in Fig. 11, the user presses down with one finger on the first force
sensor 131 at an end thereof different from the end shown in Fig. 9, the different end being shown in Fig. 11 as the back end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied. The force depicted in Figs. 10A - 10D and in Fig. 11 is greater than the force depicted above in Figs. 4A - 4D, 5, 6A - 6D, and 7.

As is shown in Figs. 10A - 10D, the computer 100 responds to the force exerted by the user on the first force sensor 131 by zooming the depiction of the screen object 115 outward. The zoom is seen in Figs. 10A - 10D to occur at a higher rate than the zoom depicted in Figs. 6A - 6D, in response to the greater force applied by the user to the first force sensor 131. Thus, the manipulation of the first force sensor 131 of the input device 120 by the user controls motion as well as rate of motion of the screen object 115 in two different directions in a third dimension orthogonal to the first two dimensions.

Reference is now made to Figs. 12A and 12B which are simplified pictorial illustrations showing the operation of the device of Fig. 1. In Figs. 12A and 12B, the user is shown pressing on the second force sensor 132.

Reference is now additionally made to Fig. 13 which is an enlarged view of a portion of the device of Fig. 12A at section lines XIII-XIII. As is shown in Fig. 13, the user presses down with one finger on the second force sensor 132 at one end thereof, shown in Fig. 13 as the front end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied.

As is shown in Figs. 12A and 12B, the computer 100 responds to the force exerted by the user on the second force sensor 132 by rotating the depiction of the screen object 115 clockwise. Thus, the manipulation of
the second force sensor 132 of the input device 120 by the user controls motion of the screen object 115 in a fourth dimension orthogonal to the first three dimensions.

Reference is now made to Figs. 14A and 14B which are simplified pictorial illustrations showing the operation of the device of Fig. 1. In Figs. 14A and 14B, the user is shown pressing on the second force sensor 132.

Reference is now additionally made to Fig. 15 which is an enlarged view of a portion of the device of Fig. 14A at section lines XV-XV. As is shown in Fig. 15, the user presses down with one finger on the second force sensor 132 at an end thereof different from the end shown in Fig. 13, which different end is shown in Fig. 15 as the back end. The user thus signals, as explained above with reference to Fig. 1B, both the direction and the degree of force applied.

As is shown in Figs. 14A and 14B, the computer 100 responds to the force exerted by the user on the second force sensor 132 by rotating the depiction of the screen object 115 counterclockwise. Thus, taking Figs. 12A, 12B, 13, 14A, 14B, and 15 together, it will be appreciated that the manipulation of the second force sensor 132 of the input device 120 by the user controls motion of the screen object 115 in two different directions in a fourth dimension orthogonal to the first three dimensions.

It will be appreciated that, in a manner similar to that explained above with reference to Figs. 8A - 8D, 9, 10A - 10D, and 11, the rate of rotation of the screen object 115 may be controlled by the degree of force applied by the user to the second force sensor 132. Thus, the manipulation of the second force sensor 132 of the input device 120 by the user controls motion as well as rate of motion of the screen object 115 in two differ-
ent directions in a fourth dimension orthogonal to the first three dimensions.

Reference is now made to Figs. 16A and 16B which are simplified pictorial illustrations showing the operation of the device of Fig. 1. Figs. 16A and 16B depict the user moving the input device 120 at a diagonal, or in two orthogonal directions, and also applying force to both of the force sensors 130 at the same time. The computer 100 responds by moving the depiction of the screen object 115 in two orthogonal directions, zooming the depiction of the screen object 115 and rotating the depiction of the screen object 115, all at substantially the same time. The user thus controls motion of the screen object 115 in four mutually orthogonal dimensions at the same time.

It is appreciated that the scope of the present invention is not limited to computer input devices as shown in the embodiment described above, but rather is applicable to all types of electrical control input devices including input devices for computer games, remote manipulation devices, and other electrical control input devices.

It is appreciated that the software components of the present invention may, if desired, be implemented in ROM (read-only memory) form. The software components may, generally, be implemented in hardware, if desired, using conventional techniques.

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 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 to what
has been particularly shown and described hereinabove. Rather, the scope of the present invention is defined only by the claims that follow:
CLAIMS

1. A hand manipulable electrical control input device comprising a finger engageable control element providing at least four mutually orthogonal parameter inputs and including at least one force sensor providing at least one of said at least four mutually orthogonal parameter inputs.

2. A hand manipulable electrical control input device according to claim 1 and wherein said control element comprises a mouse.

3. A hand manipulable electrical control input device according to claim 1 and wherein said control element comprises a computer input device.

4. A hand manipulable electrical control input device according to claim 1 and wherein said control element is displaceable in at least two dimensions.

5. A hand manipulable electrical control input device according to claim 1 and wherein said control element is displaceable in at least three dimensions.

6. A hand manipulable electrical control input device according to claim 1 and wherein said mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed, amplitude, frequency and texture.

7. A hand manipulable electrical control input
device according to claim 1 and wherein each force sensor is associated with a displaceable switch.

8. A hand manipulable electrical control input device according to claim 1 and wherein said at least one force sensor comprises a plurality of force sensors.

9. A hand manipulable electrical control input device according to claim 8 and wherein each said force sensor is individual finger actuable.

10. A hand manipulable electrical control input device according to claim 8 and wherein each said force sensor is separately actuable.

11. A hand manipulable electrical control input device according to claim 8 and wherein said control element comprises a mouse.

12. A hand manipulable electrical control input device according to claim 8 and wherein said control element comprises a computer input device.

13. A hand manipulable electrical control input device according to claim 8 and wherein said control element is displaceable in at least two dimensions.

14. A hand manipulable electrical control input device according to claim 8 and wherein said control element is displaceable in at least three dimensions.

15. A hand manipulable electrical control input device according to claim 8 and wherein said mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed,
amplitude, frequency and texture.

16. A hand manipulable electrical control input device according to claim 8 and wherein each force sensor is associated with a displaceable switch.

17. A hand manipulable electrical control input device comprising a finger engageable control element providing at least three mutually orthogonal parameter inputs and including at least two force sensors providing at least two of said at least three mutually orthogonal parameter inputs.

18. A hand manipulable electrical control input device according to claim 17 and wherein each said force sensor is individual finger actuable.

19. A hand manipulable electrical control input device according to claim 17 and wherein each said force sensor is separately actuable.

20. A hand manipulable electrical control input device according to claim 17 and wherein said control element comprises a mouse.

21. A hand manipulable electrical control input device according to claim 17 and wherein said control element comprises a computer input device.

22. A hand manipulable electrical control input device according to claim 17 and wherein said control element is displaceable in at least two dimensions.

23. A hand manipulable electrical control input device according to claim 17 and wherein said control element is displaceable in at least three dimensions.
24. A hand manipulable electrical control input device according to claim 17 and wherein said mutually orthogonal parameter inputs include at least three of the following parameter inputs: X-displacement, Y-displacement, size, zoom, rotation, color, intensity, speed, amplitude, frequency and texture.

25. A hand manipulable electrical control input device according to claim 17 and wherein each force sensor is associated with a displaceable switch.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : G09G 5/08
US CL : 345/157
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)
U.S. : 345/157, 161, 163-167

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 practicable, search terms used)
APS: mouse (p) (button or switch) (p) (zoom or scroll or pan or rotate)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
  *A* document defining the general state of the art which is not considered to be part of particular relevance
  *E* earlier document published on or after the international filing date
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  *O* document referring to an oral disclosure, use, exhibition or other means
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Date of the actual completion of the international search: 20 JANUARY 1996
Date of mailing of the international search report: 20 FEB 1996

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-5230

Authorized officer: JEFFERY A. BRIER
Telephone No. (703) 305-4700

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