BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1***a* is a top plan view of one embodiment of a control device of the present invention;

FIG. **1***b* is a top plan view of the control device of FIG. **1***a* also including actuators for force feedback;

FIG. **2** is a side elevational view of the control device of FIG. **1***a;*

FIGS. **3***a* and **3***b* are top plan and side elevational views, respectively, of the control device of FIG. **1***a* being used by the thumb of a user;

FIGS. **4***a* and **4***b* are top plan and side elevational views, respectively, of an alternate grip for the control device of FIG. **1***a;*

FIG. **5** is a partial top plan view of an alternate embodiment of the control device of the present invention including two aligned rollers;

FIG. **6** is a partial top plan view of an alternate embodiment of the control device of the present invention including two orthogonal rollers;

FIG. **7** is a partial top plan view of an alternate embodiment of the control device of the present invention including two orthogonal rollers having perpendicular axes of rotation;

FIG. **8** is a side elevational view of an alternate embodiment of the control device of the present invention including a belt routed around two rollers;

FIG. **9** is a side elevational view of an alternate embodiment of the control device of the present invention including a cylinder for frictionally engaging a flat surface;

FIG. **10** is a side elevational view of an alternate embodiment of the control device of the present invention including a sphere for frictionally engaging a flat surface;

FIG. **11** is a partial top plan view of an alternate embodiment of the control device of the present invention including a carrier coupled to tracks by bearings;

FIG. **12** is a top plan view of an alternate embodiment of the control device of the present invention including a display;

FIGS. **13***a* and **13***b* are top plan and side elevational views, respectively, of an alternate table-top embodiment of the control device of FIG. **1***a*; and

FIG. **14** is a block diagram of a control system for the control device of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **1***a* is a top plan view of a first embodiment **10** of an interface control device of the present invention. Control device **10** includes a housing **12** and a moveable arm assembly **14**. The housing **12** is intended to allow easy hand-held use of the control device. Thus, housing **12** is approximately of a size that will fit snugly in a user's hand and allow the user's thumb to reach the controlled portion of the arm assembly **14**, as described in greater detail below. The edges of housing **12** are preferably rounded to allow comfortable use by the user. In other embodiments, the housing **12** need not be hand-held but can be used on a grounded surface (see FIGS. **13***a* and **13***b*) or can be part of a fixed panel, keyboard, computer or other device housing, or other apparatus. Housing **12** includes a first end **16***a* and a second end **16***b*, where the second end l**6***b* is held away from the user and toward an apparatus interfaced with the device **10**, if appropriate. Housing **12** preferably has a bottom plate **18***a* and a top plate **18***b*, which are spaced apart by sidewalls (not shown) of the housing **12** to define a space between the plates **18***a* and **18***b*.

Arm assembly **14** is rotatably coupled to the housing **12** between the bottom plate **18***a* and top plate **18***b*. Assembly **14** includes an arm member **20** and a cylindrical roller **22**. Arm member **20** is coupled to bottom plate **18***a* and/or top plate **18***b* at a first end and may pivot about an axis A. A carrier portion **24** is coupled to the arm member **20** and is exposed to the user through an opening **26** in the top plate **18***b*. The carrier portion can be made as part of the arm member **20** or as a separate piece coupled to the arm member. Carrier portion **24** preferably has an opening **28** in its center which holds cylindrical roller **22**. For example, the roller **22** can be coupled to the carrier portion **24** by an axle **30** which allows the roller **22** to rotate about an axis B.

The roller **22** is preferably cylindrical and may include textures or other surface features to assist the user in creating frictional contact with the user's finger to turn the roller. For example, bumps, ridges, or other surface features can be provided, and/or a frictional material such as rubber can be included on the surface of the roller. In other embodiments, rollers of other cross-sectional shapes can be used, such as octagonal, hexagonal, etc.

A first sensor **32** is coupled to the arm member **20** near axis A to measure the rotation of the arm assembly about axis A. The sensor **32** can be a digital optical encoder, analog potentiometer, magnetic sensor, optical sensor (e.g. photodiode or photoresistor), or other type of sensor than can detect rotary motion of the arm member **20** relative to the housing **12**. The first sensor **32** outputs a first raw sensor signal indicative of the motion of the arm member, and can be a relative sensor or an absolute sensor. For example, if a relative sensor is used, the first sensor **32** can output a signal indicating the amount of rotation since the last detected position.

In one alternate embodiment, an optical sensor can be used as first sensor **32** and/or second sensor **34**. In one type of optical encoder, optical fibers are used to conduct received light pulses to a set of photodetectors. Movement of a member over a striped pattern thus generates electrical motion signals. The moving elements of device **10** may be coupled to a pattern member such as a code wheel or linear element, where optical fibers are used for remote motion sensing. Optical fibers are well suited to the device **10** due to the flexibility of the fibers, allowing the fibers to be routed from a moving optical pickup point (in the swinging arm) to a fixed photodetector location, such as on a circuit board mounted to the housing **12** of the device **10**. In such an embodiment, mechanically-driven sensors would not be required. Alternatively, optical channels molded in and integral with a support structure can be used with an optical encoder instead of optical fibers. Such optical channel encoders are described in greater detail in application Ser. No. 60/067,381, incorporated herein by reference.

A second sensor **34** is coupled to the axis **30** of the roller **22** to detect rotation of the cylindrical roller **22** about axis B. Sensor **34** can be grounded to the carrier portion **24** to as to measure rotation of the roller **22** with respect to the carrier portion. Similar to the first sensor **32**, the second sensor **34** outputs a second raw sensor signal indicative of the rotation of the roller **22**. The sensor **34** can be a digital sensor or analog sensor, and can be relative sensor or absolute sensor, similar to the first sensor **34**.

Two axes of motion are preferably integrated in the control device **10**. As shown in the top plan view of FIG. **1***b*, the arm assembly **14** can be moved by the user to provide input signals to the apparatus with which the user is interfacing. The user can contact the carrier portion **24** or the roller **22** with a finger and move the assembly left or right