USER INPUT DEVICE FOR CONTROLLING MEDICAL IMAGING EQUIPMENT MOTION

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to medical imaging, and more particularly, to positioning imaging components around a patient.

[0002] Diagnostic medical imaging requires accurate positioning of imaging equipment around a patient. Depending on the size and complexity of the equipment, the equipment can be positioned manually (e.g. dental X-rays) or through motorization of the equipment. With manual positioning, the operator has full control over the device being positioned and is restricted only by the range of motion of the equipment. Moreover, manually moving equipment is intuitive since one merely pushes and pulls the equipment into the desired location.

[0003] Some imaging equipment is motorized in order to help the operator move heavier equipment, or to facilitate advanced procedures in which the equipment must be precisely positioned or moved during an imaging procedure. The user device for control of larger motorized equipment typically is a joystick or a force input device (e.g. a spring-loaded handle with 1 to 3 degrees of freedom that measures the force applied to the handle). The joystick or force input devices are often located remotely from the equipment (e.g. on a user control panel) and have no particular relationship to the geometry of the machine. For example, left-right motion of the joystick may result in something other than left-right motion of the machine. Force input devices are sometimes attached directly to the device being controlled, and a force applied to the input device results in machine motion in the same direction as the applied force and a magnitude commensurate with the applied force.

[0004] In screening applications (e.g. mammography), there is a high-throughput of patients per day. Minimizing the time required for a particular exam, thus maximizing equipment and operator productivity, is highly desirable. In interventional applications (e.g. vascular X-ray), focused attention is on the patient and the medical procedure, and the control of the imaging device should be as intuitive, effortless, and efficient as possible.

BRIEF SUMMARY OF THE INVENTION

[0005] In one aspect, a system for controlling the position of medical equipment is provided. The system, in an example embodiment, comprises at least one sensor configured to be coupled to the medical equipment and responsive to an operator input representation of a desired movement of the equipment, and a processor coupled to the sensor for determining a direction in which the operator desires the equipment to move based on a sensor output.

[0006] In another aspect, a sensor comprising a core having an outer surface and a plurality of sensing areas on the outer surface is provided. Each sensing area is responsive to operator input for generating a signal representative of the operator input.

[0007] In yet another aspect, a medical imaging system is provided. In an example embodiment, the system comprises a source for transmitting signals towards a patient, a detector for detecting signals that have been transmitted through the patient, a movable member on which at least one of the source and the detector are mounted, and a user input device for controlling a position of the movable members. The user input device comprises a plurality of sensors coupled to the movable members and responsive to an operator input representation of a desired movement of the equipment. The system further comprises a processor coupled to the user input device for determining a direction in which the operator desires the member to move based on sensor outputs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** is a schematic illustration of an X-ray imaging system.

[0009] **FIG. 2** is a schematic illustration of hand motion and device motion.

[0010] **FIG. 3** is a schematic illustration of hand motion and intended device motion with an obstacle.

[0011] **FIG. 4** is a schematic illustration of hand motion and compensated device motion with an obstacle.

[0012] **FIG. 5** is a vector illustration of movement.

[0013] **FIG. 6** illustrates one example segment in an 8-segment sensor arrangement.

[0014] **FIG. 7** is a graph illustrating a nominal finite element analysis for the 8-segment sensor arrangement.

[0015] **FIG. 8** is a schematic illustration of an 8-segment sensor arrangement control circuit.

[0016] **FIG. 9** illustrates a capacitance based matrix touch switch.

[0017] **FIG. 10** illustrates a sample segment of the switch shown in **FIG. 9**.

[0018] **FIG. 11** is an exploded view of a segment of the switch shown in **FIG. 10**.

[0019] **FIG. 12** is a schematic illustration of a 32-segment sensor arrangement control circuit.

DETAILED DESCRIPTION OF THE INVENTION

[0020] The systems and methods described below are directed to operator control of medical imaging equipment position. Generally, multiple proximity sensors are located on the machine to be controlled. The outputs of the sensors are processed using a vectorial addition method to determine how the machine should move in response to an operator input. Moreover, in addition to detecting and processing operator inputs, the proximity of foreign objects (e.g. auxiliary equipment, the patient) is detected. Therefore, the equipment can be moved in a manner that attempts to satisfy the operator input as well as avoids collisions with surrounding objects.

[0021] The systems and methods described herein are based on capacitance sensors. Other non-contact proximity sensors, such as infrared or ultrasonic sensors, can be used. Capacitance sensors, however, have a simple construction and output, are not expensive, and facilitate easy customization of sensing zones by merely positioning conducting surfaces (e.g. a conductive material such as copper foil) to