

ABSTRACT

“A SIMULATOR INCLUDING A CONTROLLER”

The invention relates to a simulator. The simulator includes a controller, including a gyroscope, magnetometer and accelerometer. The controller is formed of two rotatably connected portions, and includes a bending sensor, to measure the relative angle between the two portions.

(Figure 1 to accompany abstract.)

WE CLAIM:

1. A controller comprising a first portion and second portion, the portions being rotatably connected, a magnetometer, a gyroscope, an accelerometer, and a bending sensor, wherein the bending sensor is configured to measure a relative angle between the first and second portion.
2. A controller as claimed in Claim 1, wherein the bending sensor is a potentiometer.
3. A controller as claimed in Claim 1, wherein the bending sensor is a friction plate.
4. A controller as claimed in any one of the preceding claims, further comprising a motor for resisting change in the relative angle between the portions.
5. A controller as claimed in Claim 4, wherein the motor is disposed at a first end of the first portion and includes a metallic cage, and the gyroscope, accelerometer and magnetometer are disposed at an opposing end of the first portion.
6. A controller as claimed in any one of Claims 1 to 5, further comprising a pressure sensor.
7. A controller as claimed in Claim 6, wherein the first or second portion includes a groove, the pressure sensor being positioned in the groove.

8. A controller substantially as herein described with reference to and as shown in any one of the accompanying drawings.

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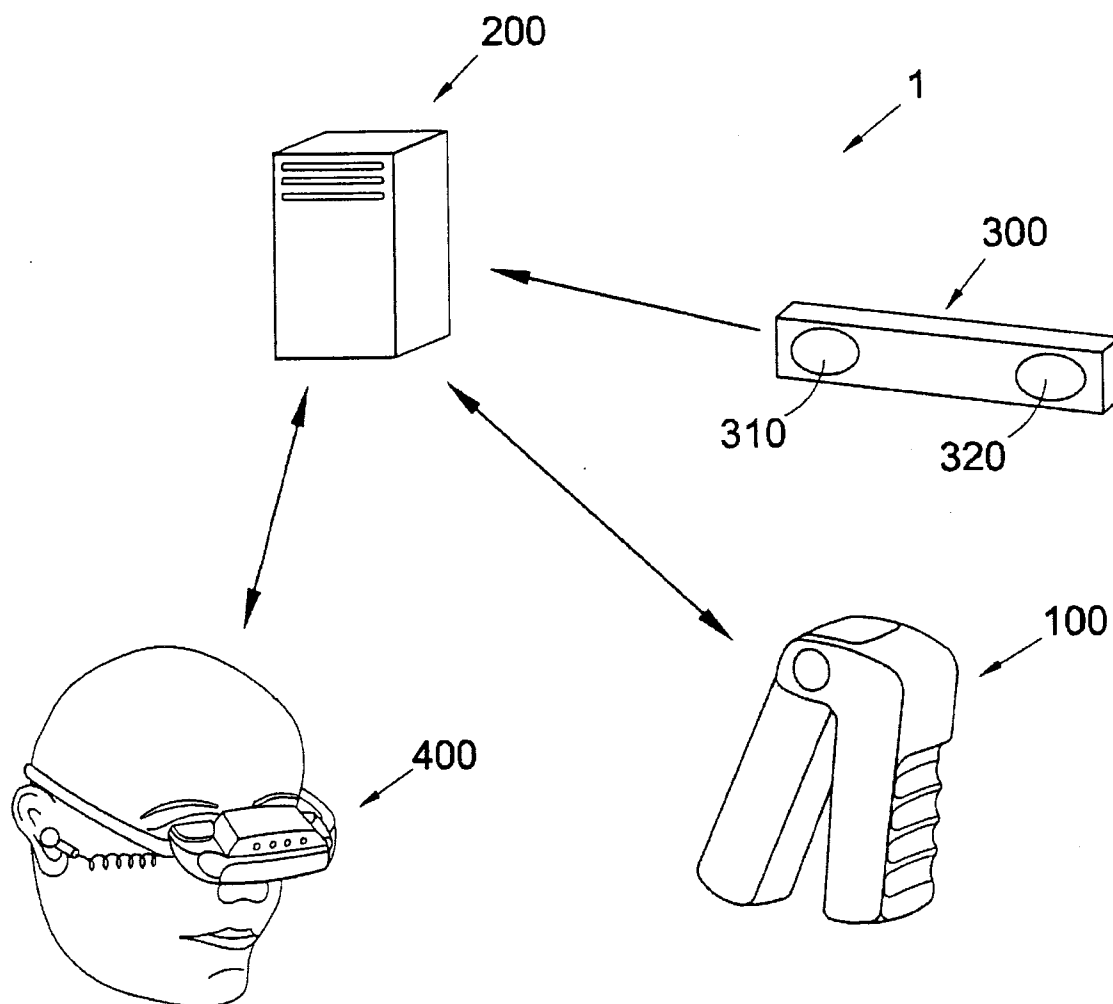


Figure 1

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Figure 2

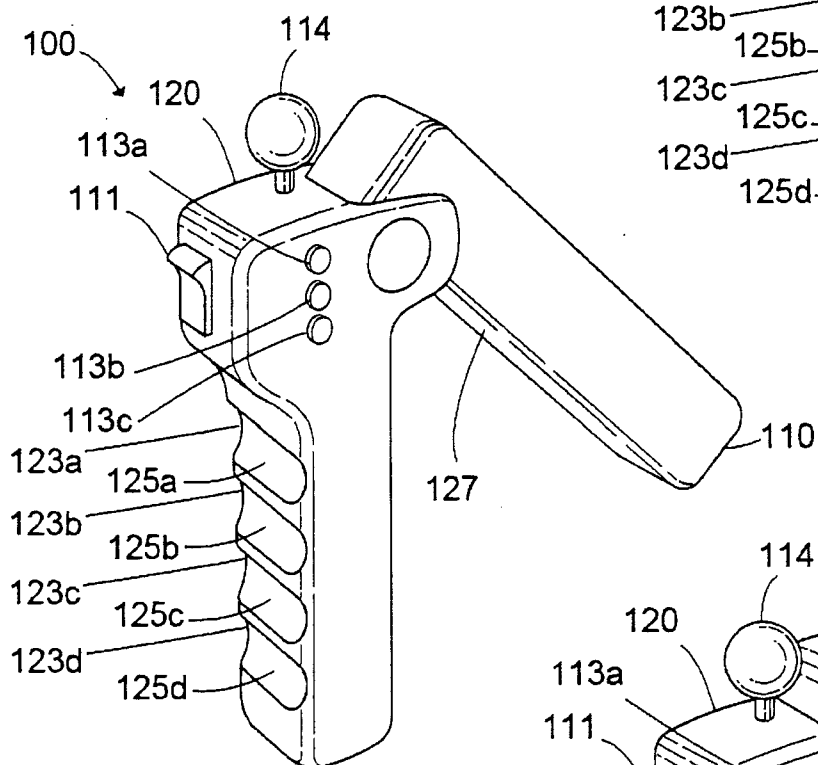
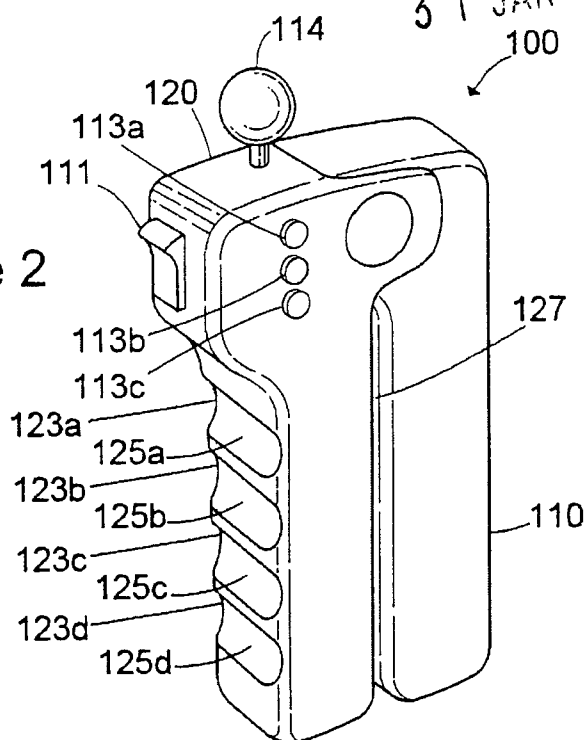


Figure.3

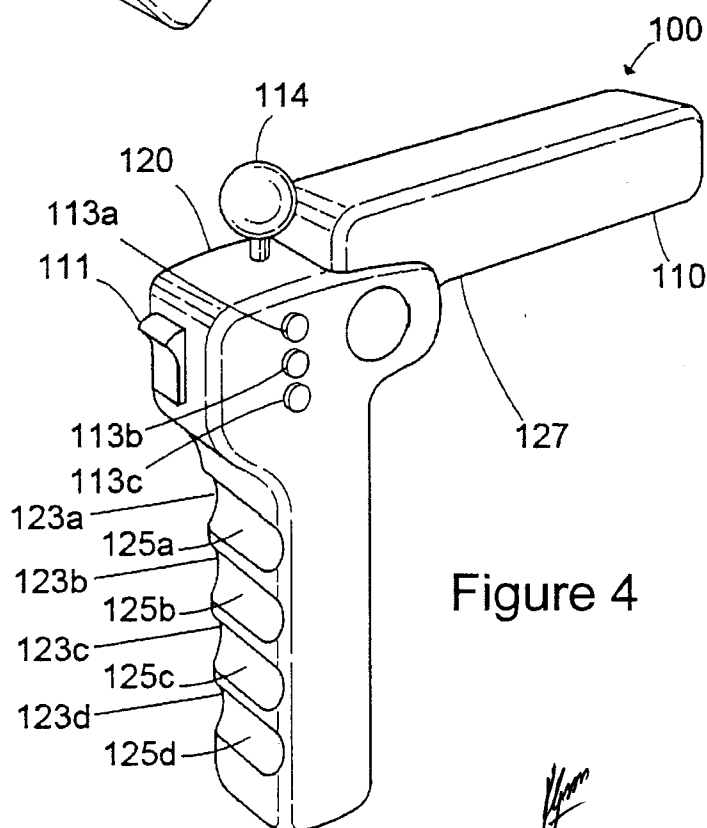


Figure 4

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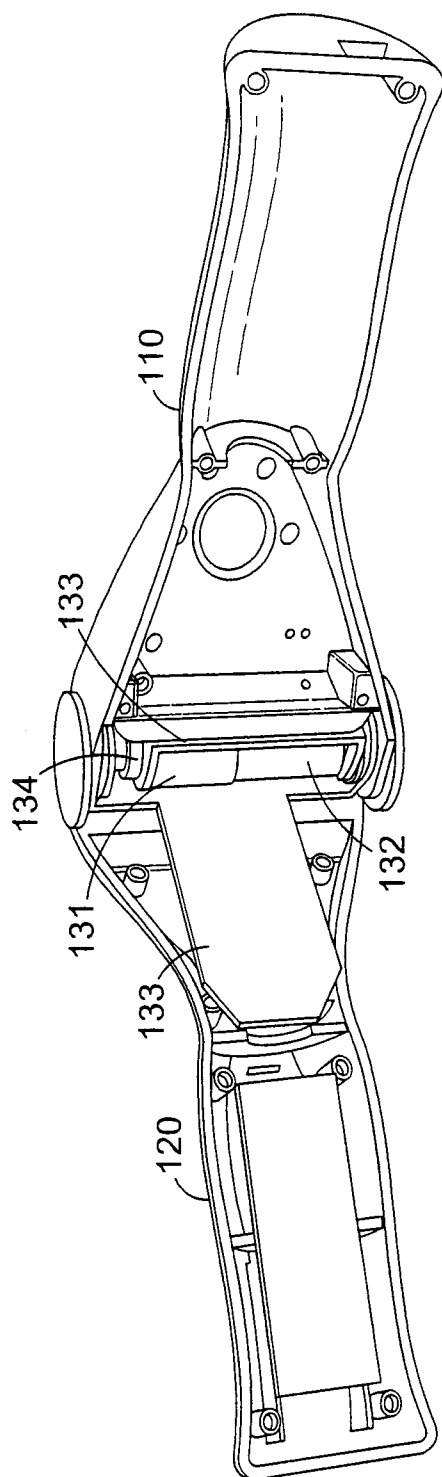


Figure 5

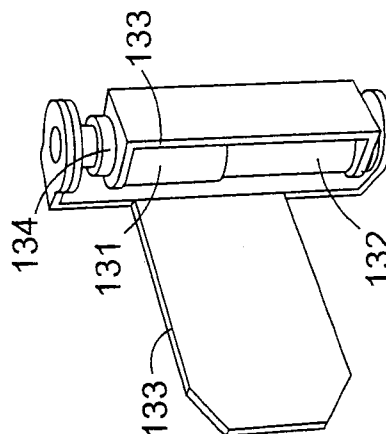
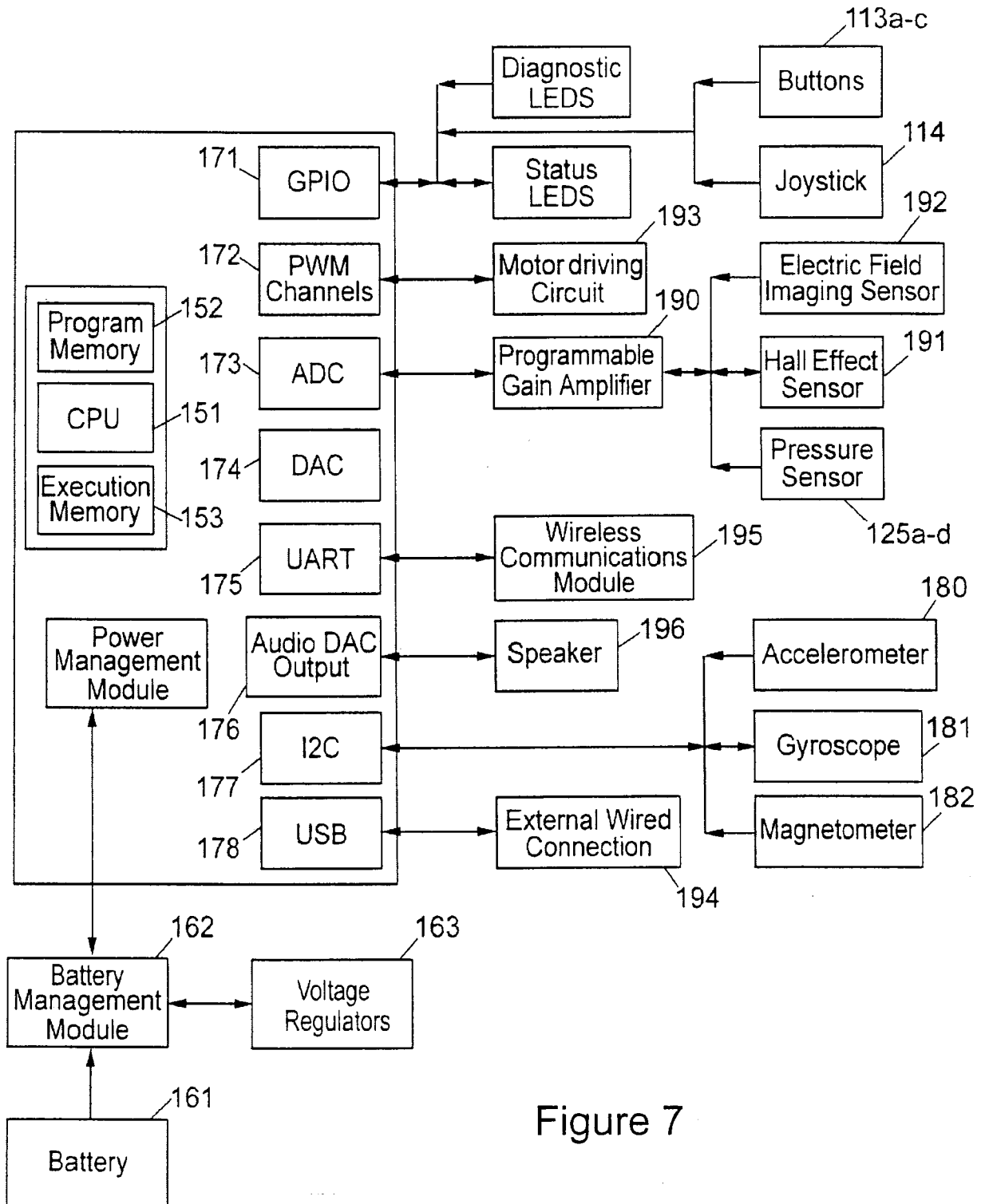


Figure 6


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A SIMULATOR INCLUDING A CONTROLLER

This invention relates to a simulator including a controller. More specifically, but not exclusively, this invention relates to a simulator for the training of a tradesman.

Traditionally, tradesmen, such as plumbers, have learned their trade on the job as an apprentice. An apprentice learns the various requisite skills by attempting to replicate their master's work. Apprenticeships provide a focussed, personal training experience. However, this form of training is not scalable, as the master's time is dissipated over many pupils. Furthermore, at least in the early stages of training, the apprentice will make mistakes, which will cost the master and deter him/her from hiring apprentices in the future.

Vocational training courses were developed to give pupils the initial experience needed to start work as a tradesman, in an attempt to reduce the initial, costly, period of the apprenticeship. However, these courses are subject to relatively high fees due to the number of mistakes the pupils make in the early stages.

According to a first aspect of the invention, there is provided a controller comprising a first portion and second portion, the portions being rotatably connected, a magnetometer, a gyroscope, an accelerometer, and a bending sensor, wherein the bending sensor is configured to measure a relative angle between the first and second portion.

The bending sensor may be a potentiometer or a friction plate.

The controller may further comprise a motor, for resisting change in the relative angle between the first and second portions. The motor may be disposed at a first end of the first portion and include a metallic cage, and the gyroscope, accelerometer and magnetometer may be disposed at an opposing end of the first portion.

The controller may further comprise a pressure sensor. Preferably, the first or second portion includes a groove, the pressure sensor being positioned in the groove.

Embodiments of the invention will now be described, by way of example, and with reference to the drawings in which:

Figure 1 illustrates a simulator including a controller of an embodiment of the present invention, also showing, for reference only, a computer, head mounted display and camera unit;

Figure 2 illustrates the controller of Figure 1, showing a first portion and a second portion in a parallel position;

Figure 3 illustrates the controller of Figure 1, showing a relative angle between the first and second portion;

Figure 4 illustrates the controller of Figure 1, showing the first and second portion in a substantially perpendicular position;

Figure 5 illustrates an internal portion of the controller of Figure 1, showing a potentiometer, braking motor, gearbox and metal cage;

Figure 6 illustrates the potentiometer, braking motor, gearbox and metal cage of the controller of Figure 1; and

Figure 7 illustrates the hardware of the controller of Figure 1.

Figure 1 illustrates an overview of a simulator 1. The simulator 1 includes a controller 100 of an embodiment of the present invention. The simulator 1 also includes, for reference only, a computer 200, a camera unit 300 and a head mounted display 400. For the purposes of this description, the computer 200 is configured to run a computer program which simulates a training scenario, such as using a blowtorch, or bending a pipe.

The computer 200 receives data from the controller 100 and the camera unit 300. The controller 100 includes various sensors to measure spatial properties, such as acceleration and orientation, and to measure user input. The controller 100 outputs the data from the sensors to the computer 200. The camera unit 300 includes a first camera 310 and a second, infrared, camera 320, for image acquisition. The camera unit 300 outputs the image data to the computer 200.

The computer 200 is configured to process the data from the controller 100 and camera unit 300 as input variables in the computer program. The controller 100 provides spatial data, such as acceleration and orientation, and user inputs, and the camera unit 300 provides images which may be processed for 3-dimensional position recognition of the controller 100. The computer program, which may simulate a training scenario, can therefore give the user an immersive and accurate simulation of a real-life skill, such as using a blow-torch or bending a pipe. The controller 100 of the simulator 1 is described in more detail below.

- *The Controller*

The controller 100 will now be described, with reference to Figures 2 to 7. The controller 100 includes a housing formed of a first portion 110 and a second portion 120. The first portion 110 and second portion 120 are rotatably connected at one end. The first portion 110 and second portion 120 are configured to rotate between a parallel position, as shown in Figure 2 where the relative angle is zero, and a substantially perpendicular position, as shown in Figure 4 where the relative angle is around 90°. In this embodiment, the relative angle in the substantially perpendicular position is 95°.

The first portion 110 includes a closing button 127, disposed between the first portion 110 and second portion 120. The closing button 127 is configured to depress as the relative angle between the first portion 110 and second portion 120 approaches zero (that is, approaches the parallel position).

The controller 100 includes a number of buttons thereon, including smaller general purpose buttons 113a-c, a larger general purpose button 111 and a thumb operated joystick 114. The buttons allow the user to input basic commands to the computer program, such as menu navigation. In this embodiment, the first portion 110 includes a plurality of LEDS (not shown) to display status and diagnostic information to the user.

The second portion 120 includes a plurality of grooves 123a-d, for receiving the user's fingers. The grooves 123a-d allow the user to comfortably hold the controller 100. Furthermore, the second portion 120 includes a plurality of pressure sensors 125a-d, positioned within the grooves 123a-d. The pressure sensors 125a-d are configured to measure the pressure exerted thereon, by varying their resistance in proportion to the

pressure. The pressure sensors 125a-d may be activated only when the closing button 127 is depressed, and include a rubber casing to absorb shock.

In this embodiment (as shown in Figures 5 and 6), the controller includes a braking motor 131, for resisting change in the relative angle between the first portion 110 and the second portion 120. The braking motor 131 is therefore disposed at a first end of the second portion 120 where the second portion 120 is rotatably connected to the first portion 110. The braking motor 131 allows the simulator to replicate the resistance to bending, for example, when the user is bending a pipe.

The braking motor 131 is associated with a gearbox 132, for varying the resistance to the change in the relative angle between the first portion 110 and the second portion 120. The motor 131 and gearbox 132 are configured such that the resistance to change in the relative angle is inversely proportional to the electrical resistance across the motor 131 (i.e. the motor 131 is shorted in order to provide maximum resistance to change in the relative angle between the first portion 110 and the second portion 120). The motor 131 and gearbox 132 are controlled by a microcontroller.

The braking motor 131 includes an external metal cage 133, which is attachable to an inner surface of the second portion 120. In this embodiment, the external metal cage 133 is injection moulded to the inner surface of the second portion 120, which improves force transmission between the motor 131 and the second portion 120.

In this embodiment, the controller includes a plurality of sensors (discussed below), disposed within an opposing end of the second portion 120 (i.e. opposite the first end of the second

portion 120). Therefore, the external metal cage 133 extends a predetermined distance from the first end of the second portion 120, such that the sensors are not covered by the motor's metal cage 133. Thus, any electromagnetic waves passing through the device are detected by the sensors without being attenuated by the motor's metal cage 133.

The controller 100 also includes a bending sensor, for measuring the relative angle between the first portion 110 and the second portion 120. In this embodiment, the bending sensor is a potentiometer 134. The bending sensor outputs data of the relative position of the first and second portion 110, 120 that may be used by the computer program to simulate a pipe bending scenario.

The controller 100 also includes vibration generator motors, which may be activated to provide a physical notification to the user.

The controller 100 also includes an input for receiving a secondary controller.

Figure 7 is a block diagram illustrating the hardware inside the housing of the controller 100. The controller 100 includes a microcontroller SOC 150 (including a plurality of modules described below), a battery 161, such as a Lithium-ion cell, a battery management module 162, and voltage regulators 163.

The battery management module 162 includes a battery charger, adapted to receive an AC input. The charger includes dynamic power path management (DPPM) that powers the controller 100 while simultaneously and independently charging the battery 161. The battery management module further includes protection and fuel gauge circuits.

The voltage regulators 163 distribute power to the modules on the microcontroller SOC 150, the sensors, and other active components detailed below.

The microcontroller SOC 150 includes a CPU 151, program memory 152 and execution memory 153, connected via a system bus. The microcontroller SOC 150 further includes GIPO 171, Power Management 172, ADC 173, DAC 174, UART 175, Audio DAC Output 176, I2C 177, and USB 178 modules, connected via a peripheral bus.

The GIPO module 171 is a digital IO, configured to receive data from the smaller and larger general purpose buttons 123a-c, 111, and the joystick 114. The GIPO module 171 is also configured to control the LEDs to provide status and diagnostic information to the user.

The controller 100 includes an accelerometer 180, gyroscope 181 and magnetometer 182, providing nine degrees of freedom tracking. The three sensors 180, 181, 182 are embodied on a circuit board. The circuit board is designed to filter noise from the sensor 180, 181, 182 readings to provide Euler angles or Quaternions to output as data relating to the orientation of the controller 100. The three sensors 180, 181, 182 are connected to the microcontroller SOC 150 via the I2C module 177, which configures, initializes and calibrates the sensors 180, 181, 182.

The pressure sensors 125a-d are connected to the microcontroller SOC 150 via a programmable gain amplifier 190 and the ADC module 173. The ADC module 173 and programmable gain amplifier 190 also connect a hall effect sensor 191 and electric field imaging sensor 192 to the microcontroller SOC 150. The electric field imaging sensor 192 is

used for non-contact sensing of objects, by generating a low frequency sine-wave field. The electric field imaging sensor 192 detects proximal objects by changes in the sine-wave field. Similarly, the hall effect sensor 191 measures the proximal magnetic field.

The ADC module 173 is configured to receive the data from the programmable gain amplifier 190, convert it to a digital signal and pass onto the CPU 151 for computation.

The microcontroller SOC 150 further includes motor driving circuitry 193, for driving motors such as the vibration generating motor, or the dynamic braking motor. The motor driving circuitry 193 is modulated by the PWM module 172, which may be configured to operate without CPU 151 intervention.

The microcontroller SOC 150 also includes a USB module 178, for connection with an external USB device 194, and a UART module 175, for interfacing with a wireless communications module 195, e.g. a Bluetooth (RTM) dongle, for communication with the computer 200. The wireless communications module 195 is a transceiver for sending the data collected from the sensors and input devices to the computer 200, and for receiving feedback data, for example, to drive the dynamic braking motor.

The microcontroller SOC 150 also includes an Audio DAC output module 176, for controlling a speaker 196 on the controller 100.

The skilled reader will understand that the pressure sensor is a non-essential feature. The pressure sensor is preferable, as it allows a further user input to the simulator 1, such that the user may engage in certain training scenarios, such as using a blow-torch.

The skilled reader will also understand that it is non-essential for the controller 100 to rotate between the parallel and perpendicular position. Rather, the controller 100 may rotate between any two relative angles, smaller or greater than 90 degrees.

In the above embodiment, the controller 100 uses a potentiometer to measure the relative angle between the first and second portion. The skilled reader will understand that the potentiometer is just one way of measuring the relative angle, and further examples may be used. For example, a friction plate, or a position encoder associated with the motor may be used. Furthermore, the dynamic braking motor is just one example of a means to resist change in the relative angle between the first and second portion. For example, friction can be achieved by positioning friction plates and applying pressure between them or by using a wound up spring system.

The skilled reader will also understand that it is not essential for the motor's metal cage to be injection moulded to the second portion 120. For example, the metal cage may be bolted to the second portion 120.

The skilled person will understand that any combination of features is possible without departing from the scope of the present invention, as claimed.