The elbow was lined up with the vertical axis of the gimbal (see **FIG. 6**). A 6-DOF load cell was placed between the support splint and the gimbal to measure the shoulder abduction/adduction and internal/external rotation torques. Furthermore, the gimbal was instrumented with position sensors used to measure the elbow and shoulder rotation angles. The mechanical interface was designed to constrain movements to a plane such that the individual moves (reaching or retrieving) his/her arm and hand in line with the shoulder. The inclination of the plane was adjustable from the user interface to different angles, resulting in upward or downward arm movements with respect to the shoulder. This accommodated individuals with limited shoulder abduction angles and allowed for a progression to greater shoulder abduction angles over various training sessions. Support splints were designed for the left and the right arm and were made in a small and large size to accommodate individuals of different sizes (see **FIG. 6**). The support splint can be attached and detached from the robot using a quick release type system. The position of the hand and wrist in the splint was such that it reduces spastic activity in hand and wrist flexors. Finally, the hand and forearm were secured to the splint using broad, stiff VELCRO straps.

Example V

Interface Between HAPTICMASTER, Biodex Experimental Chair, and Visual 3-D Display

[0222] In this Example, the robotic device was designed into a single unit integrating three separate systems: a Biodex chair, a HAPTICMASTER device and a standard 19" LCD screen (Dell, Round Rock Tex.) controlled via a computer interface. The system was a self-contained unit that could be easily operated by therapists and physicians both for patient testing setup and for designing and running therapeutic sessions.

[0223] The HAPTICMASTER device was placed on a T support track that allows a Biodex chair and 3-D robot to move relative to each other and to rotate (**FIG. 5** and **FIG. 15**). This enabled proper alignment between the robot and the arm of the individual. The HAPTICMASTER device and its controller box were consolidated into one unit to reduce the overall size of the setup. Finally, a standard 19" screen (Dell) was attached on a mobile multi-jointed arm that was connected to the back of the Biodex chair. This allowed flexibility in the positioning of the 3-D screen in the visual field of test participants.

Example VI

User Interface and Visual Virtual Reality Software

[0224] The robotic device was controlled via a custom user interface developed to allow simple operation of the device. The user interface software allowed control of the robotic device during reaching movements and specification of the training and evaluation protocols.

[0225] In order to create a realistic environment for individuals with stroke, 3-D visual feedback was incorporated into the system. In this example, a standard 19" LCD screen that provided a 3-D image based on the principle of autostereoscopic 3D imaging is used. The position signals of the robotic device combined with the segment lengths of the arm were used to estimate the paretic arm configuration. These configuration coordinates drive the position of a virtual arm/hand on the 3D screen in real-time. When designing a 3D model of the arm, a standard modeling package like Kinetix's 3D STUDIO MAX may be used. In this example, the model was driven in Windows XP environment using the Win3D Library, compatible with the DTI technology. The virtual visual environment also included the plane of the virtual table, movement targets and realistic objects that can be lifted and moved to targets like a video game. The intent was to create a stimulating and realistic environment that would motivate our stroke consumers to use their paretic arm and to teach them how to progressively overcome the negative effect of gravity in a functionally meaningful way.

Example VII

Additional Exemplary Embodiments

[0226] As noted above, other configurations of the haptics device are possible. **FIG. 15** shows one such example of a 3-D haptic device concept where the axes are fully independent.

[0227] Another example that is far more complex is a Stewart platform shown in **FIG. 8**. This is used extensively in Flight Simulators to provide motion sensation to the pilots. The hexapod structure uses six actuators, and is thus capable of providing 6-DOF motion. In our situation the end effector and associated additional hardware could be mounted on the top platform.

[0228] **FIG. 9** shows a prototype of 3-D visual feedback displaying an avatar of the subject's arm. The tip of the virtual hand is placed in a starting position (gray hemisphere) and the subject is asked to move the hand to one of the targets (blue hemispheres). The red boundary is the maximum reaching distance of the subject's hand based on measured forearm/upper arm segment lengths. This boundary is use as visual feedback to encourage subjects to reach as far as they can to determine the arm active work area. This can be repeated for different planes to determine the paretic arm's workspace.

[0229] Those skilled in the art will appreciate that various adaptations and modifications of the just-described embodiments can be configured without departing from the scope and spirit of the invention. Other suitable techniques and methods known in the art can be applied in numerous specific modalities by one skilled in the art and in light of the description of the present invention described herein. Therefore, it is to be understood that the invention can be practiced other than as specifically described herein. The above description is intended to be illustrative, and not restrictive. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

We claim:

1. A method for measuring, treating, and self-rehabilitating an individual having a neurological condition, the method comprising:

i) providing a system comprising mechanical means, at least one computer, display means, and interconnecting