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A Proposed New Design for an Educational Hap Tics Device

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Abstract - Haptic technology ***refers to technology that interfaces to the user via the sense of touch. The user applies* force*, create* vibrations *and give motion with the help of the haptic device*. So basically we are talking about an input device that has force feedback. A major benefit of educational haptic device is its hands-on nature. This makes the learning process more compelling for most students, and underscores the connection between science, technology, engineering, mathematical theory and physical reality. Haptic devices that provide force and tactile feedback are programmed to generate physical interactions that help the students to improve practical knowledge about their scientific and mathematical subjects. Haptic devices also help to generate the need for interdisciplinary robotics education, and can inspire even very young students to enter these fields. In this paper, we have proposed a design for a haptic device and its application for the students at undergraduate, graduate, and grade school level to provide knowledge about the educational kits used for different lab experiments.**

***Keywords*- Haptics devices, Force feedback, Robotics, Virtual reality, Haptics Technology.**

I. INTRODUCTION

An intuitive understanding of physical systems is the key to the success of many science and engineering students. The mouse and keyboard are normal input devices used by all users working on a computer. The learning curve is low or non-existent while using normal input devices. New input devices are creating a more engaging experience without expanding that curve. Input devices such as touch screens, multi-touch screens, joysticks, game pads, and controllers, give our users different ways to connect and interact with our applications. As the student moves the pen around, the cursor on screen will move with the same X, Y, and Z. The cursor can be mapped with a 3d model that represents one of the learning tools. The student moves the Haptic device towards the screen and as the end of the tool makes contact with the object on the screen, the haptic device's motor and arm stop the object giving the student the feeling that they have made contact between the tool and the object. The device tracks how well the student performs and can even play back pre-recorded actions. This tracked information can be used to score the student, get feedback on the overall class, show improvement, etc.

Several haptic devices have been used to create a set of demonstrations designed for elementary school students and teachers Students are able bounce a ball while the strength of gravity is varied, and feel what it would be like to bounce a ball on Earth, the Moon, or Jupiter.

Haptic interfaces are capable of conveying tactual information to augment or replace the visual and aural feedback common to computer simulations.

II. RELATED WORK

Electrical, mechanical, fluidic, and thermal systems have components that affect system dynamics by storing or dissipating energy in their own unique ways. Normally, students learn howthese parameters enter the dynamic equations without fully understanding the role each component plays. The physicalsystems would be constructed that allow arbitrary alteration of components and their configuration. By comparing dynamic response, the role of each in the aggregate system could be better understood. Unfortunately, such a systemic not practically realizable for use in lecture or laboratory settings. To satisfy the demand for a transformable system, a variety of pedagogical, computer–based simulations have been proposed, e.g. (Bonert 1989; Conley &Kokjer 1989;Lee, Daley, &McKlin 1998).With most physical systems, our understanding of them comes from some combination of visual, aural, and tactual information. The tacit knowledge gained through such physical interactions is not easily shared between individuals, but thought to be valuable for

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the process of engineering innovation (Mascitelli 2000). However, for mechanical and thermal systems, our experience and intuition are based on tactual interaction. Psychologists have demonstrated the need for different modes of interaction to improve student learning (Bird & Gill 1987; Lowenfeld 1945;Winn 1982).

III. PROPOSED DESIGN OF A NEW HAPTIC DEVICE

In this paper, we have proposed a new design for developing haptic devices which can be used by the student at different level and areas of learning. This design describes a device which consists of a spherical rotary joint module which has the capability of ascertaining the degree of rotation on two axes and resist rotation to give a feel of force feedback using an electromagnetic clutch. It can also rotate on its own on the two perpendicular axis independently. The design also describes a linear joint module which can ascertain the length of elongation and resist the elongation to give a feel of force feedback using an electromagnetic clutch. It can also change its length on its own as controlled.The three actions mentioned above can be done independently or as combination with each other or all the three together at one time.The device modules can be combined together and can be used for input data about the position, motion or the orientation of the end effecter in Three Dimensional Space. It can also act as a haptic device or force feedback system where the motion can be resisted in a controlled way depending on the position and orientation of the end effecter in Three Dimensional Space. This has the capability to act like a robot system where the end effecter can be made to follow a path in Three Dimensional Space.The device can be made to have only one of the above capabilities or any two of the capabilities or all three capabilities at the same time.

IV. MECHANISM OF THE DEVICE

A. Construction

1) The device module consists of a hollow spherical surface or a section of a sphere which has a slit along the equator. This body is fixed through the horizontal axis on to the vertical rod and is capable to rotate on the horizontal axis. The horizontal axis is fixed with the rotary sensor wheel and the rotary wheel sensor is fixed to a vertical axis rod. The vertical axis rod passes through the slit in the hollow spherical surface or a section of a sphere.

2) The vertical axis rod passes through the centre of a friction clutch which is made in the form of section of a sphere cut into one end of a cylinder. The radius of the surface of the section of the sphere of the friction clutch is made equal to the outer radius of the hollow spherical surface. The friction clutch can move along the vertical axis rod. When it moves towards the hollow spherical surface it comes in contact with it. The force applied to the friction clutch towards the hollow spherical surface determines the friction that is applied to resist the rotation of the body hollow spherical surface and the attached components along the horizontal axis and the vertical axis.

3) The vertical axis rod and the friction clutch are mounted with an electromagnet with suitable attachments so that the activation of the electromagnet pushes the friction clutch towards the hollow spherical surface. The power to the electromagnet determines the friction applied to resist the rotation of the spherical body

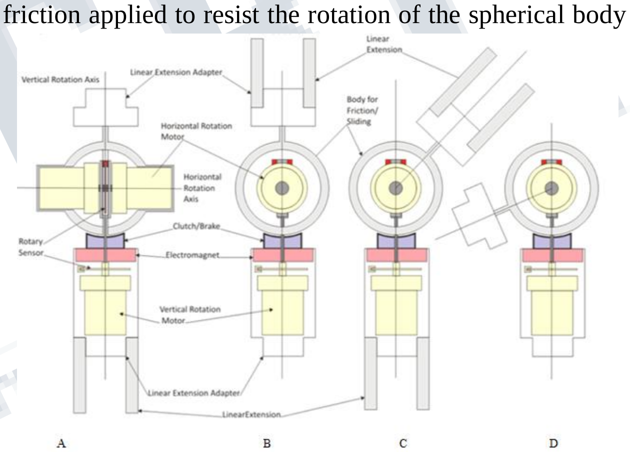

FIG 1 Main component and layout of twin axis haptic joint with guidance control anf force feedback. Fig shows different orientation of the joint

and the attached components. The friction clutch may also be actuated by any other means not limited to for example with the use of motor actuator with suitable components.

4) The vertical axis rod which passes through the friction clutch and the electromagnet is connected with a rotary wheel and suitable sensor. This rotary wheel and sensor determines the rotation of the spherical body and attachments along the vertical axis. The rotation of the vertical axis may also be determined with any other technique or method or device also. The data is output to the suitable controller.

5) The end of the vertical axis rod is coupled to the output of the vertical axis motor. The rotation of the vertical axis motor rotates the vertical axis rod and thus rotates the hollow spherical surface and the attached

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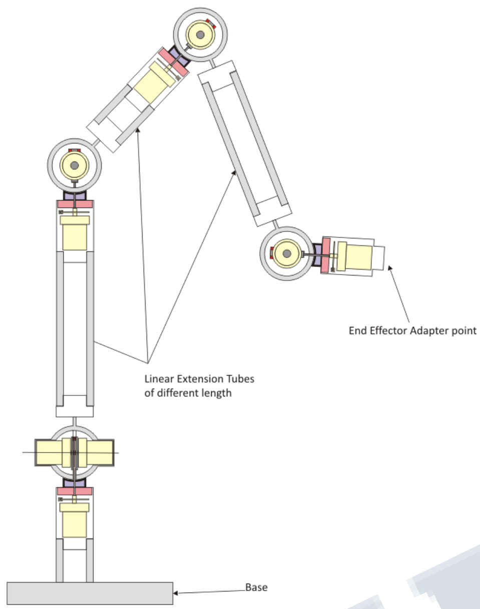
components on the vertical axis. The vertical axis motor is housed in a suitable enclosure.

FIG II Connection of different Haptic Joints with the help of different length Linear Extension tubes



B. Working

1) The hollow spherical surface and the attached components can rotate on the horizontal axis to the extent of the slit in both directions. The degree of rotation is measured by the horizontal axis rotary sensor. The suitable electronic signals to the horizontal axis motors can also rotate the hollow spherical surface and the attached components on the horizontal axis to the extent of the slit in both directions. The rotation induced due to the motor is also measured by the rotary sensor components.
2) The hollow spherical surface and the attached components can rotate on the vertical axis along the vertical rod in both directions. The degree of rotation is measured by the vertical rotary sensor. The suitable electronic signal to the vertical axis motor can rotate the hollow spherical surface and the attached components on the vertical axis in both directions. This possible rotation is depicted in Figure 1.
3) The activation of the electromagnet or any other suitable mechanism pushes the friction clutch towards the hollow spherical surface and resists its free rotation along the vertical axis and the horizontal axis of the module to the same extent. The resistance magnitude will depend on the force applied by the electromagnet or any other suitable mechanism. This may also be achieved through any other means of actuation not limited to for example with the help of a motor and suitable components and attachments.
4) As the contact area of the friction clutch to the hollow spherical surface is in the form of a section of a sphere, the contact area will remain the same for any amount of rotation in any or both of the horizontal axis and vertical axis. Thus the force of resistance to rotation will also remain the same as is applied by the actuator for the friction clutch.
5) This Motorised Force Feedback Device Rotary Joint Module using Spherical Friction Clutch Mechanism may be connected together through the adapter with the help of suitable connecting rods. A figure of the Motorised Force Feedback Device Rotary Joint Module using Spherical Friction Clutch Mechanism connected together with the help of suitable connecting rods is shown in Figure 2.

V. DISCUSSION

The device/ invention Elongation Module with Motorised Force Feedback Device using Friction Clutch Mechanism and the Motorised Force Feedback Device Rotary Joint Module using Spherical Friction Clutch Mechanism described earlier in the previous descriptions can be constructed with the different components and attachments. They can be joined together in different combinations to one another and not limited to as is shown in Figure 7 and Figure 8. There can be more numbers of ways in which they can be combined to each other. The data from the rotary sensors and linear sensors are used to compute the position and orientation of the end effecter in Three Dimensional Space. The degree of freedom of the device can also be varied according to the different modules attached together.

VI. APPLICATION

The proposed design of the haptic device is a general purpose modular design. It can be modified to design different haptic devices for many applications. As the design is modular so same parts of one design can be used in the other haptic devices without any modification and change in the basic design. The proposed design can be used but not limited to

1) Teaching Surgery and Medical Intervention Procedures.
2) Teaching mechanical assembly procedures.
3) Automation and machine control with active force feedback.
4) Three Dimensional Space force feedback joystick control for computer applications etc.

VII. CONCLUSION

We have developed an innovative haptic device that combines a parallel mechanic structurewith dedicated electronic.Our device has 6 degrees-of-freedom and its performance in terms of workspace andapplicable force and torque are beyond currently available haptic devices. The device has the capability of interacting with a high-level virtualreality engine.This haptic solution has been integrated into different fields of applications such as simulation of virtual objects, teleportation of mobile robots and nano-manipulation. These applications demonstrate both the important contribution thesense of touch has in building efficient human-computer interaction applications, and the versatility of the HapticDevice.Our research effort for the near future will aim at developing a nano-manipulation architecture using both VR modeling and haptic rendering.We will also try to interface the haptic device with other devices and develop software dedicated to the device for different types of applications.

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