Desktop Versions of the String-based Haptic Interface- SPIDAR

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ABSTRACT

There is a vast development and significant involvement of haptic interfaces in the world for virtual reality applications. In this paper, we introduce the research and development of desktop versions of friendly human interface called SPIDAR haptic interfaces on the Sato Makoto Laboratory in the Tokyo Institute of Technology. This haptic interface can be used in various types of virtual reality applications for simple pick and place tasks to more complicated physical interactions in virtual worlds.

Keywords: Haptic interface, haptic rendering, virtual reality.

Index Terms: H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities; H.5.2 [User Interfaces]: Haptic I/O

1 INTRODUCTION

Haptization technologies involve haptic interfaces, which are devices that enable users to interact with objects in a virtual world. Unlike traditional interfaces that provide visual and auditory information, haptic interfaces can generate mechanical signals, which stimulate human kinesthetic and touch channels [1]. As a result it enables the users to perform various interactions on a virtual environment to explore, touch and manipulate its object which enhance human senses in a virtual world [2]. Various types of haptic devices exist and they are being used for various kinds of virtual reality applications. In our laboratory, we are studying of human information processing through the development of the string-based haptic device called SPIDAR for various virtual reality applications ranging from desktop, workbench, human scale and networked environments.

Among them, this paper is an attempt to introduce the research and development of friendly desktop versions of SPIDAR haptic device of the Sato Makoto Laboratory of the Tokyo Institute of Technology. By using this kind of haptic interfaces user can perform simple pick and place tasks to more complicated physical interactions in virtual world [3].

2 STRING-BASED HAPTIC INTERFACE - SPIDAR

SPIDAR, which stands for `SPace Interface Device for Artificial Reality`, is a string-based haptic interface and can be used in various types of Virtual Reality applications ranging from desktop, workbench, human scale and networked environments. SPIDAR has three distinguishable features namely scalability, string based and transparency. Scalability means, the ability of SPIDAR to fit into different working spaces such as desktop, workbench, or human-scale with simple modifications on its structural layout. String based technology gives the user the ability to display position, orientation and force feedback information, providing an effective means of pointing and controlling in a virtual environment. Transparency is based on the string-based technology, because SPIDAR keeps the working space transparent without obscuring the visual display [3].

The first proposal of SPIDAR was presented by Professor Makoto Sato in 1989 and until now different versions of SPIDAR systems are available. The device measures user's fingertip position and gives the force sensation to users. Using this device user can directly manipulate computer-generated virtual objects with his fingers naturally as in the real world and feel shape, texture, collision, weight, inertia, etc.

Some of the new inventions of desktop version of SPIDAR systems are shown in Figure 1, namely SPIDAR-G, SPIDAR-mouse and SPIDAR-I. SPIDAR-G works as a three dimensional interface device for 3D virtual environment interactions. As shown in Figure 2, SPIDAR-G haptic interface is a grip type, tension based, 6 degrees of freedom (3 degrees of freedom for translation, 3 degrees of freedom for rotation) and grasp enabled force-feedback device. This device has a grip and it is used to grasp objects in the virtual world. This grip is attached to 8 strings. Each string is connected to a motor and an encoder at one end and to the grip at the other end. The feedback force is determined by the tension of each string generated by the motor, which is transformed to the users hand through the grip. By connecting this device to a personal computer, it provides a high definition force feedback sensation to the user`s hand [4] [5].

SPIDAR-mouse is a two dimensional interface device for 2D virtual environment interactions. It is an easy-to-create, low cost haptic device, suitable for interactions in 2D virtual environments [6]. SPIDAR-I is an inner-string haptic interface, which is also a 6 degrees of freedom posture and force-feedback, high fidelity, palm-sized haptic device [7]. Its frame structure derived from optimization such that all strings inside the ring-shaped grip. This avoid the interference between hand and the strings.

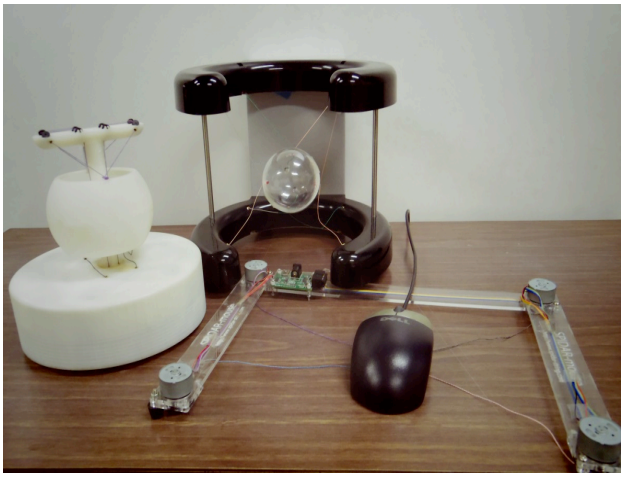

Figure 1: Desktop versions of the SPIDAR systems SPIDAR-I, SPIDAR-G and SPIDAR-mouse

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3 Recent Research Applications on SPIDAR

Figure 2: Demonstration of video haptization using SPIDAR-G

SPIDAR-G system is used for various kinds of haptic interactions. We used this system for video haptization. Our research mainly focuses on exploiting different perspectives of getting the haptic perception of feeling the movement of objects in an image sequence, with the objective of enhancing the viewing experience of viewers to the near real world level [8]. Liu et al used the SPIDAR-G haptic interface for 2D and depth image haptization [9]. It provides users with a sense of touch on general images. Apart from that, SPIDAR-G device is used for the molecular chemistry education for understanding the intermolecular interactions [10]. The research on SPIDAR-G devices are not limited to above applications. Since the capability of its 3D capability, it can be used for any 3D world applications for object manipulation in virtual world.

Based on the 2D capability and the low cost of the SPIDAR-mouse system, the device can be used for any 2D virtual reality applications. Figure 3 shows a demonstration of the SPIDAR-mouse system which enable the user to hit the Tokyo Tech symbol with the green onion by dragging the mouse. Force feedback is generated when the collision is detected.

SPIDAR-I is the latest desktop version of the SPIDAR system. Okubo et al proposed an animal image haptization system with 3D model using this haptic interface [11]. As shown in figure 4, this device can be used for any 3D world applications for object manipulation in virtual world.

Figure 3: Demonstration using SPIDAR-mouse

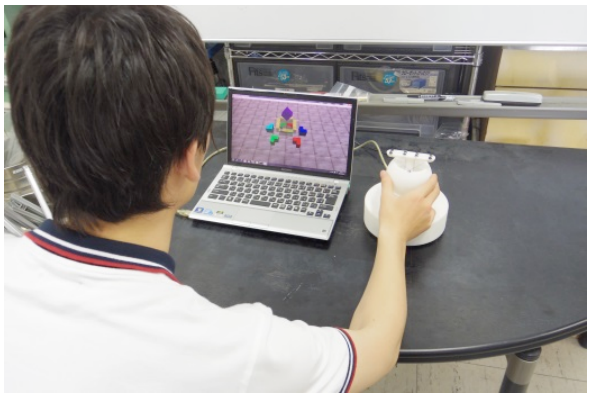

Figure 4: Demonstration using SPIDAR-I

4 Conclusion

In this paper, we introduce the desktop versions of the friendly human interface called SPIDAR haptic interface. Among the family of SPIDAR devices, there are three types of desktop versions namely SPIDAR-G, SPIDAR-mouse and SPIDAR-I. Further, we introduce recent researches using above devices.

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