SPIDAR-P: A Hybrid 6 DOF Haptic Interface for Entertainment

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Abstract

In this paper, we introduce a new 6 DOF haptic interface for entertainment named the SPIDAR-P. This device is designed as a bridge between the traditional gamepad and multi-DOF haptic interfaces. The SPIDAR-P system was evaluated against traditional keyboard-mouse and gamepad devices via a 3D coordination experiment, and qualitative feedback. Quantitative results showed that the SPIDAR-P performed not as well as the keyboard-mouse device, but better than the game controller. Qualitative results however indicated that SPIDAR-P achieved the goal of being the most immersive and fun input device.

1. Introduction

This new control system is a combination of a modern game controller, and the string based haptic device SPIDAR-G[1]. The addition of the game controller allows for richer input possibilities, in contrast to the restrictive one button input found on the grips of either SPIDAR-G or the PHANToM[2] For example, the user can use the gamepad for navigating through menus of a driving game, whereas the rotation of the controller is used to emulate the action of driving with a steering wheel.

2. Related Work

There are a number of commercially available haptic interfaces that can be used for gaming. In addition to the before mentioned PHANToM and SPIDAR-G, there are other devices such as the Novint Falcon and the Control Action Table (CAT)[3][4][5]. The majority of these devices have been used in applications such as: tele-robotics, education/training, medical simulation, and scientific discovery. However, only the Novint Falcon has been specifically marketed as a gaming device.

In comparison, SPIDAR-P is a 6 DOF device, that allows for 3 DOF of rotational movement on top of 3 DOF translational movement. This opens up more game control possibilities than the Novint Falcon. Additionally, unlike the Novint Falcon, there is no need for a separate keyboard device to supplement input requirements, since SPIDAR-P has a built in game controller to satisfy those needs.

3. System Overview

SPIDAR-P consists of a narrow rectangular frame with 8 motors/encoders attached to each corner. Each motor is mounted to a spool of thread, which in turn is connected to a game controller via a controller caddy. Position and orientation of the game controller is then calculated via knowledge of the displacement of each string[1]. Similarly, 6 DOF haptic feedback is enabled by varying the lengths of these strings. The controller caddy was designed such that the thread mounting points do not come into contact with the user's hands during usage. Mounted to the controller caddy is a PS3 SixAxis controller, which was chosen due to its light weight, abundance of analog buttons, analog control sticks, and Bluetooth connectivity. The current SPIDAR-P prototype is shown in Figure 1.

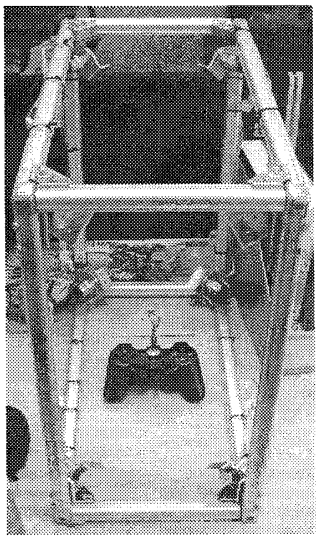

Figure 1 SPIDAR-P Prototype

4. Experiment

Two experiments were conducted to evaluate the system quantitatively and qualitatively. The quantitative experiment (Figure 2.) consisted of a 3D coordination task which tested the accuracy of moving an object along a 3D space curve within a set time limit. The qualitative experiment (Figure 3.) consisted of a questionnaire, which compared SPIDAR-P against other systems under a set of pre-defined criteria.

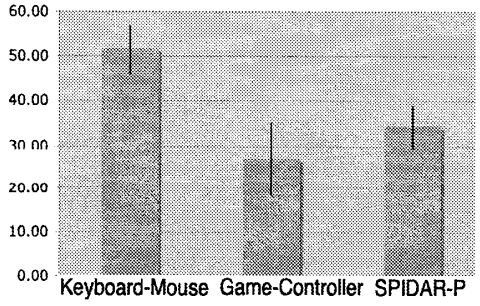

Figure 2 Quantitative Experiment

SPIDAR-P performed worse than keyboard-mouse, but better than the game controller.

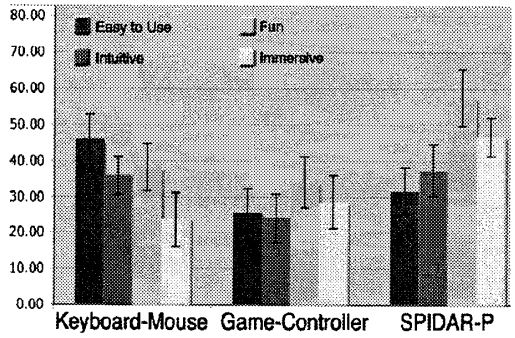

Figure 3 Qualitative Experiment

SPIDAR-P was the most fun and immersive device, but not significantly more intuitive to use, and is not the easiest to use device.

5. Discussion

Keyboard-mouse was shown to have the best score for the qualitative test, which may be because of the following reasons. First, since the mouse rests on a flat surface, fine adjustments can be more easily made compared with moving the SPIDAR-P controller to a specific orientation, or pushing on a small joystick as with the game controller. Second, device acquisition is better compared with SPIDAR-P and the game controller, since positional input can be maintained even if the user releases the control device. Finally, fatigue is less compared to SPIDAR-P, where the user must hold the controller in mid-air during device usage.

6. Conclusion and Future Work

In this paper, we introduced a new hybrid 6 DOF device for entertainment named SPIDAR-P. We achieved the goal of creating a system that combined traditional game controller technology that is familiar with users, and 6 DOF haptic technology that enriches interactivity, enjoyment and the feeling of immersion in games. Distinct advantages of this device compared to similar systems are as follows:

1. More natural game input possibilities, such as controlling a virtual paper airplane by manipulating the orientation and position of the SPIDAR-P game controller.
2. 6 DOF haptic feedback improves the feeling of immersion in the virtual world.
3. Augmentation of a game controller to a haptic interface allows the advantages of both systems to be utilized. For example, the game controller can be used for manipulating menus, whereas the haptic interface is for game input and force feedback.

Finally, we have experimentally shown that SPIDAR-P is more fun and immersive to use than traditional devices keyboard-mouse and the game controller. Even so, results indicate more work needs to be done to make it more intuitive and easy to use.

4. References

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