Perceptual Attraction Force: The Sixth Force

Tomohiro Amemiya,* Hideyuki Ando, Taro Maeda
NTT Communication Science Laboratories

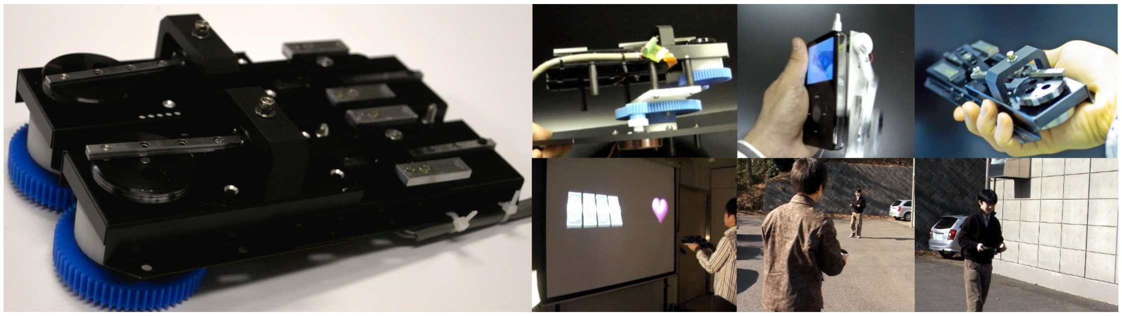

Figure 1: A novel handheld force feedback device

1 Introduction

We introduce a novel handheld force feedback device that utilizes the nonlinearity of human haptic perception; rapid and slow acceleration yield different sensations. The device generates asymmetric acceleration in one cycle, a pushing or pulling sensation. Three demonstrations will show the nonverbal communication made possible by the device.

We have utilized the nonlinear characteristics of human haptic perception to develop a handheld force feedback device; humans feel rapid acceleration more strongly than slow acceleration. We designed and built a crank-slider mechanism that creates a periodic prismatic motion with asymmetric acceleration (strong in one direction and weak in the other) leading to a ”virtual” force sensation. The prototype of the handheld device generates a sensation of uni-directional force; humans perceive a uni-directional force although the device physically generates a bi-directional force. By using a motor to pan the crank-slider mechanism, the device unit can create a virtual force in any arbitrary direction on a two dimensional plane. The direction of force can be controlled with angular sensors. We will present three applications of ”perceptual attraction force”; (1)attraction = magnet, (2)attraction = Newton’s apple, and (3)attraction = personal charm.

2 Exposition

Most force feedback devices have to use some mechanical linkage to establish a fulcrum relative the ground, use huge air compressors, or demand the wearing of a heavy device. Prior handheld force-feedback devices are unable to generate both constant and translational force; they can generate only short-time rotational force since they use the gyro effect, i.e. a change in angular momentum [Yano et al. 2003] [Tanaka et al. 2001] [Suzuki et al. 2002]. Instead, we utilize the nonlinearity of human perception to generate both constant and translational force; this approach has been neglected up to now. Our proposed device has the potential to be embedded in them and to be used as a new nonverbal communication tool such as communicating with gesture, guiding the user along a path, teaching the perfect golf swing, and dancing.

The most important innovation of the demonstration system is the novel force-feedback interface, which was designed and developed to generate asymmetric acceleration. The device induces illusion of a pushing or pulling force with no external fulcrum. With a rotational motor for pan motion, the device unit can create a virtual force in an arbitrary direction on a two dimensional plane. Commercial angular sensors allow us to measure the orientation of participants. The orientation data of two devices (or participants) are sent to the main computer wirelessly. The orientation of the devices will be controlled to ensure that the tracks of participants intersect (they meet). We also capture the trajectory of the participants with an infrared camera; each device is equipped with an infrared LED. Matching the trajectories, virtual footprints of the participants will be displayed on the ground from overhead projectors.

3 Conclusion

The device is suitable for applications such as communication, entertainment, and education through the use of mobile devices. In future, all mobile devices will include this technology. Cellular phones that have the device and GPS will intuitively guide you to where you want to go even if you do not watch the screen. We also plan to use this technology to extend the capability of visually impaired people.

References

SUZUKI, Y., KOBAYASHI, M., AND ISHIBASHI, S. 2002. Design of force feedback utilizing air pressure toward untethered human interface. In *Proceedings of CHI ’02 Extended Abstracts on Human Factors in Computing Systems*, ACM Press, 808–809.

TANAKA, Y., MASATAKA, S., YUKA, K., FUKUI, Y., YAMASHITA, J., AND NAKAMURA, N. 2001. Mobile torque display and haptic characteristics of human palm. In *Proceedings of ICAT 2001*, 115–120.

YANO, H., YOSHIE, M., AND IWATA, H. 2003. Development of a non-grounded haptic interface using the gyro effect. In *Proceedings of HAPTICS 2003*, IEEE Computer Society, 32–39.

*e-mail: t-amemiya@avg.brl.ntt.co.jp