AIREAL: Tactile Gaming Experiences in Free Air

Rajinder Sodhi[1,2]   **Matthew Glisson**[1]   **Ivan Poupyrev**[1]
[1]Disney Research Pittsburgh, USA   [2]University of Illinois, USA

1. Introduction

Interactions with our computers have expanded into the physical world. Recent developments of low-cost gesture tracking technologies, like the Microsoft Kinect, have enabled millions of users to interact with their computers by gesturing with their bodies. Furthermore, computer vision tracking and registration techniques now enable novel projection based displays to overlay projected images into our physical environments, creating entirely new augmented reality experiences. These natural interfaces will continue to be incorporated into our mobile devices enabling rich interactive experiences anywhere and at anytime. However, one missing piece to this emerging world of natural interfaces is the absence of physical feedback.

AIREAL is a technology that delivers interactive tactile experiences in free air. Currently, users are still required to wear a physical device (e.g., gloves, belts, vests) to receive tactile feedback. The need to instrument users hinders natural user interaction and limits the range of applications that can effectively employ tactile feedback. With AIREAL, interactive tactile sensations can be created in free air using compressed air pressure fields that stimulate the user's skin. AIREAL is designed to use vortices, which are rings of air that can travel large distances while keepings its shape and speed (Figure 1a). Importantly, AIREAL does not require the user or a physical object to be instrumented with a device. AIREAL is a scalable, inexpensive and a practical free air haptic device that can be used in a broad range of applications. These include gaming, mobile applications, gesture control and interaction among many others.

2. Design of AIREAL

AIREAL generates vortices by moving air from an enclosed volume through an aperture aimed into the physical environment. Our vortex generator is almost entirely 3D printed using UV-cured materials and is comprised of a 3D printed enclosure (8cm x 8cm x 8cm), flexible nozzle (4 cm length) and a pan and tilt gimbal structure capable of hitting objects with a 75-degree targeting field. Five speakers (Whisper 2" Subwoofer) are mounted around the enclosure, with the flexible nozzle facing the physical environment. When the speaker's flexible diaphragms are actuated, they push air out of the enclosure. The displacement rate of the diaphragm determines the flow rate of the air going in and out of the device. A signal generator board is mounted behind the enclosure and uses five 20W Class D amplifiers to drive each speaker on the device. Air vortices can be created with an 8.5 cm resolution at 1 meter. A more detailed description of the device, design and control mechanisms, experimental evaluation of device performance and perception on users can be found in our companion technical paper [Sodhi et al. 2013].

3. AIREAL Applications

While the application space of AIREAL is broad, we focus on creating new entertainment-based experiences that provide rich tactile sensations in free air. We are particularly interested in using AIREAL to create new gaming experiences that allows us to feel and engage with our virtual objects in new and meaningful ways. This can be achieved by enhancing traditional display devices (e.g. televisions, desktops, mobile phones) with AIREAL
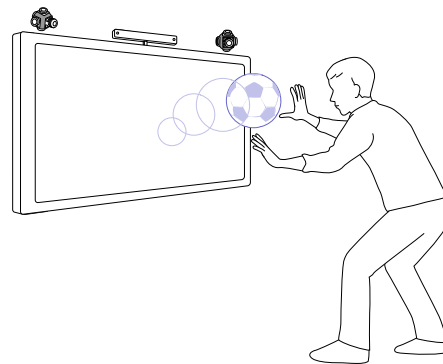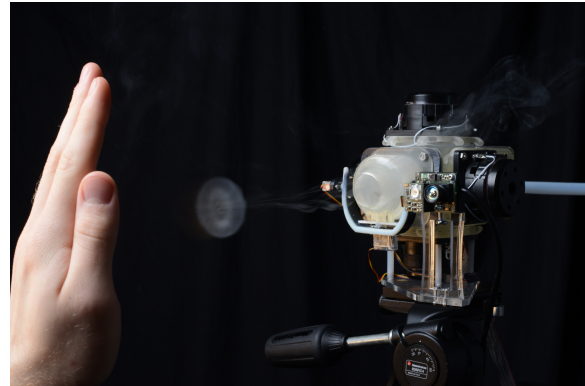

Figure 1: *Top, The AIREAL device emits a ring of air called a vortex towards a user that can be felt in free-air. Bottom, Multiple AIREAL devices can be used to provide free-air sensations when interacting with virtual objects.*

to provide users with interactive tactile sensations that are coupled to interactions with virtual 3D objects (Figure 1b). Furthermore, novel projection based displays equipped with AIREAL can be used to project virtual elements directly on the user's body that are collocated with free air tactile sensations [WILSON 2012] (please see accompanying video).

4. SIGGRAPH Demonstration

At emerging technologies, we will demonstrate an interactive tabletop with overhead projector and depth camera that showcases a series of gaming experiences with free air sensations. Visitors will be able to interact with virtual objects by selecting them on the tabletop. The system will recognize, track and project virtual elements on the user's hands that contain free air sensations (e.g., a butterfly moving on top of the users hand and arm).

References

SODHI, R., GLISSON, M., POUPYREV, I. AIREAL: Interactive Tactile Experiences in Free Air *(Submitted to Proc of SIGGRAPH, 2013)*.

WILSON, A.D AND BENKO, H. 2010. Combining Multiple Depth Camera and Projectors for Interactions On, Above and Between Surfaces. In *Proc. of UIST'10*, ACM, 273-282.