Multimodal Embodied Interface for Levitation and Navigation in 3D Space

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ABSTRACT

A multimodal embodied interface for 3D navigation was designed as a modular wearable. The user is suspended with a harness controlled by a mechanical Motion Base. This allows both physical and virtual displacement within an immersive virtual environment. Through a combination of passive and active modalities, users are enabled to fly at their own will.

Keywords

Embodiment; multimodal interaction; 3D space navigation

1. INTRODUCTION

As technology enables humans to experience individual flight, we propose to investigate what kind of techniques can be used to achieve embodied control navigation rather than vehicle-based fly control. Common approaches to embodied flight control are bird mimicking [2] or paragliding [3]. Additionally, the ability to fly using only our own body constitutes a completely new experience and thus, a design challenge. Furthermore, the perceived risk of falling is likely to cause unease. Our proposal addresses these challenges.

2. DESIGN AND USER EVALUATION

A wire-drive Motion Base (MB) allows three-axis flying movement. The MB is a carbon base connected to seven wires and seven pulleys that control wire length using a parallel link manipulator. A harness is attached to the MB, allowing deliberate user displacement (Fig. 1). Since body movements such as head and gaze orientation anticipate the direction of movement during gait [1], head orientation was chosen as passive modality for navigation. The active counterpart is pressure on the front, back, and sides of the harness. Additionally, electrophysiological signals were used for vertical navigation. While a calm user levitates, a stressed user stays on the ground. Electroencephalography (EEG) and Electromyography-based (EMG) jaw clenching detection indicate relaxation levels. The active equivalent for vertical movement is pressure on the harness bands, associated to the tendency of nervous, unaccustomed users to seek support by tightly holding on to these. The system consists of a modular wearable device that combines four flexible textile pressure sensors attached to the harness; an Inertial Measurement Unit; and a 4-channel InteraXon Muse EEG head band. The movement speed was fixed to 20 cm/s. The sensor data was smoothed and mapped to positions corresponding to three states: (1) standing in the ground, (2) levitating, and (3) flying. Users always start on the ground, and need to first levitate before they can fly around.

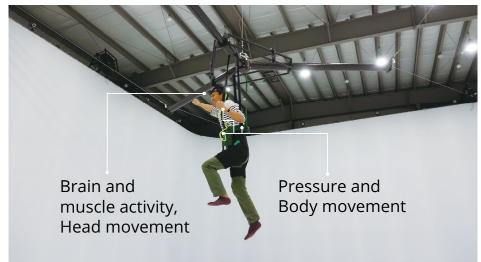

Figure 1: Motion Base and wearable harness

A user evaluation was conducted to explore users' understanding of the proposed modalities. Seven participants (mean age=29 years, SD=3.69) were invited to explore different techniques to fly. No further instructions were provided. Whilst different strategies were used to control the interface, most users did try to relax and look up and down to move vertically, and tilt their bodies and heads to move forwards, backwards, and sidewards. The average agency was 3.71 (SD = 0.95, 1 = high agency, 5 = no agency). Although they reported enjoying the floating sensation (Net Promoter Score: 43%), most discomfort present was related to the movement limitations in the harness, and unresponsiveness of the device.

3. CONCLUSION AND FUTURE WORK

A multimodal embodied interface for 3D navigation was designed and evaluated. Although their satisfaction with the flying experience was fairly good, users perceived high system latency. Despite this, they explicitly reported having tried to look around in order to move. This points to the suitability of head orientation as a passive modality for 3D navigation.

4. REFERENCES

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