Interactive Chair: Proxemic Approach to the Design of 3D User Interface

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Abstract

Conventions in 3D user interface hardly facilitate our natural body motions. While social interaction and collaboration are more emphasized in recent trends of 3D games, proxemics is considered as the fundamental framework to regulate social interaction. Since gaze and distance are major influences on proxemic behaviors, this study proposes an interactive chair to translate natural body motions into gaze and distance control in the virtual world. By effectively arranging typical sensors to detect sitting postures, we were able to achieve dynamic and transitional data from users. Future work is aimed toward more accurate and diverse detection of body motions.

Keywords

Proxemics, interpersonal space, chair, 3D navigation, gaze control

ACM Classification Keywords

H5.2. User Interfaces

Introduction

The evolution of three-dimensional (3D) games has formed strong conventions in their user interface, ranging from game controller design for video consoles to keyboard mapping in PC-based games. The ability to skillfully use them often becomes the major objective to be achieved by game players. In particular, fast and accurate manipulation of joystick, arrow keys or mouse is emphasized for navigating, reaching and aiming behaviors in most first-person shooting games, where users' tasks are very specific and limited. However, such interface design enforces users to artificially interpret between their intention and action, by ignoring the way in which our body is naturally used to behave in the physical world. This problem becomes clearer when social interaction and collaboration are more emphasized rather than competition between users, as can be seen in recent trends of 3D games (e.g. Massively Multiplayer Online Role-Playing Games (MMORPGs) and 3D Online Communities). In these cases, the range and patterns of interpersonal activities are much closer to our ordinary behaviors in the physical world. Players frequently have conversations with one another, and also tend to be easily influenced by merely the existence of others. In this study, particularly, proxemic theory is considered as the fundamental framework to regulate social interaction between people, in both physical and virtual worlds. However, the conventional interface hardly facilitates proxemic behaviors in virtual environments, since going through joystick, keyboard or mouse interpretation does not involve our bodily actions which are critical in proxemics.

Proxemics and Interpersonal Behaviors

Edward Hall described that we are surrounded by a series of socio-cultural boundaries which allow us to understand human behaviors [1]. He coined the term 'Proxemics' and developed the proxemic classification of four distance zones – intimate, personal, social and public distance. His system hypothesizes humans exhibit behavior which we call territoriality, and in doing so, they use the senses to distinguish between one space or distance and another. More recently, Bailenson et al. demonstrated that participants in virtual environments also tend to exhibit proxemic behaviors [2]. They found participants gave more personal space to the virtual agent who engaged them in a mutual gaze. In addition, when the virtual agent invaded their personal space, participants moved farthest from it. While this experiment clearly suggests that gaze and distance are major influences on proxemic behaviors, no studies have been made on the design of user interface which would support smooth gaze and distance control for users. This study is aimed at, in this context, investigating right methods to design proxemic user interface. Accordingly the chair was chosen as a means to translate our natural body motions into actions of perception and navigation in the virtual world.

Interactive Chair

In everyday life, we spend most of time sitting on a chair. While our both hands get busy with holding a book, writing a memo, or manipulating keyboard and mouse, the rest of our body is suspended on the seat or backrest of the chair. Although human body often expresses our need or intention in the form of a posture or an action, the use of chair has excluded such feedback from our daily intellectual activities. The interactive chair, as we propose herein, is expected to provide more intuitive ways to interact with the computer by sensing or responding to our bodily actions. A chair can be naturally applied in navigating the 3D space that utilizes the spatial orientation and the perspective mechanism associated with our physical body.

In this project, we presume a typical office setting as the user environment, in which a user sits on a swivel chair and stares at a desktop display. The software applications to be used are 3D games or equivalent (e.g. World of Warcraft or Second Life) where users typically see the virtual world in the first or third-person point of view. The proposed interactive chair translates a user's bodily motions to several ways as described below.

A. Control of gaze decoupled from body orientation

By rotating his or her body on the swivel chair, the user can look around the surroundings, while keeping the body constantly oriented in the virtual space. This enables, for example, changing the gaze direction even during walking toward a particular destination. It also allows multiple users to communicate "face-to-face" through their avatars, by providing them with a natural way (like what we normally do in the physical world) to make an eye contact to one another, without necessarily rotating the whole body.

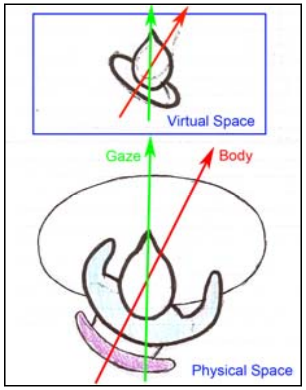

figure 1. Gaze control

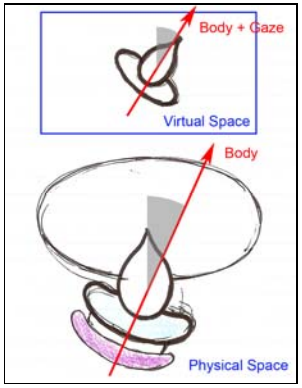

figure 2. Body orientation control

B. Control of the body orientation

The proposed interface shall be able to translate the user's intention to rotate the entire body orientation (including the gaze direction) as well. The distinction between coupled and decoupled orientations can be made by utilizing typical postures of human body in the desktop-chair setting, e.g. putting elbows on either the front-end of desk or the armrests of the chair (i.e. the whole body rotates when elbows are not pressing either the desk or the armrests).

C. Walking forward/backward

Using our physical body (i.e. leaning upper body forward, backward, left or right) in navigating the virtual world can bring us several benefits. Firstly, it does not require the conscious process as much as the use of mouse, keyboard or joystick, since it is normally what we do when we walk around the physical world. Secondly, the use of body in navigating can release both hands free to manipulate other devices, so that more cognitive actions (e.g. chatting, gesturing, grabbing or pointing) can be performed concurrently. Finally, users could control their walking speeds intuitively and immediately by leaning forward or backward to specific degree.

figure 3. Leaning postures to control walking speed

Sensing Bodily Motions on the Chair

Tan et al. developed the sensingChair as a new input device. Pressure sensing in this prototype was made possible with commercial pressure distribution measurement system. Two sensor sheets, placed inside green protective covers, were surface-mounted on the seat and the back rest of an office chair [3]. Since the analysis of pressure distribution in their study required heavy computation process for pattern recognition, it was not suitable for tracking dynamic sitting postures continuously.

To the contrary, we designed simpler mechanisms to detect transitional sitting postures. First of all, we measured the distance between the back of human body and the backrest of the chair, by using a commercial ultrasonic range finder (Ping, Parallax). Data from this sensor was translated into the walking speed of the first-person character in the 3D program. Secondly, a typical potentiometer was used to detect the swivel angle of the chair as rotated by the user. A set of force sensor resistors (FSRs) can be additionally applied to the chair so that the existence of a user on the chair can be identified, if it is necessary. Finally we used an open-source game engine named Torque 3D, to connect with the proposed interactive chair. Source code was partially modified to implement the serial communication with above sensors through Arduino Board, as well as the mapping between sensor data and actions of 3D character in the engine.

Proxemic Feedback

6 DC motors were installed on the grid of the seat so that users can sense the directional feedbacks (i.e. left, right, front and back). This haptic feedback is expected to increase users' awareness of others, especially when someone is approaching from outside of the screen.

figure 4. Ultrasonic range finder

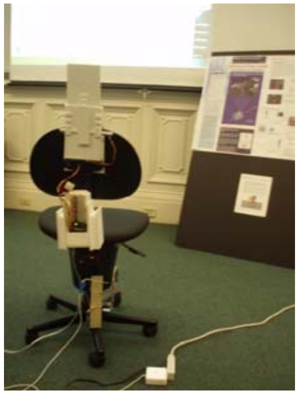

figure 5. Entire system

figure 6. DC motors for haptic feedback

Performance Evaluation

* To be done by January 8th, 2008.

Summary

We have described a proxemic user interface for 3D applications such as MMORPGs or 3D online communities. Technically, by using typical and inexpensive sensors, we were able to detect dynamic sitting postures of users, which was hard to achieve in prior works. In terms of interactivity, we proposed that proxemic approach is necessary to increase the richness of social interaction in the virtual world. In doing so, we actively took the advantage of natural body motions on the chair. Future work is aimed toward tracking more diverse postures on the chair to increase both intuitivity and accuracy of the interface.

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