A Wearable 3D Augmented Reality Workspace

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Abstract

This poster describes our work to build a wearable Augmented Reality system that supports true stereoscopic 3D graphics. Through a pen and pad interface well known 2D user interfaces can be presented to the user, whereas the tracking of the pen allows to use direct interaction with virtual objects. The system is assembled from off-the-shelf hardware components and serves as a basic test bed for user interface experiments related to collaboration between stationary and mobile AR users.

1. Introduction and Related work

Augmented Reality (AR), annotating the real world with computer generated entities, is a powerful user interface paradigm allowing users to interact with computers in a natural way. Mobilizing such an interface by deploying wearable computers is a logical extension as the body of related research shows [1, 2].

In mobile AR three different presentation mechanisms have been identified [2]: *Head-stabilized*, where information is fixed to the users viewpoint, *Body-stabilized*, where information is fixed relative to the users body position, and *World-stabilized*, where information is registered with real world locations.

Applications of AR in mobile computing often follow a distinction between augmentation in a far field that is world-stabilized and a near field that is typically either head-stabilized or - less often - body-stabilized. There are also applications using a mixture of both approaches. In the far field both 2D and 3D annotations are common. In the near field there is a preference of 2D or simple 3D information that is only browsable or navigable but not directly manipulable [3]. There are also applications mixing and connecting annotations in both fields [4].

Lack of accurate world referenced tracking systems for the users location make direct interaction with virtual objects hard or not possible. Therefore world-stabilized annotation is easier to achieve in the far field because the tracking of the users position and orienation need not be as accurate as in the near field. Also the performance of wearable computers did not allow reasonable stereoscopic rendering with satisfying performance until recently. Therefore, 3D objects that are positioned further away from the user or no direct interaction was used, because both features do not require stereoscopic rendering. With the recent advances in portable computer systems, we believe that applications that allow rich direct manipulation of 3D objects in the near field become feasible.

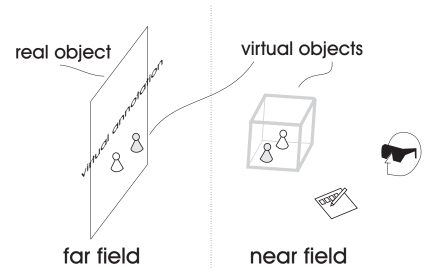

Figure 1. Far field objects may be world-stabilized and rendered monoscopic. Near field objects can be directly manipulated.

In this work, we demonstrate a wearable AR setup that allows full stereoscopic display and 6DOF manipulation of 3D objects in the near field, i.e. within arm's reach. With our 3D user interface management system, users can arrange arbitrary 3D applications around their body and carry them along. This approach allows new interesting applications that extend beyond AR browsing, such as manipulation of a live ”world-in-miniature” 3D model of the environment of constructive 3D modeling.

2. Hardware Configuration

Our setup consists only of off-the-shelf hardware components. At the core lies a powerful notebook computer equipped with a *NVidia GeForce2Go* video chip and a 1GHz processor. It is carried in a backpack by the user. As a display we deploy a *Virtual I/O* see-through stereoscopic color display. The user wears a helmet equipped with an InterSense Intertrax^2 orientation sensor and a web camera for fiducial tracking of interaction props. We also added a wireless LAN network adapter to enable communication with our stationary setup or a future second mobile unit.

The main user interface is a pen and pad setup using a *Wacom* graphics tablet and its pen. Both devices are optically tracked by the camera using markers. Moreover the 2D position of the pen (provided by the Wacom tablet) is also incorporated into the processing to provide more accurate tracking on the pad itself. Figure 2 shows different images of the setup.

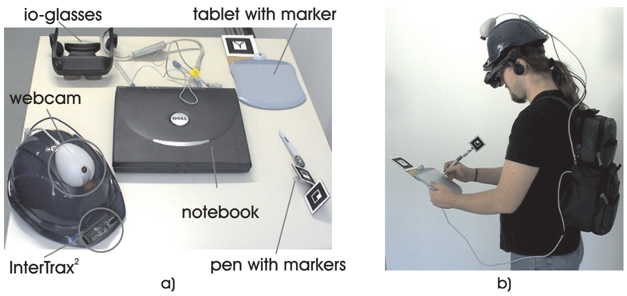

Figure 2. a) the components of the setup – b) a user wearing the system

3. Software Setup

The notebook is operating under Window2000. As Augmented Reality software system we use the *Studierstube* [5], a user interface management system for AR based on but not limited to stereoscopic 3D graphics. It provides a multi-user, multi-application environment together with 3D windows-equivalents, 3D widgets, and supports different display devices such as HMDs, projection walls and workbenches. It also provides the means of interaction, either with the objects or with user interface elements registered with the pad. The *Studierstube* software also supports the sharing and migration of applications between different hosts serving different users.

The inputs of the different tracking devices are processed by our open-source tracking library *OpenTracker* [6] that is linked to the AR software. It receives data about the users head orientation from the InterTrax^2 sensor to provide a coordinate system that is positionaly body stabilized and orientationaly world stabilized.

Within this coordinate system the pen and pad are tracked using the video camera mounted on the helmet and ARToolKit [2] to process the video information. Moreover whenever the user touches the pad with the pen the more accurate information provided by the graphics tablet is used to set the position of the pen with respect to the tablet.

4. Features

The described setup introduces a number of features not found in current systems. Stereoscopic graphics are employed to enhance the users perception of the closely located virtual objects. The tracked pen or pad can be used to directly manipulate these objects in the users interaction

Figure 3. A game of AR Chess demonstrates collaboration of the stationary user (left) and the mobile user (right).

space. Although this space is limited by the field of view of the camera used to track the interaction props, it is setup to coincide with the field of view of the HMD. This makes an interruption less likely, if the user is watching her interactions.

5. Applications and Future work

We currently use this setup to investigate collaborative issues between mobile. Support for mobile users offers new interesting problems for shared applications. Figure 3 shows an experimental game of chess between a mobile and a stationary user.

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