On-demand, In-place Help for Augmented Reality Environments

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Abstract. In many help systems, users are either distracted with a constant barrage of help or have to stop working on the task at hand and explicitly search for help. In this paper, we propose two methods to present on-demand, in-place help in augmented reality environments. In the interfaces we describe, users interact with virtual objects that are superimposed on the real world by manipulating physical cards. We describe *Tiles*, a prototype application for designing aircraft instrument panels, from which our work on help systems grew. In Tiles, users manipulate special 'help' cards in combination with data cards to invoke detailed help. This technique, which we call *Tangible Bubble Help* may be multi-modal, taking the form of text, audio, graphics, and animations. We also present *Tangible Tooltips*, a lightweight technique in which users control the display of textual help by tilting data cards. In both cases, users can seamlessly transition between performing the main task and acquiring help.

1 Introduction

Augmented Reality (AR) integrates computer-generated virtual information into the real physical environment [2]. Although several compelling AR systems have been demonstrated (see [2] for comprehensive survey), many serve merely as information browsers, allowing users to see or hear virtual data embedded in the physical world [11]. There has been little work done on designing effective AR interaction techniques, so current systems generally provide few tools for the user to request or interact with the virtual information presented [16].

Help systems have been one of the cornerstones in desktop graphical user interfaces (GUIs) and are heavily relied upon by users. Granda et al. [7] found that online help was the second most frequent source of guidance for users (asking other users was the first). Designing on-line help facilities is however, not a straightforward task [10]. It has been shown that poorly designed help systems can actually decrease both learnability and usability for novice users [12].

In designing our AR help system, we consider three main issues: when to provide help, where to provide it, and how to provide it. In previous systems, help provided was always present to the user. Examples of this include Feiner's KARMA system [5,6], which used AR to show a person how to disassemble a laser printer, and Rekimoto's NaviCam system [14], which associated AR information with real world objects for navigation guidance. We challenge the prevailing assumption that users in AR environments want all virtual information visible all the time. In fact, our early experiments with AR interfaces [3] have convinced us that virtual data that is always visible can be distracting.

Other systems such as Höllerer's MARS mobile AR system [8,9] also support help/information functions, but these are selected by pull down menus in the AR interface. We believe that real world manipulation of objects as well as displaying help where the user is working is critical to allowing the user to stay focused on the task at hand.

In addition, help should be context sensitive and provide several levels of detail and modalities to lead the user through difficult tasks [4,18]. Therefore in our AR work, we require that the help provided should be on-demand and in-place, i.e. help should be provided only by user request and without requiring the user to shift focus from the main task.

This paper is the first step toward designing effective interaction techniques for non-intrusive help in AR environments. We present two techniques – *Tangible Bubble Help* for detailed multimedia assistance and *Tangible Tooltips* for short textual reminders.

2 Application Platform: *Tiles*

Although our help techniques are broadly applicable, we implement them within our Tiles system, built for rapid prototyping and evaluation of aircraft instrument panels [13]. Tiles is a joint research initiative carried out with support from DaimlerChrysler AG and DASA/EADS Airbus.

In our interface, we allow users to quickly layout and re-arrange a set of virtual aircraft instruments on a whiteboard simulating an airplane cockpit. Each user wears a lightweight HMD with an attached camera. They interact with virtual objects (aircraft instruments) by manipulating physical data cards, or *tiles*, marked with square tracking patterns (Figure 1). Our computer vision system [1] identifies these patterns in the video stream and determines their 3D positions and orientations relative to the head-mounted camera. Virtual objects are then rendered on top of the tiles.

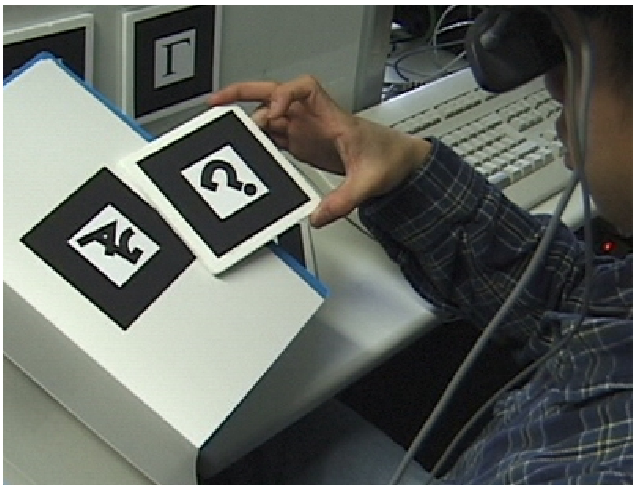

Figure 1: Physical manipulation of help and data cards in the *Tiles* system

In our application, instrument designers first create virtual instruments and associate them with tracking patterns laid out on pages in a book. Next, the user copies these virtual instruments onto data tiles, which can then be arranged on the board to form the cockpit. Using various interaction techniques, the designers are able to quickly and easily add new instruments or remove those that are not needed, to rearrange instruments, as well as to evaluate the layout.

All tiles can be manipulated in space and arranged on the whiteboard: the user simply picks up any of the tiles, examines its contents and places it on the whiteboard. Operations between tiles are invoked by bringing two tiles next to each other (within a distance less then 15% of the tile size).

For example, to copy an instrument to the data tile, the user first finds the desired virtual instrument in the menu book and then places any empty data tile next to the instrument. After a small delay to prevent an accidental copying, a copy of the instrument smoothly slides from the menu page to the tile and is ready to be arranged on the whiteboard. Similarly, if the user wants to "clean" data from tile, the user brings the trashcan tile close to the data tiles, removing the instrument from it. We extend this interaction metaphor in the creation of our AR help system.

3 Tangible Bubble Help

In Tangible Bubble Help, users are provided with dedicated 'help' cards designated both with distinct physical 2D tracking patterns and with 3D virtual help widgets. To receive help on any other virtual object, users simply place the help card next to the data card on which they require help. In simplest case, this triggers explanatory text that appears within a bubble next to the icon (Figure 2).

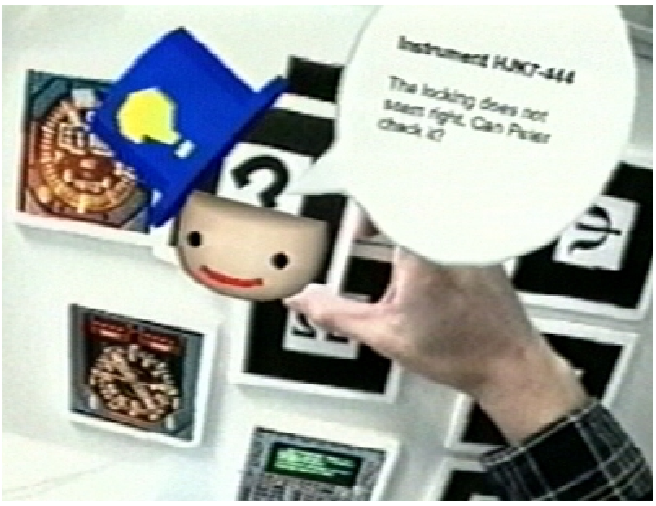

Figure 2: Moving help card next to data card to acquire Tangible Bubble Help

Initially this function was used for the instrument designer to leave annotations on instruments or to provide instructions on control cards of the Tiles interface, e.g. the use of the trashcan/delete card. However, we found multimedia help, such as audio annotations or 3D animations, to be particularly effective. Multimedia help can augment regular textual help, which does not support visualization of spatial relations or of interaction processes required to complete tasks.

Besides the textual help card, we created a help card that animates the instruments, demonstrating the full extent to which certain instrument dials and levers can move. By using the animation Tangible Bubble Help card, the user may visualize the spatial requirements and motion envelope of each instrument. A third help card provides users with a 3D arrow that allows them to probe at different parts of the virtual or real objects in question, bringing up detailed help on component pieces.

Although we have mainly used the Tangible Bubble Help techniques for providing help on virtual objects, it can just as easily be used for physical objects. For example, a real aircraft part that is marked with tracking patterns can be augmented with different levels of user help using the tangible bubble help technique. Alternatively, we could instrument large spaces with our tracking patterns and allow users to bring up directions or other such annotations on-demand and in-place.

A key difference between Tangible Bubble Help and other help systems is that Tangible Bubble Help provides help in the users task space. While the user is performing a real world task (in this case laying out a aircraft instrument panel), they are able to receive help in their workspace without having to turn away to an external computer screen or manual. Providing the user the help support they need in their task space helps them remain focused on the task at hand.

4 Tangible Tooltips

Users do not always need extensive help. In some cases, all they need are short reminders, or tips, on the functionality of particular interface controllers. Help systems for this purpose have been implemented in other interfaces. In GUIs, for instance, briefly placing the cursor over a region may bring up a Tooltip – a concise description of the interface control. Such help techniques must blend seamlessly into the working process without requiring the use of special purpose tools.

Using the Tangible Tooltips technique, the user triggers the display of short descriptive phrases associated with each virtual object by bringing corresponding data cards into their working space and tilting them more than 30 degrees away from the body (Figure 3). Other researchers have shown that tilting may be used as an interface controller [15]. In the Tiles application this was typically used to display the name of the instrument, perhaps with the date of design. The Tangible Tooltips are activated only within the user personal working space, defined as the area less than an arms-length away from the user's body. This allows us to eliminate unsolicited help on cards with which the user is not interacting. Also, users can activate Tangible Tooltips on multiple cards simultaneously in order to compare textual notes. We are currently experimenting with displaying different amounts of help based on the degree of tilt.

Figure 3: Tilting a data card to attain Tangible Tooltips on virtual instrument.

Early observations showed that Tangible Tooltips were surprisingly intuitive because users tend to hold cards perpendicular to the camera when interacting directly with them. Tilting the data card also borrows from our interaction with everyday physical objects, e.g. to find out information about the contents of a package, we turn it around to look at the label on the back. Initial testing, however, suggested that users occasionally tilt the cards for short periods of time while they perform other tasks, such as evaluating their layout from different angles, or looking down to pick them up. Because tooltips rising out of the card at this point are distracting, we implement a small delay (~1 second) before the help message is rendered. This is not unlike GUI Tooltips systems in which the cursor must linger over a region for some time before help is shown.

5 Discussion

In building our help system and interaction techniques, we explored different methods to map the degrees of freedom provided by the position and orientation of the physical cards to input parameters. We also looked at the frames of reference in which these parameters could be considered.

In the Tangible Bubble Help technique, we use the relative position of the help cards with respect to the data cards upon which they act. Additionally, with the component help, we use the orientation of the help cards to determine which component the user would like assistance on. In Tangible Tooltips, we instead use the position and orientation of the cards with respect to the user in order to trigger the help text. These two approaches illustrate two general approaches to designing help techniques for AR environments that we refer to as *In-place* and *On-demand* help techniques.

In all these instances we set a threshold value in order to determine if the help should be displayed. We are currently looking at ways of more subtly allowing the user to control the level of help they receive, for example by tilting the cards differently. In such schemes, one could envision complex techniques such as shaking cards or creating gestures with them in order to get different forms of help. We believe that there is much potential in using these physical manipulations to create novel interaction techniques.

6 Future Work

The Tiles system and help techniques were demonstrated at IEEE/ACM ISAR2000. About seventy users, including many AR researchers, tried the system. With simple instructions, users were able to simulate the design process, laying out and rearranging the instruments on the board and acquiring help when necessary. DaimlerChrysler AG engineers are now evaluating the Tiles interface concept for feasibility in industrial applications. We are currently looking at conducting formal user studies to evaluate the AR help system and to improve the design of interaction techniques.

Another line of related research that we would like to pursue is to build an authoring tool that would aid in the creation of the actual help content. Currently, most of the content has to be separately designed, built, and coded by the system programmer. We envision a system in which the designer may simply place a 'create-help' card by a selected instrument and create content using whatever means they are most comfortable and familiar with. This could be as simple as typing help text or as complicated as a full-blown authoring tool that exports 3D images with hierarchy and animations, as well as associated interaction events.

7 Conclusions

We have described interaction techniques for providing AR users with on-demand, in-place multi-modal help with multiple levels of detail. Although design of the help systems has been an important area of research in traditional user interfaces, we are not aware of prior attempts to explicitly design help interfaces for AR environments. We presented two help techniques, Tangible Bubble Help and Tangible Tooltips, that we implemented within the Tiles AR environment. These techniques provide users with simple tools to acquire help without shifting focus away from the main task. Preliminary user observations were encouraging and we are planning more formal user studies.

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