

Augmented Reality In-Situ 3D Model Menu for Outdoors

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ABSTRACT

We present a design and implementation of an in-situation menu system for loading and visualising 3D models in a physical world context. The menu system uses 3D objects as menu items, and the whole menu is placed within the context of the augmented environment. The use of 3D objects supports the visualisation and placement of 3D models into the augmented world. The menu system employs techniques for the placement of 3D models in two relative coordinate systems: head relative and world relative.

INDEX TERMS: H.5.2 [User Interfaces]: Graphical user interfaces (GUI) — Interaction styles; I.3.7 [Three-Dimensional Graphics and Realism]: Virtual reality — Animation.

1 INTRODUCTION

This paper presents an in-situation menu system for outdoor augmented reality systems that leverages the first person perspective nature of augmented reality (AR). The menu system employs a collection of techniques tailored to different relative coordinate systems for the support of different tasks. The *head relative technique* allows the user in a single operation to select a 3D model, visualize the model in context of physical and virtual objects, and perform translation operations to quickly position the object in the correct position. The *world relative technique* allows the user to specify a location on the ground plane, select 3D models, and preview those models at the specified location. Instead of textual or iconic representations, our menu system uses the 3D models themselves as menu items. The 3D models in the menu itself are placed within the context of the augmented reality environment, thus the name of the in-situation (in-situ) menu. The critical features of this menu system enable the visualisation, comparison, selection, and placement of 3D objects in an outdoor real world context.

Our menu system is implemented in Tinmith system [1] outdoor mobile AR wearable computer system. This system is in the form of a belt mounted computing system, video see through head-mounted display (HMD) helmet, and a pinch gloves input device. Pinch gloves are the main input devices for the Tinmith system, with camera tracked fiducial markers placed on the thumbs for the control of two cursors. Pinch actions allow the user to execute commands with their hands outside the camera's view.

This paper starts with an overview of related work on menu systems for augmented and virtual reality. The concept of in-situ menus is then presented, with the options of a world relative and head relative menus. Finally, some concluding remarks are given.

2 RELATED WORK

Research into menu systems in an AR or VR environment has been mainly concerned with command execution. One of the most

common approaches to menu systems in AR/VR is based on the conventional pull-down menu in a desktop 2D environment. The Bowman and Wingrave's TULIP menu system [2] exploits pinch glove to associate each menu item with a finger on the glove. Thus, by pinching the appropriate finger, the corresponding menu item is executed, in a similar fashion to the current menu system in Tinmith. Circular menus are a compact visualisation of menu items in a virtual environment. Liang and Green [3] presented the JDCAD 3D modelling system that uses a spherical and ring menu for object selection. The idea is further evaluated and developed by Gerber and Bechmann [4] into a hierarchical spin menu as a context menu in a VR environment.

3 IN-SITU MENU FOR 3D MODELS

Our in-situ menu system supports visualisation and placement of 3D models into the augmented world, by placing 3D models within the context of the AR environment. The previously mentioned AR/VR menu implementations have their own limitations. All of the above-mentioned menu systems require the user to shift their attention off the current task, and most of them are only exploited for command execution.

3.1 Overall menu concept

The in-situ menu is created in the form of a linear array of 3D models, whose object placement position is either world relative or head relative. The user may step through different models by pressing the *Next* or *Previous* options in the pinch glove menu, which moves the array of models to either the left or the right. The models from the in-situ menu are placed into the world by pressing *Create Model* option. The user may choose to commit or delete all the placed models into the world by pressing *Ok* or *Cancel* option. Figure 1 depicts a user's view, from a distance, of an in-situ menu to consider placement of virtual cars along the footpath on the side of a physical building.



Figure 1. World relative in-situ menu for placing car models

Our in-situ menu system helps to visualise 3D models in an outdoor AR environment. Instead of being part of the user interface, the in-situ menu situates the 3D model options within the augmented world. The menu itself allows the user to see 3D

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models within the context of surroundings, which makes it easier to decide which model to place into the world. The act of scrolling through the 3D model items provides the visualization of prospective virtual object placement. A linear menu is preferred over circular one to allow for a greater number of models to be loaded and the ability for comparison between models. Based on the method of placement of models, the in-situ menu provides head-relative and world relative options.

3.2 World relative AR In-Situ menu

The world relative AR in-situ menu operates in three phases. First the user specifies a location for the 3D model placement and viewing. Second, the user will walk to a vantage point to allow for the proper context of the 3D model. Then the user cycles through and views the different models before making a selection. The first phase is performed by the user entering the world relative object placement mode. The user then walks to the location in the physical world the object will be placed, and then selects the *World Relative* command to create a linear array of 3D models on the ground plane, starting from the user's current position, extending to the right of the user. Because the location of the menu is relative to the world, the user can walk around and view 3D models in different positions in the physical world. Once the user has chosen the model, the *Create Model* menu option may be employed to place 3D models into the augmented world. Placement of a model detaches them from the menu, but retains their position and orientation to the physical world, as was depicted from the viewing menu. Once detached, models are no longer affected by the in-situ menu commands, but can be edited from the existing Tinnmith menu system.

The world relative option facilitates tasks that require a high level of visualization at specified locations. The models are full-size, and located at a convenient distance apart, thus allowing user to examine and compare models in detail and from various viewpoints, or to consider models in their natural placement from a distant vantage point. The in-situ menu enables 3D models to be compared with existing physical objects geo-referenced near the specified location. The user commits the placement of suitable models; all the other ones will disappear upon menu deactivation.

3.3 Head relative AR In-situ Menu Head

The second option for the in-situ menu is the head relative technique, which attaches the array of objects to the user's head orientation. This technique allows the user to move the menu/3D object into the required position by orienting their head and/or physically moving. The models are constructed at full size and placed on the ground plane to increase visualisation. Considering this form of the menu allows for a flexible placement of 3D models, this menu option is recommended for tasks that involve the consideration and visualisation of 3D models in various locations. The example in Figure 2 depicts a user considering placement of a virtual tree within the context of a virtual house. With the flexibility of the head relative option, the user is able to visualise prospective placements of the tree, such as either in front of or at the side of the house.

The head relative in-situ menu is highly intuitive with its position being controlled with head position orientation, as previously mentioned, i.e. the user merely looks at the position of the object placement. Browsing through the menu is similar to the world relative method, and only involves pressing pinch gloves commands, *Next* or *Previous*. The 3D models may be selected in one of two methods, with the cursor controlled by pinch gloves or with the head relative eye cursor, which is always located at the centre of the display. The whole process of loading the menu, browsing, and selecting models can be completed with the user's

hands comfortably at their side. This approach is similar to the intuitive use of gestures of the Look-at menu [5].

Prior to activating the menu, the user has a choice of either placing the models into the world at the current position of the model in the menu or of the user. The former option has the in-context advantage. While the latter allows the user to visualise perspective models, and the GPS positional information allows the precise place of 3D models into the augmented world.

The head relative in-situ menu is an interactive 3D models selection tool to place various models into the augmented world. Previous systems only allowed textual or iconic representations of the 3D models, and the user could not see the models in the context of the environment before committing to their placement.



Figure 2. Using head relative menu for placement of objects

4 CONCLUSION

The in-situ menu represents a versatile concept that serves the following purposes in an AR environment: selection, comparison, visualisation, and manipulation of 3D graphical objects. Using 3D models as menu items brings those models within the context of the physical and virtual environments; allowing the in-situ menu to greatly aid the visualisation and placement of 3D models. The collection of techniques for the in-situ menu supports two forms of visualisation and placement. Firstly, the world relative technique supports tasks when the final placement of the 3D object is known in the physical world. This technique facilitates a choice between models and viewing from different vantage points. Secondly, the head relative techniques supports tasks that require adjustments to the position of the model to determine which model is chosen and an interactive placement of the model before a commitment.

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