Smartphone as an Augmented Reality Authoring Tool via Multi-touch based 3D Interaction Method

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Abstract

In this paper we present an Augmented Reality (AR) authoring tool for smartphones which facilitates intuitive interactions that manipulate the augmented virtual objects in real-time. A novel 3D interaction method using multi-touch interface and camera pose is proposed for intuitive authoring. With the gestures of two fingers on the touch screen, the user can adjust 3 DOF translation and 3 DOF rotation to a selected virtual object. The capabilities of the authoring tool are demonstrated on a smartphone.

CR Categories: I.3.7 [Information Interfaces and Presentation]: Artificial, augmented, and virtual realities;

Keywords: Augmented Reality, Mobile Augmented Reality, Multi-touch interaction, Authoring tool

1. Introduction

Since a video see-through device with a high-resolution touch screen and additional sensors, i.e. mobile device, has come into wide use, Augmented Reality gets noticed in the mobile application marketplace [Gervautz 2012; Wagner and Schmalstieg 2009]. As one of the emerging technologies, mobile Augmented Reality (AR for mobile devices) has a wide range of applications so that naturally the needs of AR authoring tools which facilitate easy manipulation of AR content via intuitive interaction for various functionalities have been increased [Tobias et al. 2012]. There are existing authoring tools for mobile AR which support various functionalities of authoring, for example [Wang et al. 2009] and [Zauner and Haller 2004]. Interactions in the typical GUI, however, do not provide an intuitive way to generate the AR content. In [Tobias et al. 2012], smartphone is used as the platform of the authoring tool while the interaction in [Tobias et al. 2012] is not significantly different from the others. The fundamental reason of unintuitiveness comes from inconsistency of dimensions between the space of an interaction and the space of an AR content. The user should control the virtual object of the content in 3D space through 2D interaction on the screen. For example, a projected ray from a mouse position to the ground plane is only able to create a 3D position on the plane due to the ambiguity in depth.

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In this paper, we propose an authoring tool for mobile Augmented Reality which enables an intuitive 3D interaction for manipulation of 3D AR contents via multi-touch screen. Through the proposed 3D interaction method, the user can utilize a smartphone as an authoring tool to organize the contents in a 3D scene on site. Multi-touch interface of a smartphone is employed to generate 3D interactions on the screen. On site authoring is established by simultaneous tracking and interaction module of our framework. In this work we use Jung's method [Jung et al. 2012] in the tracking module to enable the sufficient computing power for interaction during tracking.

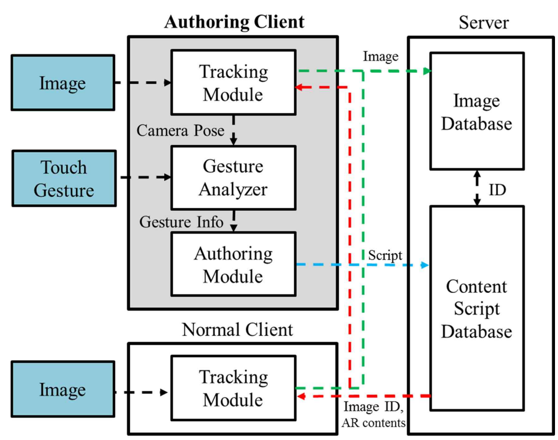


Figure 1. *Illustration of overall framework and dataflow of content providing. AR contents with script generated by Authoring Client are distributed to Normal Client through a remote server.;*

2. Mobile Augmented Reality Authoring Tool Framework

As the major functionalities of an on site AR authoring tool, we divide the authoring client system into 3 parts: tracking module for registration, gesture analyzer for interaction and authoring module for generating scripts as shown "Authoring Client" in Figure 1. The flow of the framework is as follows: the input image given by camera is transmitted to the server to identify an ID of the image. If the ID is available, corresponding AR contents are transferred to the client. The 6 DOF pose of the camera, i.e. the mobile device, is calculated in the tracking module. Coarse-to-fine tracking method in [Jung et al. 2012] takes low computation power. The gesture analyzer proceeds to make an interaction from the gestures and the camera pose while tracking succeeds. Finally, the authoring module generates a script based on the given interactions and transfers it to the server. The scripts in the server are integrated to the corresponding AR contents. The saved AR contents can be transferred to use for the normal client.

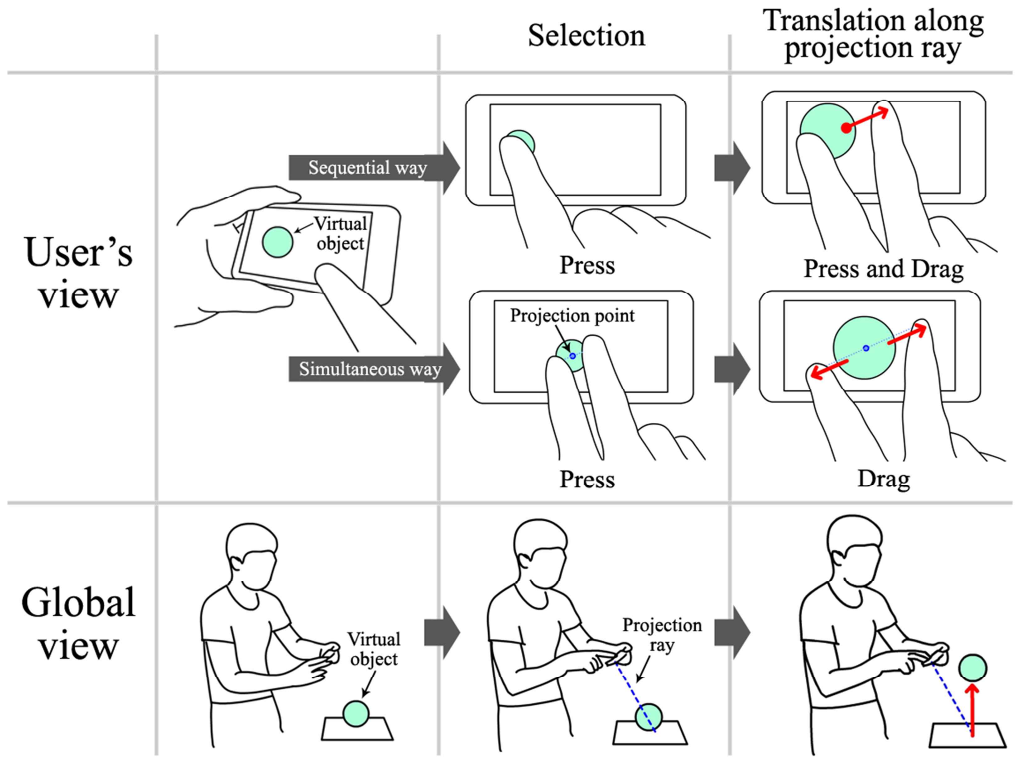


Figure 3 *Two ways of interaction(selection and translation). Sequential way of the interaction starts from one finger and ends with two fingers, contrastively the both fingers are always used in simultaneous way.*

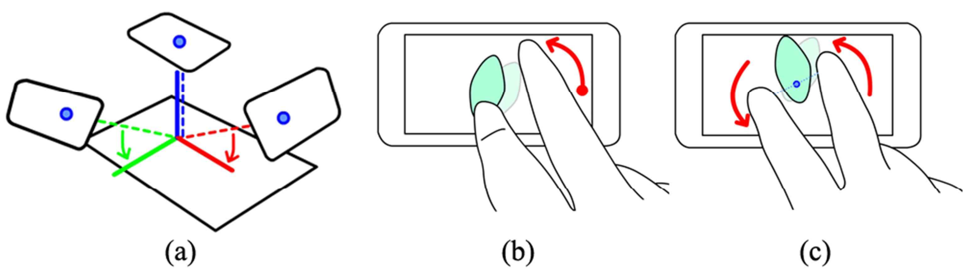


Figure 2 *Two ways of interaction(rotation). The actual axis of rotation is approximated to the nearest world axis from the projection ray like the magnetic tool (a). After the selection, the user can rotate the object along the axis using the sequential touch gesture (b) or the simultaneous touch gesture (c).*

3. Multi-touch based Interaction Method for Authoring

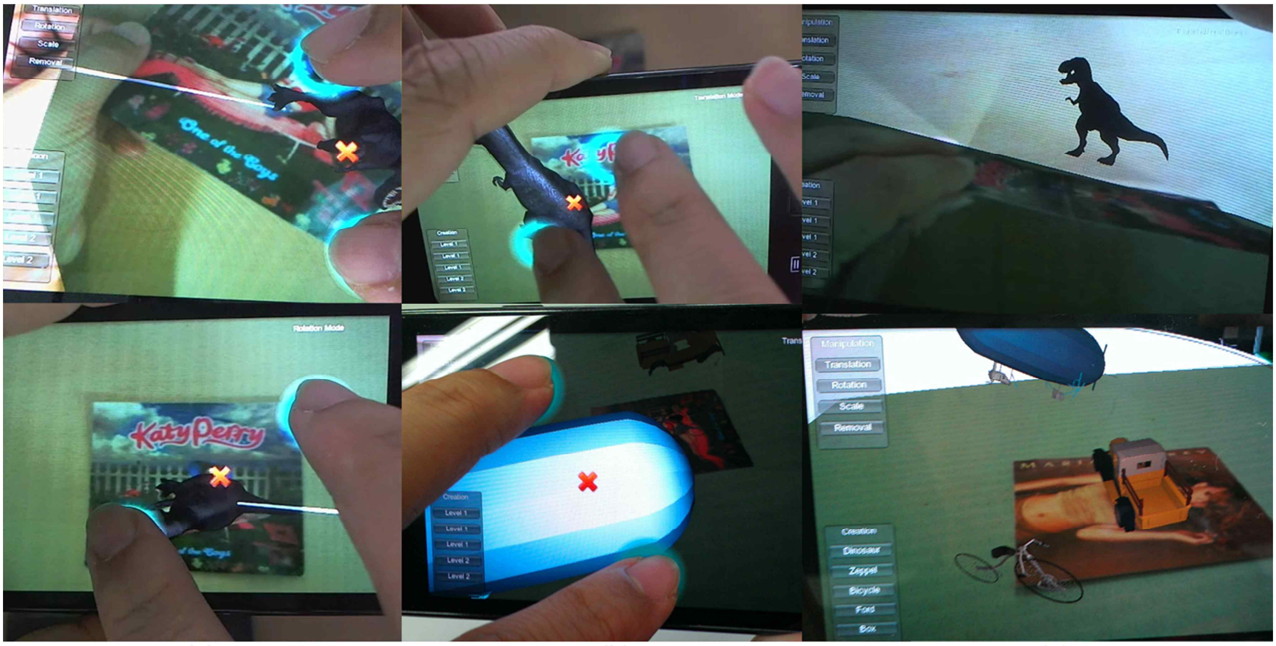
The proposed interaction method for authoring employs very simple finger gestures like tap (briefly touch surface with a fingertip), press (touch surface for extended period of time), and drag (move a fingertip over surface). The combination of each finger gesture generates three interactions: translation control, orientation control, and scale control. We differentiate the mode for each interaction to avoid ambiguity and get an accurate interpretation of gestures. The requirements for interaction are that the target object should be tracked on the screen to calculate the camera pose and the multi-touch functions via a touch screen should be available.

3.1 Translation control

As shown in Figure 2, the user can select the first object which is hit by the projection ray that starts from the camera. After the selection, translation above the planar surface of the target, i.e. direction of x and z axis, is controlled by moving the projection point using one or both fingers. Translation along y axis is performed by getting both fingers closer or farther. The direction and the magnitude of translation are decided by the relative difference of the distance between two fingers. After 3D translation is applied, the translated object can be seen from different viewpoints.

3.2 Orientation control

Figure 3 shows the 3 DOF rotation after the selection using the device and two fingers. Before the rotation, the user can select an axis of rotation by controlling the projection ray, i.e. two touched points and direction of the device. We employed this constraint on



(a) (b) (c)

Figure 4 *Screenshots of demonstration. All interactions are implemented as the simultaneous way. We add a glow effect on the touched points, and X marks on the projection point. In (a), first column, the user rotates the object upon the axis which is near from the direction of the camera. In (b), the user translates the object in 3D space. (c) shows the resulting screenshots of manipulation. Upper figure of (c) column shows a dinosaur in the air as the result of the translation.*

the rotation axis to avoid confusion in rotation. After selection of the object and the axis, the magnitude of rotation depends on the relative difference of the angle between two fingers.

4. Implementation

In the experiment, we used Samsung Galaxy S2 as the platform and Unity3D as the rendering engine of the client systems. In the authoring client system, we employed different programming languages in each module; C++ for the tracking module, C# based Unity script for the gesture analyzer, and Java for the authoring module because of processing speed, use of Unity3D, and flexible functionalities of networking, respectively.
In order to demonstrate our authoring tool, we implement an authoring client system which manipulates virtual objects through the proposed interaction method as shown in Figure 4. With the proposed interaction method, the user can select a virtual object and adjust 3D position or 3D orientation to the object with multi-touch gestures in real-time.

5. Conclusion

We proposed an on site AR authoring tool which tracks and interacts with virtual objects simultaneously on smartphones. Through proposed multi-touch based interaction method, the virtual objects can be manipulated in 3D space in intuitive way. The demonstration showed that the interaction method gives an easy and convenient ways of manipulating virtual objects to non-experts. We expect that our framework and authoring tool help to facilitate the use of the mobile AR authoring experiences in public.

6. Acknowledgement

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