A Web Application for Creating Real-Size Augmented Reality Content without 3D Modeling Skills

Akira Sano*

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Abstract Despite many Augmented Reality (AR) applications and development environments in existence today, almost all require 3D modeling skills in content creation. The purpose of this work is the development of a Web application that enables users to create real-size AR content without 3D modeling skills or software. The developed experimental system allows for the creation of real-size AR content using captured images via a Web application. Twenty-two out of twenty-four individuals who tested the experimental system were able to successfully create AR content. The experimental system was concluded to enable users to create AR content without 3D modeling skills.

Keywords: Augmented Reality (AR), Mixed Reality (MR), multi-platform, real-size

1. Introduction

Augmented Reality (AR) refers to technology that allows users to see virtual objects superimposed on or composed with the real-world environments. Recent years have seen increased interest in AR thanks to improved computer performance and the proliferation of smartphones equipped with digital cameras. Many AR applications or services already exist for smartphones and web browsers. Several research specialists have reported on the use of AR applications for educational purposes. They concluded a favorable educational effect is obtained by using AR applications.

Despite the large number of AR applications in existence today, almost all emphasize the manipulation of AR content rather than its creation. For example, “Sekai Camera”, an AR platform for iPhone and Android, equips users to post textual information linked to location information. “Layar” and “Junaio” are popular smartphone-based AR platforms that allow developers to make 3D content. However both require skills for the creation and manipulation of AR content.

It therefore seems that the development of a system that enables users to create AR content without the need for 3D modeling skills would be welcomed. It would benefit many aspects of online communication.

Some books on science or nutrition contain real-size pictures of animals or foods as references. These books help readers to realize actual sizes of objects in real life. If such real-size content can be viewed by using AR on the Internet, people can know about the objects from different angles virtually and learn far more about them. Furthermore if real-size AR content can be created and shared easily, it will enrich communications on the Internet.

2. Previous Research

2.1 Development environment for AR content

Thanks to the original conception of ARToolKit by Kato, the development of AR content without special mathematical skills has been greatly simplified. Still required, however, are programming skills in C and C++, as well as 3D modeling skills.

As an additional toolkit for Macromedia Director, a popular commercially available software environment for creating multimedia content, DART has simplified the process of creating AR content. According to MacIntyre et al., DART enables designers to create AR content rapidly and easily. Special software and 3D modeling skills, however, are still required in its use.

POPINTO, an integrated AR content development application developed by Kondo and Mizuki, does not require special software. Although POPINTO has its own authoring functionality, downloading and installation requires a significant amount of time. Furthermore, like DART, POPINTO requires users to have 3D modeling skills.

A multi-platform web-based AR content develop-
ment application developed by the author(12) enables users to easily create AR content. However the application still requires 3D modeling skills.

Currently, no software or development environment allows for the creation of 3D AR content without 3D modeling skills or 3D object data.

2.2 Displaying objects in real-size

While 3D modeling skills remain important for the creation of AR content, some AR applications display simple 3D objects to help users determine the actual size of items.

For example, the US Postal Service features this type of application(13). It makes use of a webcam and a special marker for the system to determine suitable parcel sizes. Users can view a real-size parcel image on the special marker to ascertain the parcel size they need. Figure 1 shows the Olympus America website promoting its camera E-PL1(14). Users can access the interactive guide and observe real-size products in their web browsers. Sony Marketing Japan provides a similar kind of real-size simulation services on its website(15).

These sites utilize one or more features of marker-based AR. The relative size of overlaid objects is controllable by the size of markers. The uses of appropriately sized markers allow users to accurately control the sizes of objects.

2.3 Goals of the experimental system

The experimental system outlined below enables users to create and use AR content in their web browsers. Photographs, taken by users, are used as the primary input method for AR content. The application developed for this experimental system was designed to work in web browsers, without the need to download specialized software. The system requirements for the application are listed in Table 1. The application browser is based on an Adobe Flash plug-in used on 99% of web browsers worldwide(16). Flash Builder 4 is employed for this development. The development language is ActionScript3.

The goals of the experimental system were as follows.

(1) No required special software
(2) No required 3D software and modeling skills
(3) Must have multi-platform compatibility
(4) Must allow users to easily create real-size AR content

| Table 1. System Requirements. |
|-----------------------------|
| OS | Windows7, Windows Vista, Windows XP, Mac OS 10.4 (Intel) or later, Red Hat Enterprise Linux 5 or later, openSUSE 11 or later |
| Web browsers | Internet Explorer 6.0 and above, Mozilla Firefox 3.0 above, Google Chrome 2.0 and above, Safari 4.0 and above |
| Plug-in | Adobe Flash Player 10.2 (downloadable from website) |
| Figures | Cameras (built-in or external) |
| Others | A sheet of markers (downloadable from website) |
3. Development of the Experimental System

3.1 A sheet of markers

A printed sheet of markers is used for this system (Figure 2). This sheet is downloadable as a PDF and is designed to fit on standard A4 sized paper. On the sheet are two types of markers. The first type (Figure 3) is used for viewing AR content. Its printed size is 80 x 80 mm, and when printed on A4 sized paper, it allows the size of displayed objects to be accurately controlled.

The second type of marker (Figure 4) is “creation marker”. It is a set of markers used for creating AR content. The distance between the two markers is designed to be 100 mm. The application is able to calculate the real-size size of captured objects by making use of this information.

3.2 Specifications of Web servers

Web server software employed consists of Apache 2.0, PHP 5.2.8 and MySQL 5.0.51a.

3.3 How to create and use AR content

All programs will work on web browsers. Users can use this program as a Web application.

3.3.1 Procedure to create AR content (Figure 5)

1. Access the website and launch application.
2. Launch the user’s web camera.
3. Show objects and the creation marker to the camera (Figure 6).
4. When the creation marker is shown clearly the application captures an image in 3 seconds with sound effects.
5. Continue taking pictures (front, right, back, left, top).
6. Crop the pictures (Figure 7).
7. Enter information about objects and click upload button.

3.3.2 Procedure to use AR content

1. Access the website and choose one of the items from the object list (Figure 8).
(2) Launch the user’s web camera.
(3) Show the view markers to the camera (Figures 9 and 10)
(4) Share or embed the content as desired; address or embedding tags are available.

3.3.3 Consideration of errors in calculation

According to the test with 7 personal computers using Windows or Mac OS X, the creation marker was properly captured at the minimum distance of 147 mm and maximum of 448 mm from the camera. Accidental errors were observed depending on the marker position. In the experiment capturing a cubic object 100 mm on a side (Figure 11), the system took the length as 101.46 mm on average when the marker was placed in parallel with the surface to be captured (n=30, SD=0.28). On the other hand, it was taken as 105.87 mm on average when the creation marker was put 10 mm beyond the surface (n=30, SD=0.35). It was taken as 122.25 mm
on average when the marker was put 60 mm beyond the surface (n = 30, SD = 0.18). This result clearly shows that positioning of the creation marker affects calculation of object sizes.

3.4 Modules

The experimental system consists of two modules.

3.4.1 Creation module

This module works for capturing, calculating object size and uploading pictures. When the module recognizes the creation marker, camera images are captured in 3 seconds. The size of the captured object is calculated from information collected on the distance between the two markers in the creation marker set. In Figure 12, the size of the object (a) is calculated as (100 × 341)/(320 = 106.5625 mm).

Finally, this module uploads pictures and other information (username, object name and descriptions) into this system’s database on the Web.

3.4.2 Display module

This module shows the AR content on a web browser. It uses FLARToolKit(7). The AR content is shown when the viewing markers are captured from an application. The shape of the shown objects is a real-size rectangular parallelepiped with five textures (Figure 13). These five textures are pictures taken by the creation module. A bottom picture is not required because the bottom surface cannot be viewed in this system.

4. Results

Twenty-four individuals (ages 19 to 53, non 3D modeling specialists) participated in the test of this system on the Web. Twenty-two could successfully create AR content within 10 minutes. Seventeen said that they could create AR content easily and that they found the process enjoyable. After creating the requested AR content, fifteen enjoyed creating other AR content and nine were able to create the content quickly. Two embedded their AR content in their blogs.

5. Discussion

Suggestions made by participants pointed out the following:
(1) Lack of shape variety: Ten participants said there was a lack of variations with the shape. Many of them desired a cylindrical shape and some wanted the ability to modify shapes as they liked.

(2) Inaccuracy of calculated size: In spite of instructing how to hold the creation marker, the difficulty of holding it in a proper position affected the accuracy of the calculation. To hold the creation marker in the right position, a marker aid was suggested (Figure 14). It consists of the creation marker and a transparent plastic board. Figure 15 shows its use.

(3) Difficulty of understanding the procedure: Eight participants took pictures upside down. Almost all failed to take the top-surface one. The interface needs to be improved so that the instructions are more understandable.

(4) Difficulty of holding objects: This system requires the users to stand still for 3 seconds when taking snapshots. Seven said it was hard to keep the object still. Holding both the object and the sheet was too unstable. An exclusive smartphone application for taking pictures was suggested as an alternative (Figure 16). Retouching of the rotation function was also suggested.

(5) Time to print sheet: Four found printing the sheet of markers to be inconvenient. The use of smartphones that show markers’ images instead of the printed sheet was suggested.

6. Conclusion

An experimental system was developed and a test was made using it. The test results showed that twenty-two out of twenty-four participants could create real-size AR content without possessing 3D modeling skills.

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Akira Sano is an associate professor of Kyushu Sangyo University in Japan. He received his Master of Human Sciences degree in 1998 at Osaka University, Japan. He is a member of ACM, IEEE, AACE, JSET and JSiSE.