Estimation of Light Position for Outdoor Augmented Reality

Suhwan Kwak and Sanghyun Seo

Abstract—Many of the contents using augmented reality, which is one of the fields that have recently been spotlighted, The virtual contents in the augmented reality is achieved through the synthesis of the virtual environment composed of 3D models having own lighting with the background of the real world video. The harmonization of these two scenes is an important factor for users handling and enjoying augmented reality contents. Distortion between virtual and real world reduces the user's sense of immersion. In this study, we propose the estimation method that predicts the relative position of the sun to set the light to illuminate the virtual object and shadow. The proposed method is able to produce a more realistic augmented reality result by reducing the gap between virtual and real contents.

Research Keywords— Augmented Reality, Outdoor Illumination, Light Position

1 INTRODUCTION

Augmented reality is one of the hottest issues these days. Particularly, the appearance of Pokemon GO, a location based outdoor augmented reality game, played a big role in informing the world of augmented reality technology.

Augmented Reality is a field of virtual reality [1]. It is a CG technology that synthesizes virtual contents or information in real space and makes it look like objects in the original environment. It is possible to apply not only game but also various fields such as education, medical, marketing, etc. which can give a great visual effect to participants because it enhances the effect of reality unlike virtual reality which assumes a complete virtual world. The augmented reality allows the user to feel the virtual object matched to the actual space as if it is located at the actual position, allowing the user to immerse in the content [2]. However, the problem in the augmented reality is that there is a sense of divergence between the real world and the virtual object [3, 4].

We defined the Harmonic Rendering keyword which means rendering technology for minimizing the distinction between actual and virtual image that occurs when a moving image input from a camera and a three-dimensional image generated by a computer are composed in augmented reality system. Figure 1 is a conceptual diagram of harmonic rendering for image matching of augmented reality.

Fig. 1. A conceptual diagram of harmonic rendering

In this paper, we propose a method to reduce the gap between real background and virtual contents in augmented reality by determining the virtual location of illumination in Unity3D game engine in outdoor. For this, we calculate the position of real sun considering the time and GPS location in Earth coordinates system and covert real position of sun to virtual object coordinate that can be used in game engine.

2 ESTIMATION OF LIGHT POSITION FROM SUN

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2.1 Calculation of Sun Position

Since the position of the sun depends on the earth's coordinates and time, it is expressed using the geographical coordinate system at the current location shown in Figure 2. The horizon coordinates are the coordinate system with the horizon as the baseline and the north as the reference point. The position of a celestial body can be expressed in terms of altitude and azimuth. The altitude is represented by an angle measured vertically from the horizon to the celestial body, and the azimuth is represented by a clockwise angle from the reference point to the vertical intersection between the celestial body and the horizontal plane. Horizontal plane coordinates are convenient because they can intuitively identify the direction in which the object is located. In this study, the relative position of the sun is represented by the azimuth and elevation using the horizon coordinates.

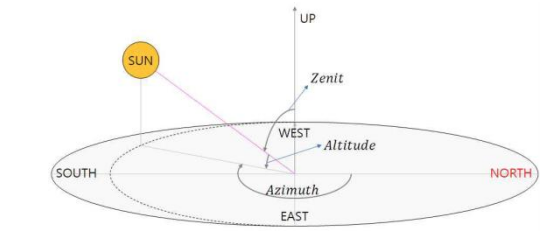

Fig 2. Relationship between azimuth and altitude of the sun

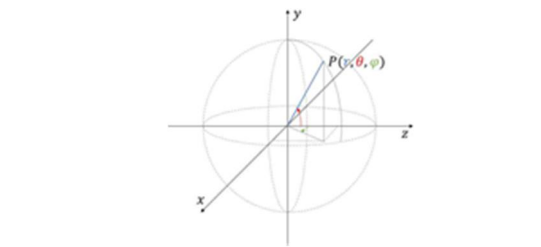

Fig 3. Sphere coordinates P on the spatial coordinate system

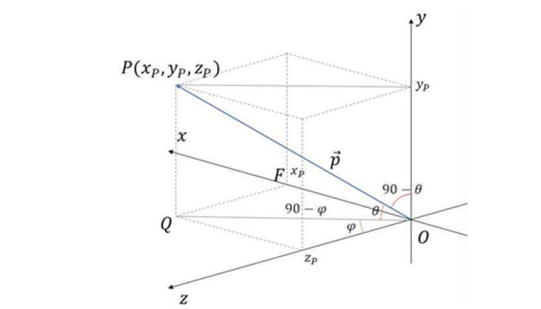

Fig. 4. Transformation Spherical Coordinates to Spatial Coordinates

2.2 Transformation of Coordinate System

In this study, we take the radius from the user and convert the sun coordinates, which are spherical coordinates, into the unity coordinates. Figure 3 shows the spherical coordinate P on the spatial coordinate system. Since Unity uses the left-handed coordinate system, the + z direction is set to the north-right direction as shown in Figure 3.

Figure 4 shows the transformation of coordinate systems.

The length of $\overline{OP}$ is r and the azimuth and elevation are expressed as ϕ and θ respectively. Transformed $P(x_p, y_p, z_p)$ can be calculated as follow equations.

$$x_p = \overline{OQ}\sin\phi = r\cos\theta\sin\phi,$$
$$y_p = r\sin\theta,$$
$$z_p = \overline{OQ}\cos\phi = r\cos\theta\cos\phi$$

3 Result and Conclusion

We developed the proposed method using C# script for Unity3D. We wrote the script in Unity, and the test program was built and tested with the Android OS. The smartphone used in the study is IM-890S (Vega Secret Note) and Android version is 4.4.2 (Kit Kat). To compare shadows with virtual

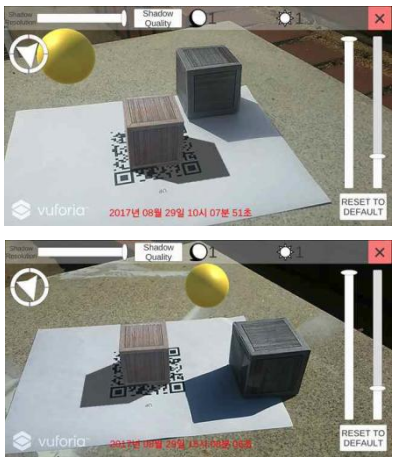

Fig. 5. Transformation Spherical Coordinates to Spatial Coordinates

contents, we tested at the same location (37.38 ° N, 126.93 ° E) with different times.

As shown in Figure 5, we intuitively recognize the direction of current sun by expressing the relative position of the real sun (yellow spheres at the top of the screen). It can be confirmed that the directions and shadow lengths of the actual object (right box) and the virtual contents (left box) are the same.

In this study, the position of the light was de-

termined by calculating the relative position of the sun based on the user GPS location and gyroscope sensor installed in smart phone. Applying caculated information to the Unity engine, I created shadows from virtual objects. Our approach reduces the gap between the real background and the virtual objects, thereby inducing the user to be more immersed in the augmented reality contents.

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