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An Efficient Method of Scanning and Tracking for AR

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Abstract

In this paper, we propose an efficient method for AR toolkit Vuforia. In order to increase the scan rate when using the 3D object scanner, the scan rate parameters need to be analyzed in terms of the angle and distance. In addition, in order to increase the tracking rate when tracking an object, the tracking rate has to be evaluated according to the position, complexity, and contrast of the object. To this end, we have defined the difference of scan rate according to angle and distance between camera and object when using object scanner and the recognition time according to object's position, complexity and contrast when tracking object.

Keywords: *Augment Reality, Vuforia, Object Scanning, Object Tracking*

1. INTRODUCTION

Augmented reality is a computer graphics technique and interactive experience that synthesizes virtual objects or information in a real world environment and makes them look like objects in the original environment. Augmented reality changes the perception of the real environment, while virtual reality completely replaces the user's real environment [1-4].

Vuforia is one of the representative platforms for producing AR content. Vuforia has the advantage of tracking the target efficiently even in low light and providing extended tracking so that the app can keep track of the target [5]. In addition, the Vuforia can recognize and track not only 2D images but also 3D objects. The Vuforia object scanner scans 3D objects and converts them into a format that can be used by the view engine. Registering it with the Target Manger, a Vuforia web application, allows you to create and use a database of targets. You can apply the generated database to Unity to track the objects. However, there is no method to use the Object Scanner efficiently. For image scanning, effectiveness studies have been only founded [6]. In addition, very little research has been done on the effectiveness of scanning objects and tracking images afterwards. Therefore, we propose a guideline which can improves efficiency of scanning and tracking through experiments with the parameters such as position, complexity, and contrast for tracking and scanning angle, distance for scanning. The contribution of this study is to present a guideline on how to effectively scan and track objects using the 3D Object Scanner provided by Vuforia, an augmented reality development platform.

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2. 3D OBJECT SCAN

Before scanning an object, we need to configure the scanning environment presented in the 'Vuforia Object Scanner User Guide' of the Vuforia Developer Library [7]. It is recommended to use proper lighting conditions and turntables and to rotate the objects. The gray background paper to minimize the interference could be made by attaching colored paper on the hard board to prevent shadows as shown in Figure 1.

The object scanner wraps the object in a dome divided into four floors. 1st to 3rd floors are divided into 16 areas and 4th floors are divided into one area. As shown in Figure 1, we designed the angle and distance of the smartphone camera which are the parameters of the experiment for scanning.

The angle was set by ± 5 ° from the center angle of each floor. Since the distance is based on the table play, the minimum distance was set to 15 ~ 35cm, and the interval was 5cm. Then we rotate the object 360 ° onto the azimuth at this angle and distance. We have carried out three experiments repeatedly with minicar and panda models to ensure accuracy.

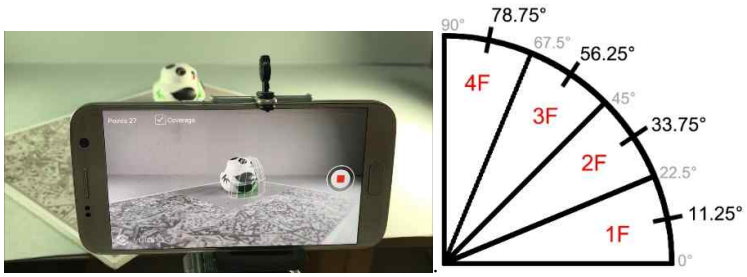

Figure 1: Example of Object Scanning and angle for each floor

Experiments and Discussion for Scanning

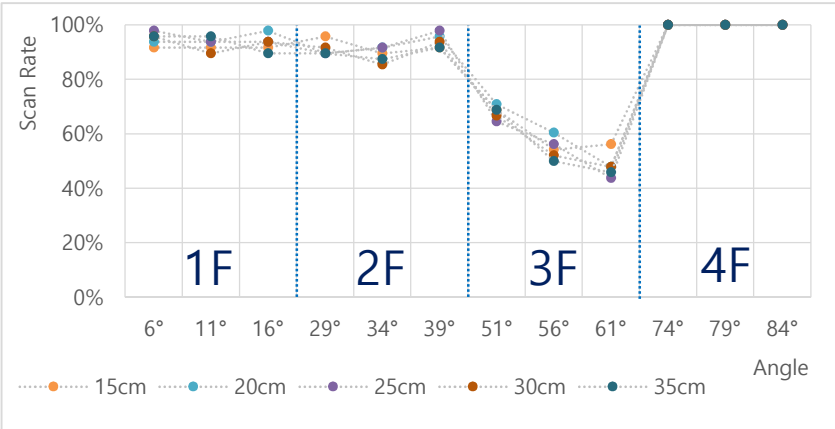

Figure 2: Scanning results of Minicar

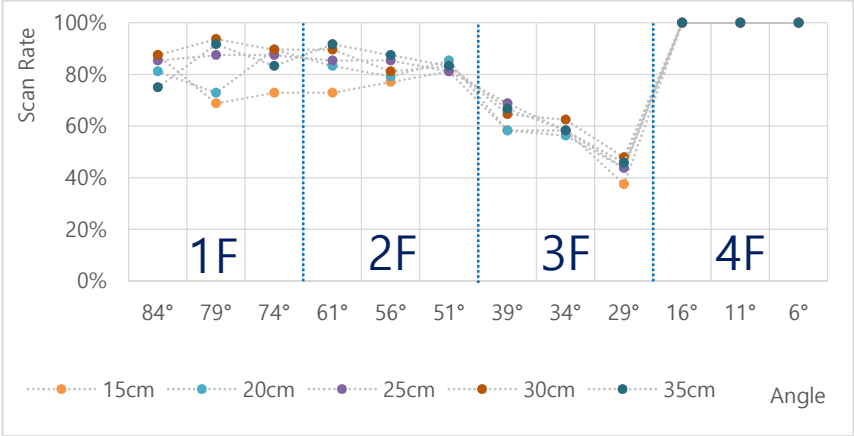

Figure 3: Scanning results of Panda

3. 3D OBJECT TRACKING

Prior to tracking 3D objects, we defined two features such as Complexity and Contrast that associate with each object. Complexity is the number of points in the object scanner (for example, object 1: 278, object 2: 232, object 3: 504). Object contrast was calculated using OpenCV (object 1: 0.87, object 2: 0.97, object 3: 0.98) shown in Figure 4 (left).

Figure 4: The left side is the objects 1, 2, and 3 used in the experiment in order. The right side displays the window number to divide the screen for tracking

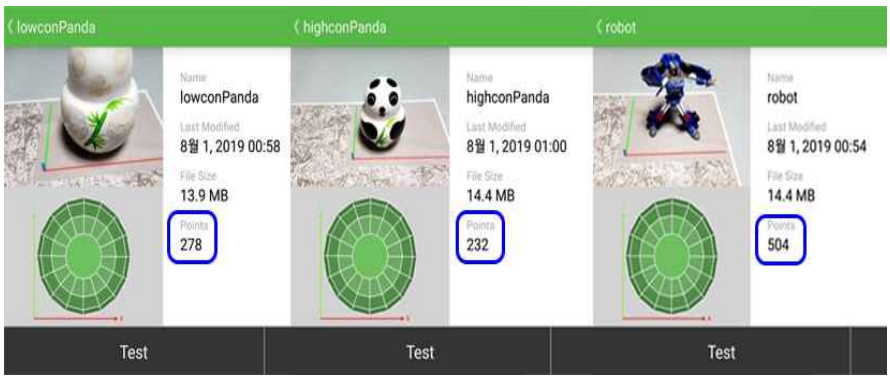

Figure 5: Object Complexity: 278, 232 and 504 from the left

As shown in Figure 4 (right), the main parameter of the experiment is the window located on the screen. It is divided by object window. We repeat three times with the window to measure the time in second it took for the object to be tracked. Figure 5 shows object complexity as well.

The main parameter of the experiment is the window on the screen. We show Figure 4 (right) for the assigned window numbers. Combinations of windows that allocate two spaces are (1, 2), (2, 3), (4, 5), (5, 6), (7, 8), (8, 9), (1, 4), (2, 5), (3, 6), (4, 7), (5, 8), (6, 9), and the four space assignment is (1, 2, 4, 5), (2, 3, 5) , 6), (4, 5, 7, 8), (5, 6, 8, 9), and the six-space assignment is (1, 2, 3, 4, 5, 6), (4, 5, 6, 7, 8, 9), 9-space allocation is (1, 2, 3, 4, 5, 6, 7, 8, 9). We have carried out three times repeatedly to record the time in second it took from the time the project began to the time the object was tracked.

Experiment and Discussion for Tracking

The experimental results are shown in Tables 1 and 2. The only exception is windows that do not track in Objects 1 and 2. In addition, object 3 was not tracked and was excluded.

Table 1: Results of Object 1

Window Count	Number of window	1st (sec.)	2nd (sec.)	3rd (sec.)	Mean (sec.)	Mean of windows (sec.)
Two windows	(1, 2)	8.45	8.55	7.75	8.25	5.98
	(2, 3)	2.83	15.27	1.41	6.50	
	(4, 5)	14.05	6.51	2.22	7.59	
	(5, 6)	0.96	2.65	8.42	4.01	
	(7, 8)	2.38	8.36	6.11	5.62	
	(8, 9)	3.30	4.94	3.48	3.91	
Four Windows	(1, 2, 4, 5)	4.61	3.22	10.88	6.24	3.76
	(2, 3, 5, 6)	7.64	6.94	3.56	6.05	
	(4, 5, 7, 8)	2.85	1.15	0.94	1.65	
	(5, 6, 8, 9)	0.98	1.04	1.28	1.10	
Six Windows	(1, 2, 3, 4, 5, 6)	0.85	0.89	0.98	0.91	0.99
	(4, 5, 6, 7, 8, 9)	1.01	1.33	0.88	1.07	
Nine Windows	(1, 2, 3, 4, 5, 6, 7, 8, 9)	2.62	2.36	2.08	2.35	2.35
Grand mean		4.25				

Table 2: Results of Object 2

Window Count	Number of window	1st (sec.)	2nd (sec.)	3rd (sec.)	Mean (sec.)	Mean of windows (sec.)
Two windows	(1, 2)	2.95	3.25	2.87	3.02	2.33
	(2, 3)	0.97	1.42	2.76	1.72	
	(4, 5)	1.05	3.24	0.98	1.76	
	(5, 6)	1.02	1.26	0.99	1.09	
	(7, 8)	1.95	1.96	5.62	3.18	
	(8, 9)	6.71	1.02	1.86	3.19	
Four windows	(1, 2, 4, 5)	1.40	3.22	6.95	3.85	1.76
	(2, 3, 5, 6)	0.92	0.98	1.00	0.97	
	(4, 5, 7, 8)	0.98	1.75	0.95	1.22	

	(5, 6, 8, 9)	0.96	1.07	0.95	0.99	
Six windows	(1, 2, 3, 4, 5, 6)	1.40	1.29	1.02	1.24	1.10
	(4, 5, 6, 7, 8, 9)	0.98	1.02	0.92	0.97	
Nine windows	(1, 2, 3, 4, 5, 6, 7, 8, 9)	2.42	1.52	1.60	1.85	1.85
Grand mean		1.93				

As a result of the experiment, it was confirmed that when the overall average is compared, the time of the high contrast object 2 takes less time. As shown in Figure 6, on the other hand, we find that when the number of windows that are commonly allocated to objects 1 and 2 is six, an average time is the least. As a result, objects with high complexity should be avoided and objects with high contrast should be selected for fast tracking of objects. It's also a good idea to occupy about half of your cam's screen (six windows allocated) not too far or too close when tracking.

In short The contribution of this study is to propose a guideline on how to effectively scan and track objects using the 3D Object Scanner provided by Vuforia, an augmented reality development platform.

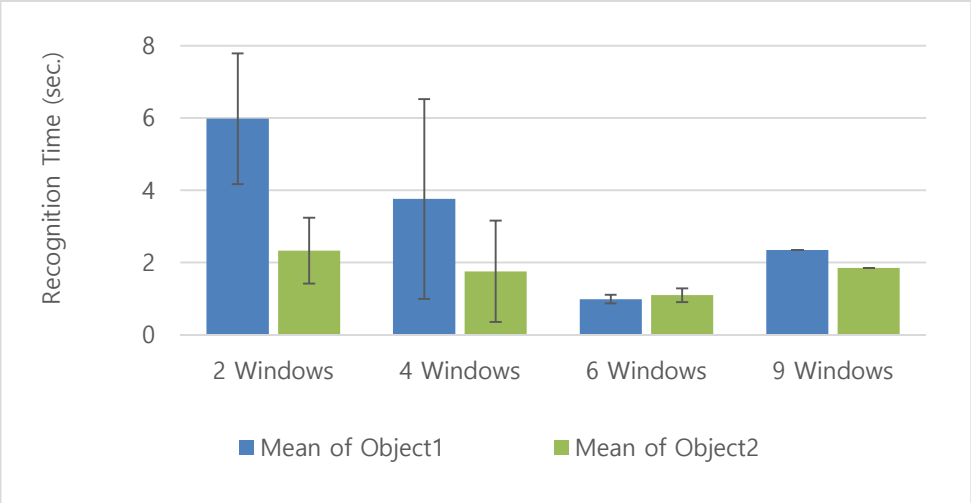

Figure 6: Tracking time according to the number of assigned windows of objects 1 and 2

4. CONCLUSION

In the process of implementing 3D objects in augmented reality, stability and naturalness are inevitable for developers. In this study, we proposed guidelines through experiments on how to effectively scan objects using the 3D Object Scanner provided by Vuforia, an augmented reality development platform. We also mentioned the factors that can cause faults when scanning. In addition, we proposed through experiments what objects should be selected to improve tracking efficiency even when tracking objects within a project.

This study is meaningful to suggest efficient scanning and tracking methods for augmented reality content developers using 3D object recognition

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