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Development of Cultural Contents using Auger Reality Based Markerless Tracking

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Abstract

This paper aims to improve the quality of cultural experience by providing a three - dimensional guide service that enables users to experience themselves without additional guides and cultural commentators using the latest mobile IT technology to enhance understanding of cultural heritage. In this paper, we propose a method of constructing cultural contents based on location information such as user / cultural heritage using markerless tracking based augmented reality and GPS. We use marker detection technology and markerless tracking technology to recognize smart augmented reality object accurately and accurate recognition according to the state of cultural heritage, and also use Android 's Google map to locate the user. The purpose of this paper is to produce content for introducing cultural heritage using GPS and augmented reality based on Android. It can be used in combination with various objects beyond the limitation of existing augmented reality contents.

Key words: *Augmented Reality, GPS, SmartPhone, Markerless Tracking, Marker*

1. Introduction

Currently, various applications coming out of smartphones are on the market, and augmented reality and location-based service applications are attracting user's interest. These applications are becoming more and more concentrated on display devices as the smartphone evolves, and augmented reality and location information system technology, which had not been used before, appeared as contents optimized for the smartphone environment.[2] In particular, augmented reality has been used in various genres such as location information, mobile contents, and games, and has been called another name, Mixed Reality, by inserting virtual objects in the real world[3]. It is necessary to be able to combine images of real-world elements with imaginary images in a condition of contents using augmented reality and to be able to interact in real time and be placed in

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a three-dimensional space[1]. The elemental technologies of augmented reality include Marker Detection Technology, Marker Registration, Tracking, 3D Object Rendering, and the like. Of these technologies, Marker Detection Technology or Markerless Tracking Technology is one of the most fundamental technologies in augmented reality.[4] Marker Detection Technology, which is one of these augmented reality technologies, is a technique of recognizing a square marker serving as a reference coordinate and using the marker as a reference point. Markerless Tracking Technology is a feature point- It is also called feature based tracking, which extracts feature points from an image and extracts a coordinate system based on these feature points. These technologies are considered to be the most difficult and increasingly important technologies in augmented reality technology used to develop cultural heritage contents. The purpose of this paper is to develop contents for introducing cultural heritage in order to enhance understanding of our cultural heritage by providing a three-dimensional cultural heritage guidance service using the latest IT technology based on mobile and without a commentary or guide. Also, we propose a method of making contents according to user 's location information using augmented reality and GPS.

2. Related Research

2.1 Android based augmented reality technique

Key technologies required for realizing augmented reality include Tracking, Interaction, Calibration, & Registration, Display, Evaluation / Testing, AR authoring, Visualization, Rednering. Figure 1 shows the architecture of the AR system.

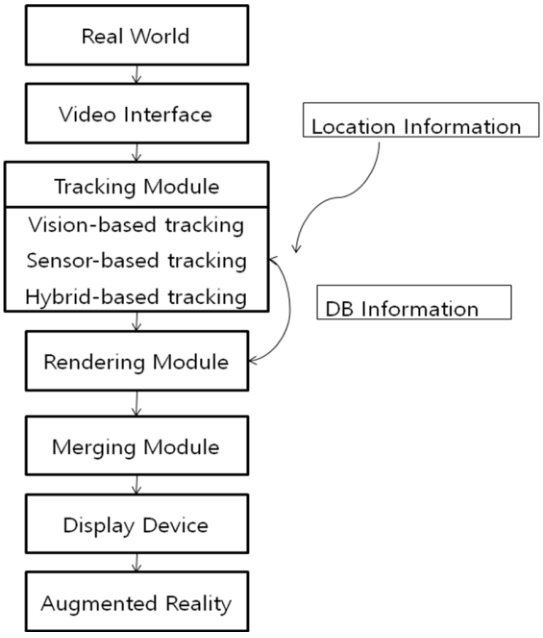

Figure 1. Configuration diagram of general AR system

As shown in Figure 1, the AR system transmits the captured image through the Video Interface to the Tracking Module by tracking the position, movement, and speed direction of the transmitted image through the Video Interface. The next step, the Rendering module, creates an enhanced image by creating or removing virtual objects based on the location identified through the Tracking module. Then, the distance

between the virtual shapes generated through the Merging module, the distance and direction between the generated coordinate systems is measured, and AR is displayed through the display by confirming the interference between virtual shapes. Tracking module can be divided into Vision-based tracking and Sensor-based tracking. Vision-based technology can be divided into marker based and non-marker based [5].

2.1.1 GPS (Global positioning system)

GPS (Global Positioning System) is a satellite navigation system, which is a technique used to determine whether a user's content position is reached by measuring real-time positions of users and real coordinates of users and real-time coordinates of contents. Locate the satellite using satellites and determine latitude, longitude, and altitude. The GPS position of the smartphone is observed using a real-time dynamic observation method. [6] GPS, however, is subject to errors due to satellite position, clock, or atmospheric conditions during the data measurement process. GPS errors are corrected as in the geometric position error calculation equation (1).

$$\text{기하학적 } DOP\text{: } GDOP=\frac{\sqrt{(\sigma_\phi^2+\sigma_\lambda^2+\sigma_h^2+c^2\sigma_{\delta t}^2)}}{\sigma_0}$$

$$\text{위치 } DOP\text{: } PDOP=\frac{\sqrt{(\sigma_\phi^2+\sigma_\lambda^2+\sigma_h^2)}}{\sigma_0}$$

$$\text{평면위치 } DOP\text{: } HDOP=\frac{\sqrt{(\sigma_\phi^2+\sigma_\lambda^2)}}{\sigma_0}$$

$$\text{수직위치 } DOP\text{: } VDOP=\frac{\sigma_h^2}{\sigma_0}$$

$$\text{시간 } DOP\text{: } TDOP=\frac{\sigma_{\delta t}^2}{\sigma_0}$$

(ϕ : 측점의 위도, λ : 경도, h : 탄원체상의 높이,
c : 진공중에서의 빛의 속도
$\sigma_\phi, \sigma_\lambda, \sigma_h$: ϕ, λ, h의 표준편차,
$\sigma_{\delta t}$: 수신기의 시계오차에 대한 표준편차
σ_0 : 거리에 대한 기준표준편차)

(1) Geometric position error calculation

2.1.2 Marker-based Augmented Reality

The method of recognizing the real space of the augmented reality technique exists in various ways such as marker detection, marker matching, tracking, 3D object rendering, and the like. These recognition methods are typically divided into marker detection techniques and markerless tracking techniques. The marker detection technique is a technique for realizing augmented reality by recognizing based on a marker having a regular pattern such as a QR code (Quick Response code). The recognition rate is very high because it uses the object made of the specific pattern, but it has a disadvantage that it can not be used for the object other than the pattern.

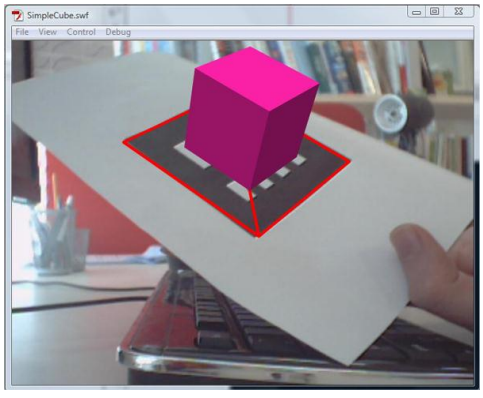

Figure 2. Marker-based Augmented Reality

2.1.3 Markerless tracking technique

Unlike the marker detection technique, the markerless tracking technique implements an augmented reality by using the data of the target itself rather than a special pattern. Object recognition is realized by image form, object form, and so on to realize augmented reality. There is no limit to the range of the object to be recognized, so it is a suitable technology for the recognition of cultural heritage. It is used for event occurrence when the content is reached. When the content position is reached, it is converted to an augmented reality screen.

Figure 3. Markerless Augmented Reality

In this paper, the markerless tracking method is used as a basis for self-recognition of cultural heritage. However, if the cultural heritage is huge or has a large area, or if it is damaged and can not be recognized as an image, then marker detection technology is used to recognize cultural heritage do.

3. Results

In this paper, we implement augmented reality contents production method based on cultural heritage based on user 's location and cultural heritage location information using augmented reality and GPS. Figure 4 shows the proposed content creation process.

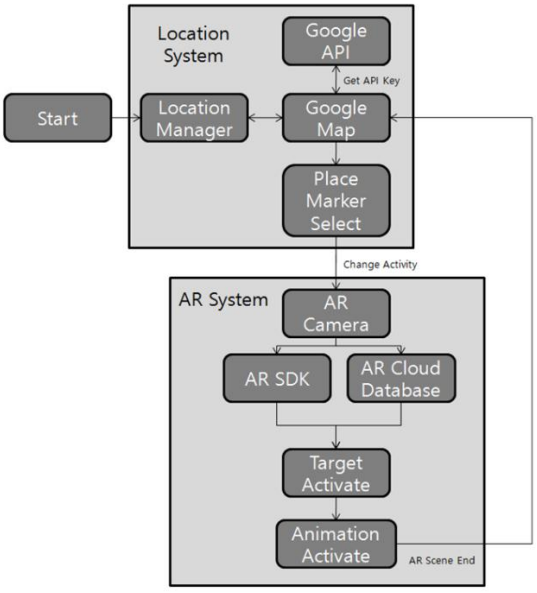

Figure 4. Proposed content creation process

3.1 Implementing coordinates using GPS

Use Android's LocationManager to get position coordinates from GPS or Network information in Android OS. The location coordinates are received as longitude, latitude, and altitude. In this paper, all values are used to locate cultural heritage. To use the LocationManager on Android, you need to get the ACCESS_COARSE_LOCATION and ACCESS_FINE_LOCATION permissions. Figure 5 shows the process of obtaining the corresponding rights.

```
<uses-permission android:name="com.google.android.providers.gsf.permission.READ_GSERVICES" />
<uses-permission android:name="android.permission.INTERNET" />
<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE" />
<uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
<uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
<uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
<uses-feature
    android:glEsVersion="0x00020000"
    android:required="true" />
```

Figure 5. Android Authorization

In addition to the authority to use the GPS, the additional authority to use the Internet and data storage. After the permission acquisition is completed, the location information of the user is periodically read when the application is executed. In order to find out the most accurate location, the process of sorting is repeated and the acquisition of location information is stopped. Figure 6 shows the timeline of user location information collection in LocationManager [5].

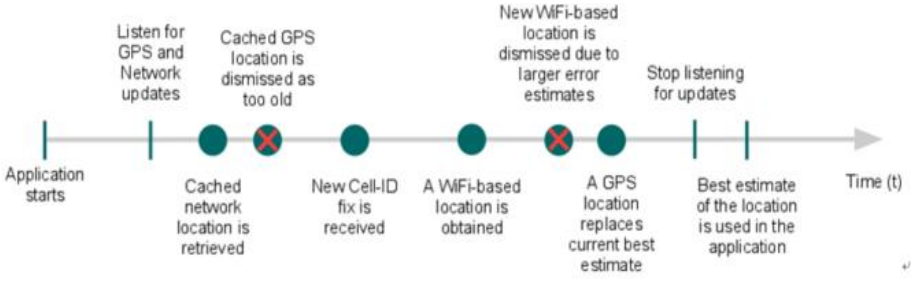

Figure 6. Location information reception timeline

Using this timeline, GPS, network information update, network-based location information acquisition, old GPS location information deletion and error value modification procedure are measured and the corrected latitude, longitude, altitude and speed are measured as shown in Fig. 7 .

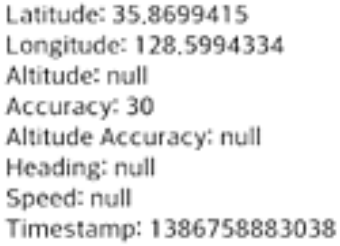

Figure 7. Location information reception timeline

3.2 Map implementation

Use the map to display the real-time location and content location to the user. Although various APIs are

provided to display the map, this paper uses Google Maps, which is installed in Android smartphone, to omit the installation of additional plugins. In order to acquire the qualification for Google Maps, we acquire the Google API key. We use keystore by using Android studio as shown in Fig 8.

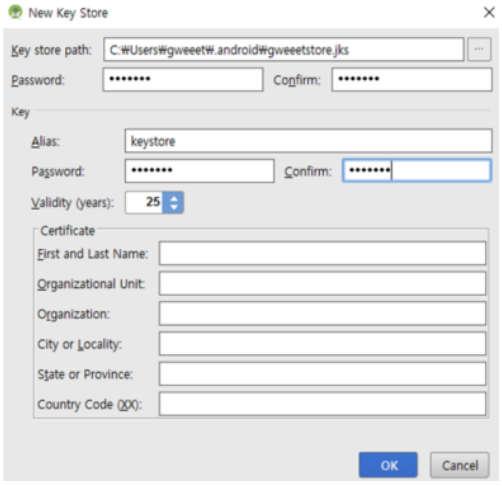

Figure 8. Keystore Issued

After obtaining the API key using the generated keystore, the user is entitled to use Google Maps in the Google developer portal in Fig 9.

Figure 9 Qualify for Google Maps

Then, the user's position is displayed on the map in real time, and the position of the contents is displayed as shown in Fig. 10 using markers.

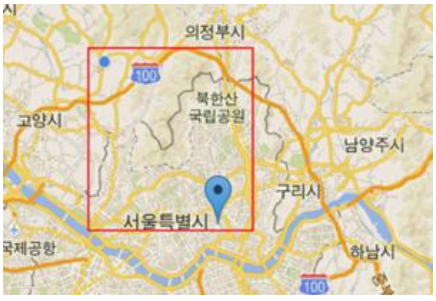

Figure 10. Show Google Map marker

3.2 AR implementation

3.2.1 Extracting feature points and applying markers

It is a process of extracting feature points for use of markerless tracking technology and is used to recognize the own form of cultural heritage. Feature points are extracted using Vuforia AR SDK in Fig 11.

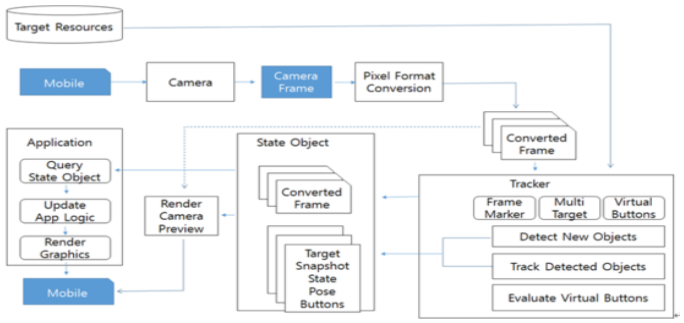

Figure 11. Vuforia AR SDK

The method of extracting feature points is divided into two methods; extraction of image form and method of using object scan. The image type extraction is used to store the image of the object in the form of an image, and is mainly used for plate form such as a main plate. In addition, when the entire structure of an object is required, the object is scanned using Vuforia's Object Scanner, and the feature point is extracted [9]. In order to use the extracted feature points, the shape of the recognition target uses four types such as an image, a cube, a cylinder, and an object. Every method except the object recognition object recognizes the characteristics of the image. The characteristics of the image are judged by the color change and the contrast difference as shown in Figure 12.

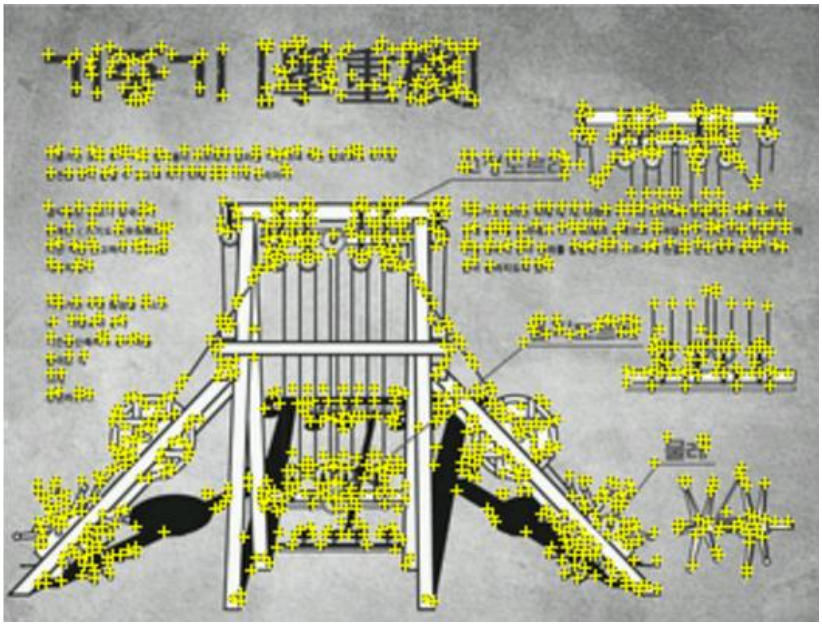

Figure 12. Multiple feature points image

Object Scan also recognizes an object based on the lightness and color change of the object. The base of the recognition uses the marker image specified by Vuforia, and the object is placed on the top, and the scan is performed by rotating 360 degrees. At this time, the scan area is designated as shown in Fig. 13, and the front and back of the object can be recognized using this scan area. Immediately after recognizing the object of the smartphone, the search and correction of the placement object proceeds, and frame adjustment and graphic correction are performed. After that, the scan data is stored and retrieved when the corresponding content area is selected on the map.

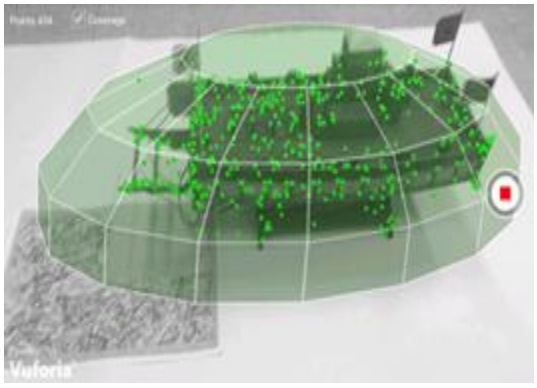

Figure 13. Object Scan

3.2.2 Establishment of marker recognition basis

If you can not use the markerless tracking technique, make markers for cultural heritage. The unique QR code of cultural heritage is produced and attached to cultural heritage. Then, using the Vuforia SDK, the marker data is extracted by processing the marker image as shown in Fig 14. In contrast to the markerless tracking method, the marker recognition based technique has a merit in that it can not extract feature points because the color change lines and contrast differences are distinct [8].

Figure 14. QR code Feature Point extraction

3.2.3 Augmented Reality Implementation

As a process of implementing contents for each cultural heritage, 3D content suitable for the cultural heritage is implemented in the virtual space, and the placement is performed. After that, extracted feature point data and marker data are applied to virtual space so that Vuforia SDK can be used. After that, when the object is recognized by the actual camera, the object is searched for the object to be recognized, the frame is corrected, and the frame is corrected. Then, the virtual space overlaps the object and the animation is explained to explain the cultural heritage as shown in Fig 15.

Figure 15. Cultural Heritage Description Augmentation Reality Animation

4. Formatting your paper

Recently, the issue of contents industry has been changing from realistic contents to PC or Internet contents, and it is becoming more and more realistic and interacting with real world. Screen sports, virtual simulation, etc. Is experiencing a tendency to be activated. Although various virtual reality contents are being released for the purpose of activating experiential business contents, there is a limitation that the scope of contents implementation is limited within the virtual reality. In this paper, we propose a method of constructing an augmented reality contents for cultural heritage based on user 's location and cultural heritage location information using augmented reality and GPS to widen the content range. Using the proposed augmented reality, the explanation of cultural heritage became more effective. In the future, we intend to lay the foundations for expanding the augmented reality contents field. Future challenges include developing augmented reality content that incorporates a variety of technologies.

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