

# Automatization of Augmented Reality Creation Process Using Unity and Vuforia

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*This work is devoted to the automatization of users' own AR objects (Augmented Reality - AR) creating process. The paper presents an application that, thanks to the described methodology, can significantly simplify and speed up the process of creating augmented reality. A comparison of methodologies is presented, a comparison of their effectiveness and accessibility for users without technical skills.*

**Keywords:** augmented reality, AR, Unity, Vuforia.

**Introductory part.** Over the past argument years, the demand for AR-applications has grown almost 4 times, but at the moment in the market of AR-products, it is difficult to find a solution that would allow users to add their markers and add their content. Today in the world there are many tools to create augmented reality. Libraries for creating AR-applications for mobile devices, such as Vuforia, Wikitude, ARcore, ARKit, and others, allow you to load 2D images and simple 3D objects of the real world, which later become “markers” - the source of AR. They simplify the integration of AR into applications, thereby bringing augmented reality to the masses of users. However, the creation of applications on their base requires developer skills, and the software solutions themselves become tied to a specific subject area. The need to solve these problems with the desire to propagate AR technology enhances the relevance of the paper.

**Main part.** The work of the AR mechanism can be described by the Model-Process scheme. We represent the model and the process as sets of arguments Model <Marker Content>; Process <Detecting, Descriptive, Matching>;

The key argument of the AR model is a marker. To search for markers, algorithms are used that search and compare images by key points. A key point is a specific part of a picture that is a feature of a given image. What exactly is taken for this point - directly depends on the algorithm used. In our work, key points are represented in the sets of their coordinates <x, y, z>.

The content may be a 2D image, a 3D model, audio, video, and text information.

The process, in turn, consists of the following arguments:

- feature detector (searches for key points in the image);
- descriptor extractor (produces a description of the found key points, evaluating their position through a description of the surrounding areas);
- matcher – (carries out the construction of correspondences between two sets of points).

The steps that make up the standard process of creating a reality supplement using Vuforia, Wikitude and other SDKs:

- 1) Download the Integrated Development Environment (IDE), for example, Unity3D or Android Studio;
- 2) Establishment of an augmented reality library (SDK), for example, Vuforia;
- 3) Registration of a license key on the official website of the SDK;
- 4) Adding markers to the database on the official website of the SDK;
- 5) Adding markers to the development environment and binding of the content of AR content;

In our work, we propose the following process, as a result of which we have explicit applications for the automated creation of AR:

- 1) Development of UI for interaction with a database of markers via specific API (when created, the photo is automatically uploaded to the storage of all markers)

2) Development of UI for selecting and adjusting the content of the augmented reality that uses API for automatic binding of it to created marker;  
completing the presented tasks to create an application, following the next steps required from a user to create own AR:

- 1) Downloading the application to a mobile device;
- 2) Creating a photo (AR marker), setting content and saving the result;

During the work, the following stages were completed:

- 1) Development of technical requirements:

The main goal of this work was to create an application that can significantly reduce the complexity level of creating augmented reality by users without development skills and thereby increase the number of active users of AR technology.

The application should have had a convenient user interface for creating and configuring AR objects, the ability to select ready-made content, as well as add your own. As AR content, images, video, audio, text, and graphic (hand-drawn by the user) information should be available.

A methodology was developed, the main advantage of which was a system for automatically connecting of application to a database and Vuforia when creating AR markers and imposing user content on them - automation of the developer's manual actions to the algorithm.

- 2) UI / UX Design:

A minimalistic graphical user interface was developed, which allows you to conveniently create and supplement markers with content.

The main window of the application is a phone's camera, a button for creating a photo, as well as a scale of potential marker's quality (Fig. 1).



*Fig. 1. UI to take a picture and create an AR marker*

After creating a photo, the user will see buttons for selecting content with which he can supplement his marker, a button for adding his materials from the phone's file system and a button for saving the result - sending it to the database, after which all users will be able to see their augmented reality when hovering over created marker (Picture 2).



*Fig. 2. Marker augmentation UI*

- 3) Development:

During the work on the project, we got the opportunity to put into practice several AR-frameworks, popular among mobile developers. However, the final decision was the choice of a combination of Vuforia SDK and Unity game engine, the choice of which was made due to the versatility of the Vuforia framework, the availability of the functionality we need, high stability of marker recognition, ease of use, as well as rich documentation, high popularity as well as highest scores in most popular SDK comparison (Table 1). Unity is also an official partner of Vuforia and provides a convenient interface for working with it, which makes this combination the most successful.

Table 1. Comparison table of SDK characteristics

	Vuforia	Wikitude	ARcore	ARKit	MaxST	DeepAR	EasyAR	Xzimg	ARToolKit
Max capture distance (m)	1.2 - 3.7	2.4 - 5	1.0 - 3	1.5 - 5	0.5 - 0.9	0.7 - 5	0.9 - 2.7	0.5 - 1	3 - 3
Recognition stability of an immovable marker (10 – max)	10	6	9	9	7	8	7	4	8
Mobile marker recognition stability	6	6	6	7	2	7	3	3	6
Minimum recognition angle	30	10	50	30	50	35	35	45	10
Minimum Visibility for Overlapped Marker Recognition	20%	100%	75%	50%	50%	10%	10%	25%	100%
2D recognition	✓	✓	✓	✓	✓	✓	✓	✓	✓
3D recognition	✓	✓	✓	✓	✓	–	–	✓	–
Geo-location	–	✓	✓	✓	–	–	–	–	–
Cloud Token Recognition	✓	✓	✓	✓	–	–	–	–	–
SLAM	✓	✓	✓	✓	✓	–	–	–	–
Limit the use of the free version	1000 markers, 1000 cloud recognition Per Month	No cloud recognition	–	–	10 markers	–	–	–	–
Total (rating)	<b>8.0</b>	<b>7.9</b>	<b>7.8</b>	<b>7.6</b>	<b>5.5</b>	<b>5.0</b>	<b>4.7</b>	<b>3.4</b>	<b>3.1</b>

To store markers and user materials, MongoDB, a document-oriented database management system was used in the work. The reason for choosing this database was its compatibility with Unity and C#, as well as ease of use and maintenance of the functions necessary for development, namely, image storage.

All program scripts were written in the C# programming language in the VisualStudio development environment. First of all, a Vuforia account was created, a free license key was taken, and a cloud target database was created.

In addition to the main the graphical interface of the program, REST API was created to post and get data to/from MongoDB and Vuforia Cloud using the HTTP protocol. Function was created to add custom content, as well as prepared libraries of ready to use materials to supplement markers.

4) Testing and documentation:

Successful tests of the program were carried out and a user manual was created, which describes the algorithm for using the program.

To create augmented reality in our application, a person needs

- download and install it,
- create a photo, which then goes to the database of all markers;
- choose the available materials or add your own to place them on the marker in any way you want;
- click on the save button, after which the result of the work will be sent to the database and other users will be able to see it when the application camera hovers over this marker.

5) Comparative analysis of the processes of Augmented Reality creating:

Table 2 shows the steps and phase time calculations of the standard process of AR -applications development using Vuforia by a regular user.

*Table 2 - Steps in the standard AR creation process using Vuforia*

№	Stage	Time
1	creating a vuforia account and obtaining a license key	5 to 7 minutes
2	learning how to work with unity 3d	> 30 minutes
3	learning how to work with the Vuforia plugin in Unity3D	> 30 minutes
4	download and import Vuforia in Unity3D	> 5 minutes
5	creating a project inside the development environment for future work	5 to 15 minutes
6	creating marker images	5 to 15 minutes
7	upload marker images to the Vuforia website	5 to 15 minutes
8	import and attachment of marker libraries to Unity	5 to 15 minutes
9	building and running an application on a mobile device	5 to 15 minutes
10	spare time for possible errors during development	0 to 60 minutes
Final result:		> 2 hours

Table 3 summarizes the steps involved in the creation of AR using our application.

*Table 3 - The process of creating an AR using our application.*

№	Stage	Time
1	installation and start of the application	1 to 2 minutes
2	pointing the camera and creating a photo that will automatically become a Vuforia marker and will be loaded into the database	< 1 minutes
3	customization of your marker - selection and placement of content using a convenient interface	< 2 minutes
4	pressing the save button - sending the finished work to the server, whereupon other users will be able to see it	instantly
Final result:		4-5 minutes

As a result of the comparison, we can conclude that a person with no development experience will need more than 2 hours to create an AR. For a person with experience in Unity3D and Vuforia, the process from scratch will take about 30 minutes. However, using our app the whole process takes no more than 4-5 minutes and less than 1-2 minutes with the already installed application.



*Fig. 1. An example of using the application*

**Conclusions.** Owing to simplification and acceleration of augmented reality creation our project can be applied in all spheres of human activity - both for fun and in professional activities (in the sphere of culture, marketing, charity, in the offices of companies, etc.), which will promote the technology of computer vision through it's use by people without any development experience.

As future plans of this application were highlighted:

- expanding the choice of content that can be used for AR, as well as allowing the user to add his own materials ;
- adding the ability to create mini-databases for users;
- ensuring censorship of user-generated content;
- connection of the relational database to the application;
- add the ability to work with the application in augmented reality glasses.

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