

Development of an Augmented Reality Mobile Application in Educational Purposes

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Abstract. This work is devoted to the issues of visualization and data processing, in particular, improving the visualization of three-dimensional objects using the technology of augmented reality in education. This article describes the development of augmented reality mobile applications on the theme of the galaxy. The main purpose of the application: educational and cognitive. In the process of performing work, computer graphics, algorithms and modeling methods were used. Use case: there are special images on the stand that the mobile application recognizes and shows the created 3D models of the “Sun” and “Milky Way”. In addition, while the 3D model is being displayed, a short training audio lecture will be held. To create a 3D model of objects, the Unity program was used in conjunction with the augmented reality platform Vuforia.

1. Introduction

Augmented reality is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory. AR can be defined as a system that fulfills three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects [1]. The overlaid sensory information can be constructive (i.e. additive to the natural environment), or destructive (i.e. masking of the natural environment). This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one. Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality [2].

Augmented reality is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies (e.g. adding computer vision, incorporating AR cameras into smartphone applications and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulated. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space. Augmented reality also has a lot of potential in the gathering and sharing of tacit knowledge [3]. Augmentation techniques are typically performed in real time and in semantic contexts with environmental elements. Immersive perceptual

information is sometimes combined with supplemental information like scores over a live video feed of a sporting event. This combines the benefits of both augmented reality technology and heads up display technology (HUD). The primary value of augmented reality is the manner in which components of the digital world blend into a person's perception of the real world, not as a simple display of data, but through the integration of immersive sensations, which are perceived as natural parts of an environment.

In the work to create a 3D model of objects, the Unity program was used together with the Vuforia platform of augmented reality. Vuforia is an augmented reality software development kit (SDK) for mobile devices that enables the creation of augmented reality applications. It uses computer vision technology to recognize and track planar images and 3D objects in real time. This image registration capability enables developers to position and orient virtual objects, such as 3D models and other media, in relation to real world objects when they are viewed through the camera of a mobile device. The virtual object then tracks the position and orientation of the image in real-time so that the viewer's perspective on the object corresponds with the perspective on the target. It thus appears that the virtual object is a part of the real-world scene. The Vuforia SDK supports a variety of 2D and 3D target types including 'markerless' Image Targets, 3D Model Target, and a form of addressable Fiducial Marker, known as a VuMark. Additional features of the SDK include 6 degrees of freedom device localization in space, localized Occlusion Detection using 'Virtual Buttons', runtime image target selection, and the ability to create and reconfigure target sets programmatically at runtime. Vuforia provides Application Programming Interfaces (API) in C++, Java, Objective-C++, and the .NET languages through an extension to the Unity game engine. In this way, the SDK supports both native development for iOS, Android, and UWP while it also enables the development of AR applications in Unity that are easily portable to both platforms [4].

Unity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Inc.'s Worldwide Developers Conference as a Mac OS X-exclusive game engine. As of 2018, the engine had been extended to support more than 25 platforms. The engine can be used to create three-dimensional, two-dimensional, virtual reality, and augmented reality games, as well as simulations and other experiences. The engine has been adopted by industries outside video gaming, such as film, automotive, architecture, engineering and construction [5].

2. Main part

This article describes the development of augmented reality applications. The main purpose of the application: educational and cognitive. Theme of the application: space. Use case: on the stand there are special images that the application will recognize and show the created 3D model. Also, while the 3D model is being displayed, a short training lecture will be played. Images that the application recognizes are presented in Figure 1 and Figure 2.

To create a 3D model of objects, the Unity program was used in conjunction with the augmented reality platform Vuforia.

The following objects were used to create the "Sun" model:

- ✓ **PSunSurface** - is responsible for ensuring that all other objects are collected together.
- ✓ **PSCorona** - simulates the crown of the Sun.
- ✓ **PSLoop** - models light rings (radiation) around the Sun.
- ✓ **SunSphere** - responsible for the model of the sphere of the Sun.
- ✓ **ImageTarget** - responsible for a special image.
- ✓ **ARCamera** - is responsible for visualizing the device's camera.
- ✓ **PSLoop, PSCorona** - created using the Particle System effect.
- ✓ **SunSphere** - created using a 3D Sphere object.

Configure PSCorona (Figure 3.):

- ✓ **Duration** - effect duration.
- ✓ **Looping** - Repeat Effect.
- ✓ **Prewarm** - the effect starts playing immediately upon hovering over the picture.
- ✓ **Emission** - the number of particles formed in 1 second

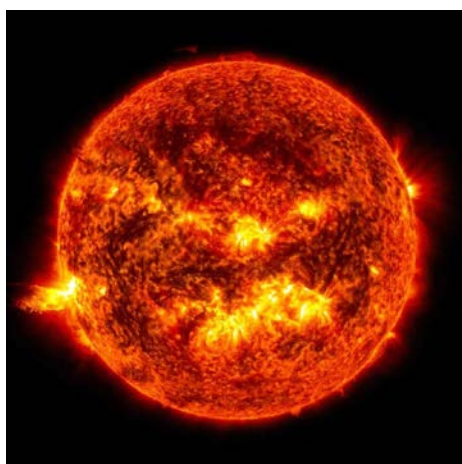


Figure 1. Image Sun.

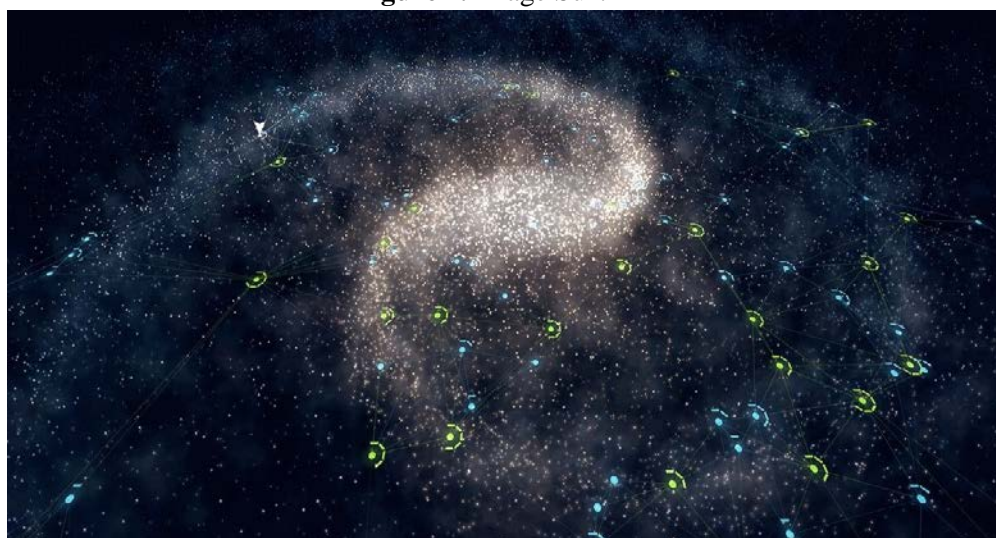


Figure 2. Image Galaxy.

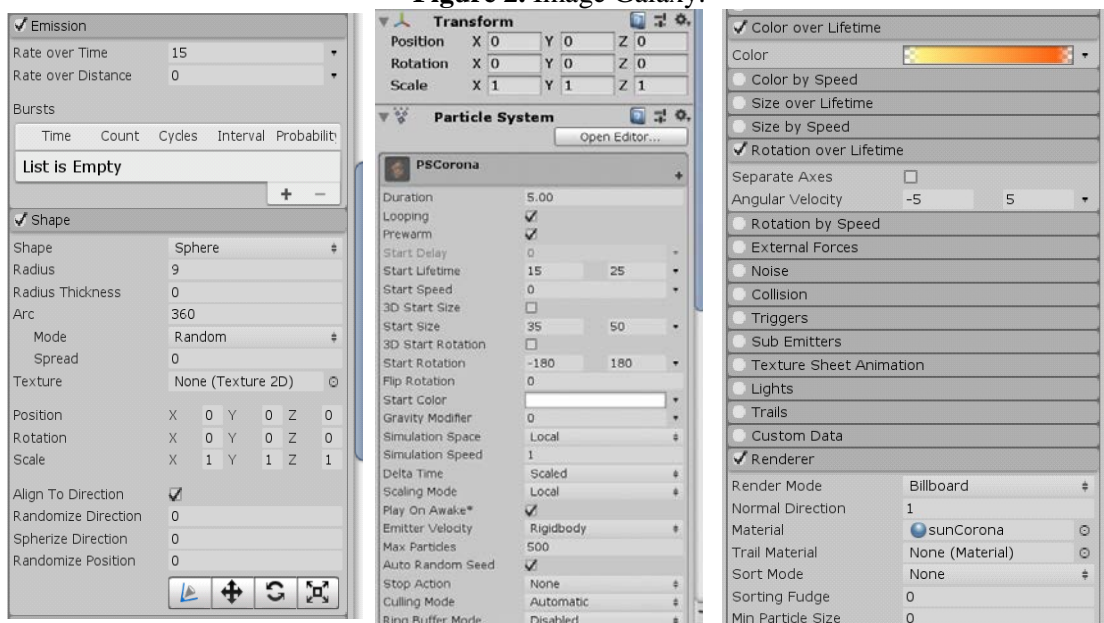


Figure 3. Configure PSCorona.

The material used to create the crown is shown in Figure 4. To create it, we find a suitable picture of smoky rings. We import it into the project. Select Shader Particles / Standard Unlit. We create the material in the project, insert the selected image into the oAlbedo parameter. In the same place we select the orange color.

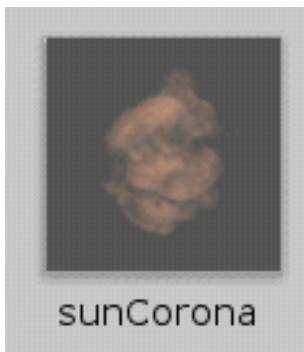


Figure 4. The material used to create the crown.

Figure 5 shows Configure PSLoop. The material used to create the rings around the Sun is shown in Figure 6. To create it, we find a suitable picture of the luminous ring. We import it into the project. Select Shader Particles / Standard Unlit. We create the material in the project, insert the selected image into the oAlbedo parameter. Figure 7 shows Configure SunSphere.

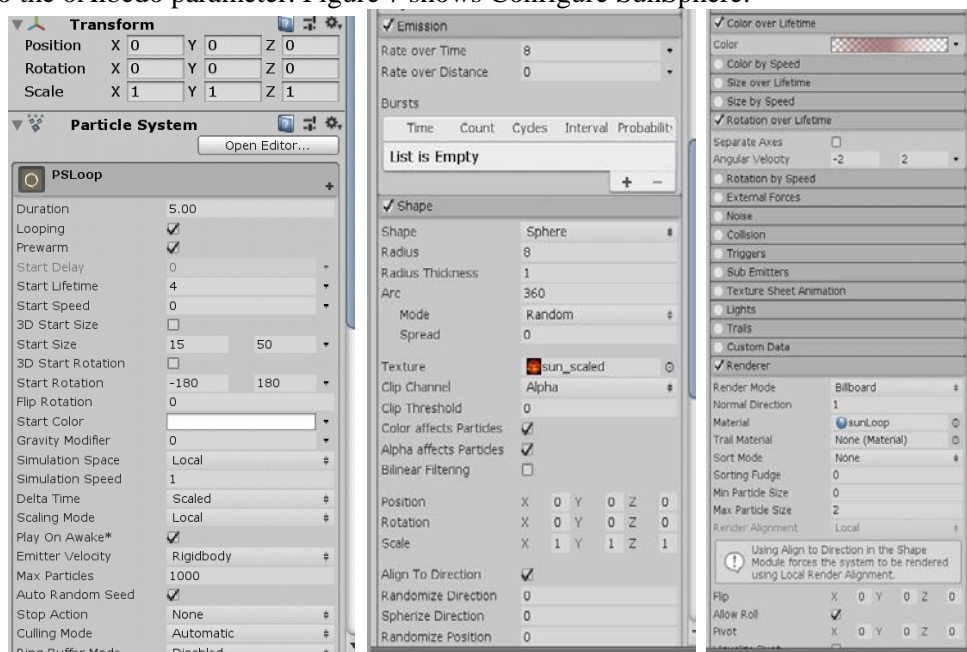


Figure 5. Configure PSLoop.

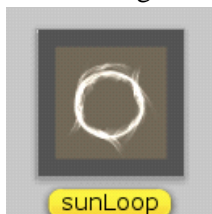


Figure 6. The material used to create the rings around the Sun.

3. Configure Image Target

We find the desired picture. We go to the site <https://developer.vuforia.com/>. Register and create a database. We load the selected picture into it. The system will appreciate it. It is desirable that the rating of the image was from 3 points for the correct recognition of the image by the device's camera.

Download the database and import it into the project. Next, in the ImageTarget settings, select the database and the picture from it in the settings. Next, download the audio, which we will play when you hover over the picture, import it into the project. Check the box next to Audio Source. In the Audio Clip item, insert the imported audio. In order for the audio to play, you need to change the original script. Go to Packages/Vuforia Engine AR/Scripts/, select the file Default Trackable Event Handler.cs. In it we find the On Trackable State Changed method. Add the lines audio.Play() and audio.Stop() to the desired places (Figure 8.). Position our 3D model over Image Target. We edit their scale as it seems necessary.

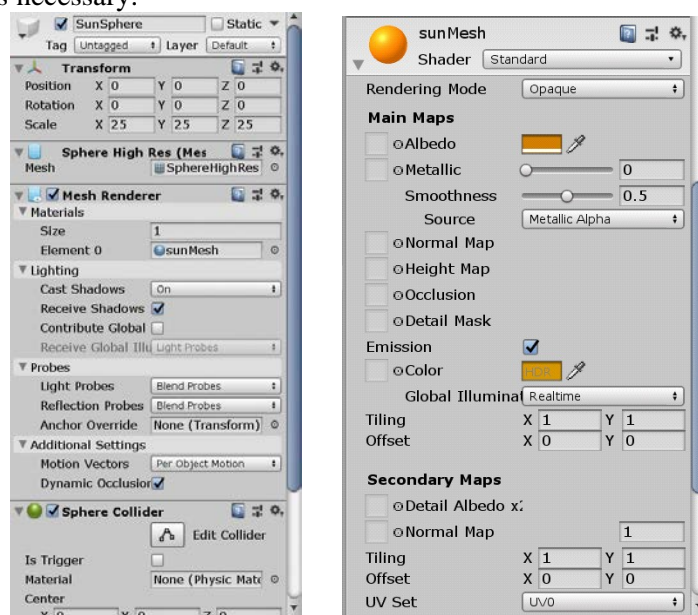


Figure 7. Configure SunSphere.

```
public void OnTrackableStateChanged(
    TrackableBehaviour.Status previousStatus,
    TrackableBehaviour.Status newStatus)
{
    m_PreviousStatus = previousStatus;
    m_NewStatus = newStatus;

    Debug.Log("Trackable " + mTrackableBehaviour.TrackableName +
        " " + mTrackableBehaviour.CurrentStatus +
        " -- " + mTrackableBehaviour.CurrentStatusInfo);

    if (newStatus == TrackableBehaviour.Status.DETECTED ||
        newStatus == TrackableBehaviour.Status.TRACKED ||
        newStatus == TrackableBehaviour.Status.EXTENDED_TRACKED)
    {
        audio.Play();
        OnTrackingFound();
    }
    else if (previousStatus == TrackableBehaviour.Status.TRACKED &&
        newStatus == TrackableBehaviour.Status.NO_POSE)
    {
        audio.Stop();
        OnTrackingLost();
    }
    else
    {
        // For combo of previousStatus=UNKNOWN + newStatus=UNKNOWN|NOT_FOUND
        // Vuforia is starting, but tracking has not been lost or found yet
        // Call OnTrackingLost() to hide the augmentations
        audio.Stop();
        OnTrackingLost();
    }
}
```

Figure 8. Method for playing audio.

4. Configure ARCamera

Add ARCamera to the project design. Set as if the device camera existed in relation to the visible ImageTarget. Next, go to the License Manager and select the created database. Copy the license key.

Find the VuforiaConfiguration file in the Resources folder. In the App section of the License key, insert the License key. Putting together a project. The final Sun model is shown in Figure 9.



Figure 9. The final Sun model.

To create a model of "Milky Way", the following items were used:

- ✓ **Galaxy** - responsible for ensuring that certain objects are brought together.
- ✓ **Stars** - simulates stars in a galaxy.
- ✓ **glowCentre** - simulates the center of the galaxy.
- ✓ **mist** - responsible for creating the fog effect.
- ✓ **ImageTarget** - responsible for a special image.
- ✓ **ARCamera** - is responsible for visualizing the device's camera.
- ✓ **Stars, glowCentre, mist** - created using the Particle System effect.

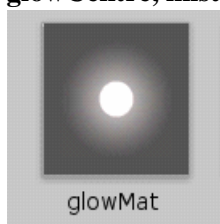


Figure 10. The material that was used to create the stars.



Figure 11. The material that was used to create the fog.

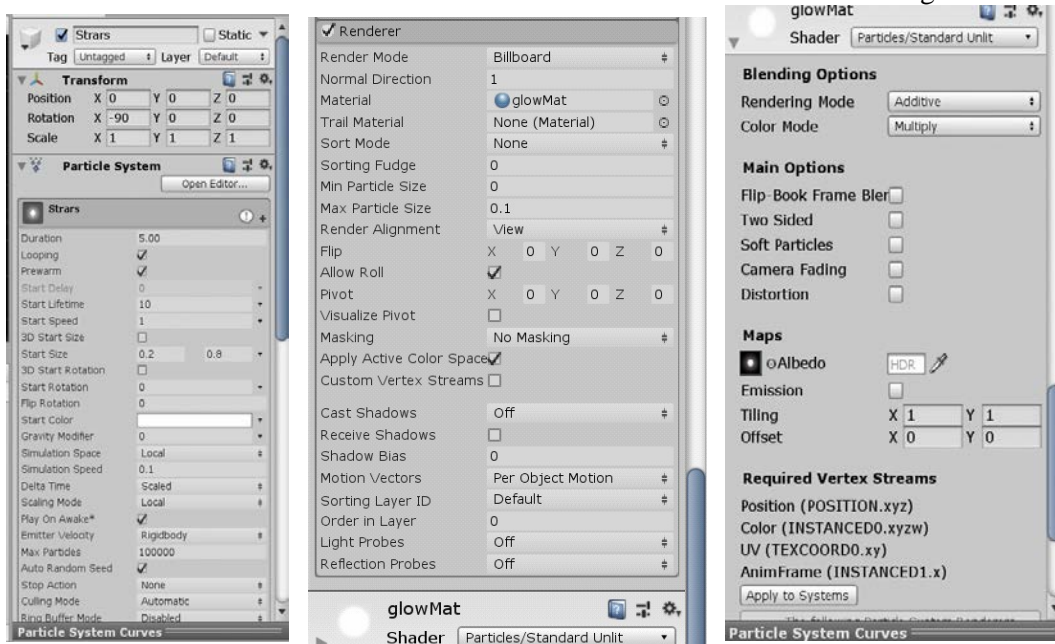


Figure 12. Configure Stars.

The material that was used to create the stars is shown in Figure 10. To create it in Photoshop, put a large white dot with a brush with blur along the edges of the canvas. We import it into the project. Select Shader Particles / Standard Unlit. We create the material in the project, insert the selected image into the oAlbedo parameter. The material that was used to create the fog is shown in Figure 11. To create it, we find a picture of smoke. We import it into the project. Select Shader Particles / Standard Unlit. We create the material in the project, insert the selected image into the oAlbedo parameter. Figures 12-14 show all settings for the corresponding objects.

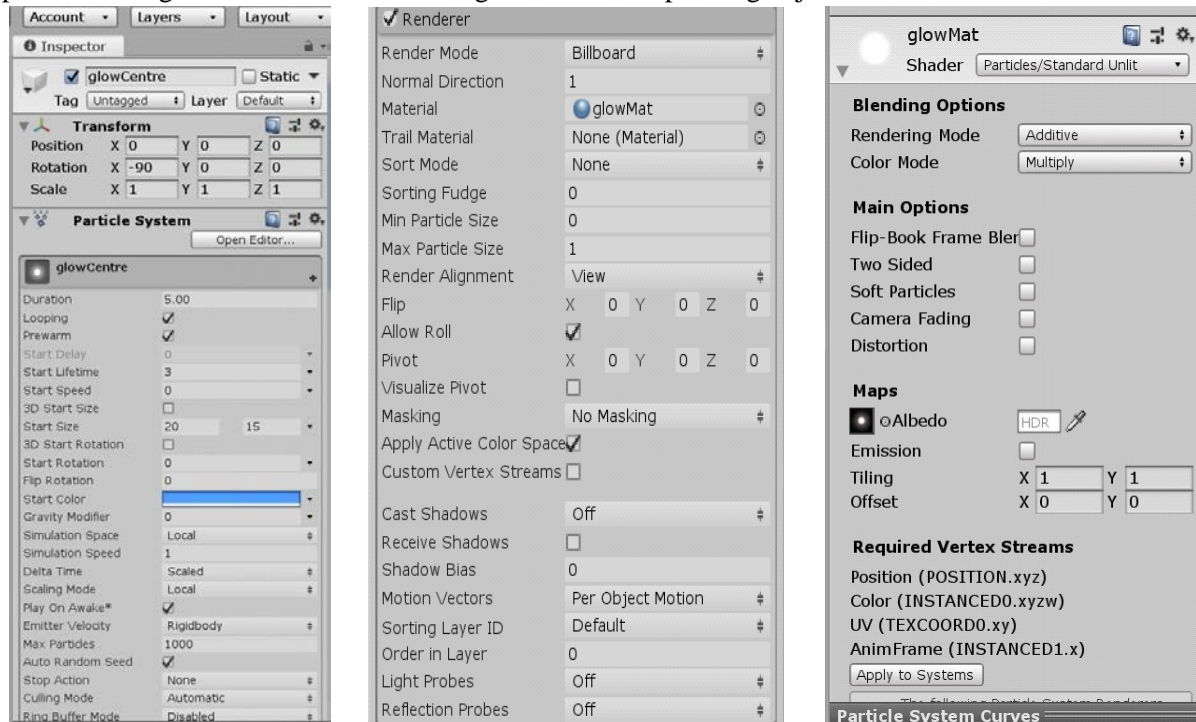


Figure 13. Configure glowCentre.

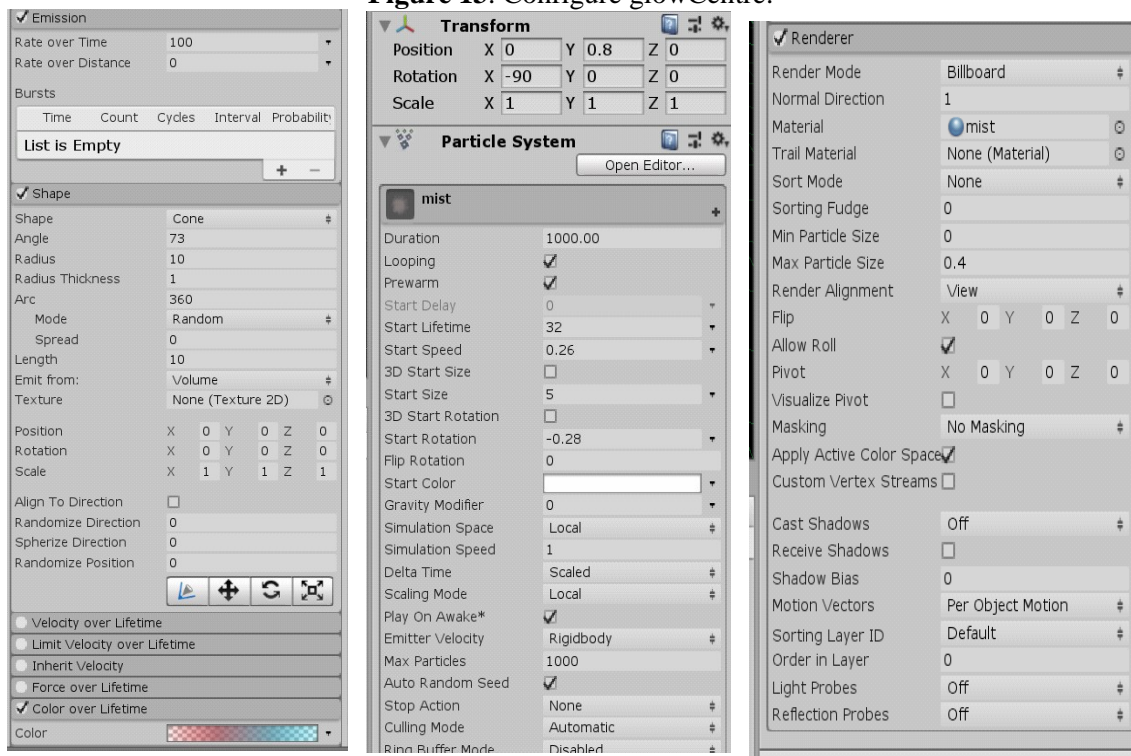


Figure 14. Configure mist.

We set up the Vuforia, ImageTarget, ARCamera database, obtain the license key according to the same plan as for the Sun model. The final Milky Way model is shown in Figure 15.

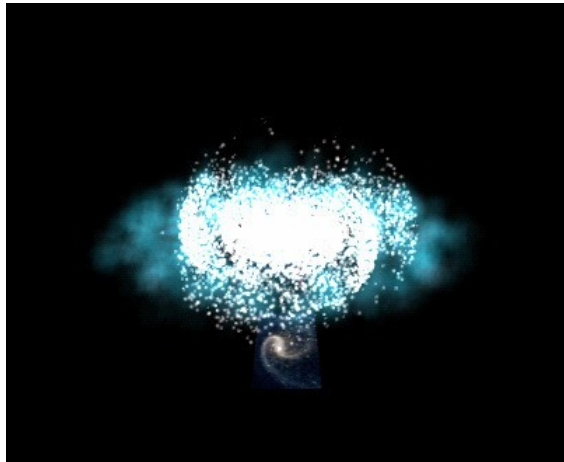


Figure 15. The final «Milky Way» model.

5. Conclusion

Using the possibility of augmented reality in education can regenerate the process for the visual perception of the necessary information. The article provides examples of using augmented reality technology. The possibility of using this technology in the educational environment for the visual modeling of educational material, supplementing it with visual information, while developing spatial representations, imagination, volumetric design skills, which saves teachers and students time on the transfer and assimilation of educational information, and accelerates the learning process. The application can be downloaded from the link: <https://drive.google.com/open?id=1JjjA2SHPsXBDNtOFEwbFCfVChe7hsdkK>.

6. Acknowledgements

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7. References

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