Developing augmented reality based application for character education using unity with Vuforia SDK

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Abstract. Character education is an education-focused in implementing moral values, ethics and citizenship education. This is an approach to developing good character and developing the school as a caring community [1]. The youngest generation nowadays, which primarily targeted by character education was born facing already-advanced ICT (Information and Communication Technology), so it recommended using an ICT's benefit like AR. An AR (Augmented Reality) is a system that supplements the real world with virtual objects that appear to coexist in the same space as the real world. Augmented Reality offers an immersive virtual learning experience; as a result, an education that was giving more than standard audio-visual material [5,6]. Augmented reality in the past had several limitations, giving the developer challenging problems [7]. Most of those problems are

1. Introduction
Character education is an education-focused in implementing moral values, ethics and citizenship education. This is an approach to developing good character and developing the school as a caring community [1]. The youngest generation nowadays, which primarily targeted by character education was born facing already-advanced ICT (Information and Communication Technology), so they can use the potential of the ICT to enhance the learning process [2]. ICT will take role in affecting the curriculum and environment (both physical and virtual) in the learning process [3,4]. An AR (Augmented Reality) is a system that supplements the real world with virtual objects that appear to coexist in the same space as the real world. Augmented Reality offers an immersive virtual learning experience; as a result, an education that was giving more than standard audiovisual material [5,6]. Augmented reality in the past had several limitations, giving the developer challenging problems [7]. Most of those problems are
eliminated as the phone (also called smartphones) nowadays has a powerful chip that was connecting high-resolution camera, speeding 3D processing, and location sensing using the GPS that could help to replace HMD (Head Mounted Device) and external server system [8,9].

On previous research, in 2000, an AR system for education was developed, the AR used in mathematics and geometry for the university level, the result is an AR system operated using HMD to encourages experimentation with geometric [10]. Over a decade later, in 2014, the AR system developed for helping the junior high school students in China to improving chemistry learning process, they using the desktop monitor with a camera to run the AR [11]. Later, the AR developed to offer the more attractive way of learning Biology Science in Malaysian secondary school, not mentioned what device their use for the AR application [12]. On this paper, the research will develop an AR for improving the character education learning process, which we are unaware of any research mainly aimed towards character education directly.

The main goal of this research is developing the AR system that will improve the learning process of character education by helping the teacher to provide the new interactive tools for teaching the students.

2. Research method

2.1. Get education the material

First of all, we need the education materials, that suitable for the students. In this research, the content will be taken from the kindergarten storybook, the example of this storybook can be found here http://anaksekarang.com/. We will take some story theme, for example, "Keeping Promise." From there, we'll take anything that will be needed for making this application, such as: how is the storyline, who are the characters and how this character interacts with each other.

![Figure 1. “Keeping Promise” story theme.](image)

2.2. Design material

For making the AR on Unity, we need "assets." Assets made using Blender, a 3D creation suite software that capable to do modeling, rigging, animation, simulation, rendering, compositing and motion tracking, even video editing, and game creation. This software is free that could make development process low cost [13]. When using Blender to create the assets, we were using basic cube model to create head or hand part of the character's 3D model. We are using "multi-res" modifier subdivide 30. The figure below is the example of the texture that will be used on Blender when making a 3D asset, one of the characters named "Zakir," as seen in Figure 1 above, the boy with a grey shirt.
3D Modelling and developing AR Software in Unity requiring a sophisticated PC, here we are using DELL Inspiron 14 R 5437 Notebook with the following specification:

Table 1. PC specification for design and developing.

| Component       | Details                                           |
|-----------------|---------------------------------------------------|
| Processor       | Intel Core i7 4500u                               |
| RAM             | 8GB                                               |
| Graphics Card   | NVIDIA GeForce 750M                               |
| HDD             | 1 TB HDD with 100 GB of free space                |
| Operating System| Windows 8.1                                        |
| Camera          | 1.0 MP Web Cam                                    |

2.3. Make the augmented reality on Unity

Unity, a game engine with the capability of multiplatform distribution [14], combined with Vuforia support capable of making an AR Software that will be running on the mobile device, on this research, we'll specific targeting mobile devices that use the Android operating system. Almost all Android devices nowadays are capable of running AR software. They have such a powerful enough chipset that'll run 3D graphics, much higher resolution camera than non-smartphone devices, also, of course, equipped with a GPS.

In this research, the AR app will be built using the Ruby programming language; Ruby is a dynamic, interpreted, reflective, object-oriented, general-purpose programming language. It was designed and developed in the mid-1990s by Yukihiro "Matz" Matsumoto in Japan [15]. Ruby provided three essential advantages [16]:

- A fast implementation,
- Changes in the language could be easily made, and
- Ruby constructs can be used to write complex transformations.

Ruby programming language used here to applying the algorithm between animation scenario on the 3D model, to become an Augmented Reality media as a result. These are step-by-step how to create AR on Unity:

Figure 3. Select the Vuforia AR support.
The first step, create a Unity Project, then select Vuforia Augmented Reality Support on XR Setting on the right bottom panel of the Unity Windows to activate the Vuforia SDK integration on Unity Engine (only available on Unity 2015.3 and later version).

Second, set the Vuforia configuration (app license key and database image target) on the right panel of the Unity Windows. The user must have the app license key; this key can be obtained by registering your project to the Vuforia’s website for free (https://developer.vuforia.com/). For the database image target, also must be recorded at the Vuforia’s site. After the database has been registered, it can be downloaded in the form of a unity package file.

Third, import all the assets, such as the 3D models that already made using Blender earlier, sound, Figure, texture, all the things that related to this AR project. Then, setting up all the assets that already imported and configured into an AR system using Unity.
Figure 6. Configuration on unity.

After all configuration completed, the application ready to test, if succeeded, the 3D AR will appear on the screen while camera turned on and targeted at the storybook cover (at Figure 1), the testing will use 2 devices, the first one is using Notebook used to developing the AR since it has a camera (at Table 1), and the second is smartphone with the following specification:

| Component          | Details                          |
|--------------------|----------------------------------|
| Chipset            | MediaTek Helio P10               |
| Processor          | Octa-core 1.95 GHz Cortex A53    |
| Memory             | 4 GB                             |
| GPU                | Mali-T860MP2                     |
| Internal Storage   | 32 GB with 3 GB of free space    |
| Main Camera        | 16 MP                            |

3. Results and discussion
The Augmented Reality application could run directly at the notebook when the camera pointed towards the marker, the AR run without problem, graphic, animation, sound all worked well. When camera away from the marker, the AR animation also stopped, this is intended as we want that AR only runs when camera pointed towards the marker because AR system usually triggered to a particular object [17].

The final result of this research is the apk file (Android application package). The apk file is an installer file that created for devices that run on Android devices. The .apk files needed to be installed
first on the Android smartphone. After installed, open the app and point the camera towards the "marker." The example of the marker is figure 1 above. If the app detects the tag, either it's on the paper, just on monitor, laptop or tablet screen, the 3D AR will pop up on the smartphone's screen. The graphics, animation, and sound also worked well; the AR animation also stopped when we put away the camera from a target marker.

![Figure 7. AR run on the notebook.](image)

At figure 8a, the camera pointed towards the marker, then the AR starting to pop up on the screen, then at 8b, the 3D animation scene began to play. When we put away the camera from the marker at 8c, the AR then go off.

4. Conclusion

4.1. Conclusion

Using the Unity Engine combined with Vuforia SDK, we will be provided by some advantages into making an Augmented Reality system for education:

- The first one is we could make the AR system with the minimum development cost because Unity is cheaper (there is also the free version) than another engine, also making the assets using Blender, which it's free, make this even almost no-costly.
- The second is the fast development, Unity support Ruby language, which provide us with quick implementation and make us possible write complex transformation such as making AR system with many 3D assets.
- The last one is with Vuforia SDK, it is possible to make an AR system where a specific device such as HMD (Head Mounted Device) didn't need [18], jut using any mobile devices that support the AR, so with this method, the system is usable in any education environment, which very suitable to improving the character education

4.2. Suggestion

For further development of this system, some points could be a notice:

- Some bugs still exist on the app, sometimes it takes a long time to identify the marker, or it won't be identified at all, restarting apps might solve the problem.
• More study on how well student's response to this new learning system, and the impact on the education process.
• Improvement of the animation so the students willing to use it over an extended period.

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