# An Augmented Reality Based Mobile Education Application for Preschool Children

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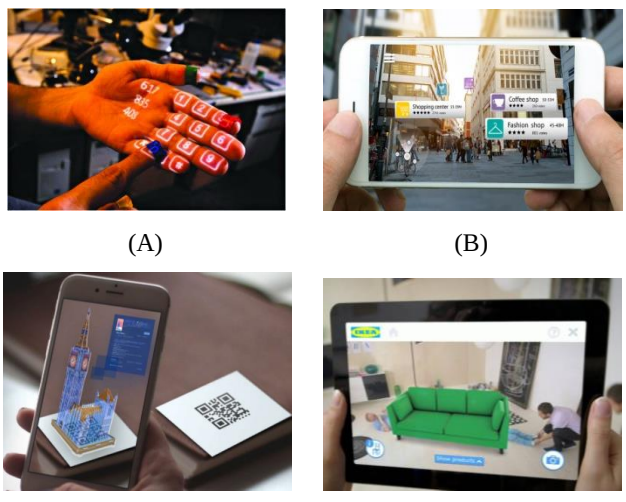
**Abstract**— Augmented Reality (AR) is one of the most interesting visual technologies in the world. With this technology, you can hear, see, and feel virtual experiences in the real world. Especially in recent years, with the increase in the use of this technology, it is seen that the environments where this technology is developed have also increased. In the 21st century, the new generation has a great advantage in using and learning technology. For these reasons, new methods and trends in education are constantly being developed and different applications are developed for each learning age group. The aim of this study is to increase the learning knowledge and skills of preschool children in Turkey by using mobile applications developed with augmented reality. The proposed AR-based application was developed using the Unity 3D platform and the Vuforia SDK Augmented Reality Library and it is aimed at providing three different learning skills (number, shape and color applications). The developed AR-based application is entirely for preschool children (3-4 years old) in order to make their learning more interactive and fun.

**Index Terms**— Unity 3D, Education App, Augmented Reality, Vuforia SDK.

## I INTRODUCTION

Augmented Reality (AR) is the ability to overlay computer graphics onto the real world. Unlike Virtual Reality, AR interfaces allow users to view the real world at the same time as virtual images attached to real locations and objects. AR interfaces enhance the real-world experience, unlike other computer interfaces that draw users away from the real world and onto the screen. The usage areas of AR technology have increased considerably in recent years. Some of these stand out as areas such as gaming [1], navigation [2], advertising [3] and education [4]. There are four different types of AR according to usage area and platforms. As shown in Fig. 1, these are projection based AR, location based AR, marker based AR and markerless AR.

In projection-based AR, a physical three-dimensional model is utilized on which a computer image is projected to produce a realistic-looking item [5]. Location-based AR includes GPS, accelerometer, digital compass, and other technologies to recognize the user's position with a high level of precision [6]. A marker-based AR searches a specific image marker (QR code, data matrix) in the environment and superimposes the virtual object on top of it. The camera of the AR device always tries to recognize the marker-image by scanning the input, and when it finds and recognizes the pre-defined marker, it places the virtual object on the marker. When the marker is gone from the camera view, the virtual object disappears [7][8]. Markerless AR is used to represent an AR application that no needs prior knowledge of a user's background to overlay 3D content into a view and hold it to a fixed point in space [9].



(A) (B) (C) (D)

Figure 1 Examples of AR: (A) projection based AR, (B) location based AR, (C) marker based AR, (D) markerless AR.

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The use of AR technologies in education, which has come with the advancing technology in recent years, is becoming widespread and the use of these technologies is getting easier. It is predicted that the importance of augmented reality technologies, which are thought to contribute to learning based on experience in learning environments, will increase even more. Therefore, it is important that such technologies are recognized and used by educators [10].

The combination of virtual objects and real environments helps students to understand complex spatial relationships and abstract concepts. In this context, augmented reality emerges as a developing technology for education. The use of this technology in the field of education is a good idea as it becomes quite interesting when you bring objects that are difficult to imagine and think about into a form that can be imagined and relate to the real world. In recent years, there is a considerable amount of research on AR usage in educational settings [11]. Some of these studies are: Lu and Liu proposed augmented reality (AR) technology integrated with the learning program for enhancing learning achievement in marine education [12]. Kamarainen and his/her friends presented EcoMOBILE project integrating augmented reality and environmental probes which helps students to understand [13]. In the study of Ferrer-Torregrosa and his/her colleagues, a new tool (ARBOOK) was presented, which is based on augmented reality focusing on the anatomy of the lower limb [14]. El Sayed and his/her friends proposed the Augmented Reality Student Card (ARSC) which leads to a better understanding by increasing visualization ability in the field of education [15].

Although AR-based technology provides many advantages in educational environments, there are some difficulties encountered in applying AR-based technology [11]. The most challenge is that AR is "difficult for students to use. The biggest challenge is that AR-based applications are difficult for using by students [16]. The other some challenges in AR-based educational applications are usability difficulties that may cause time loss for students [17], Global Positioning System (GPS) error [18], and low sensitivity in triggering recognition [19] in especially location-based AR applications.

The AR applications can be used in many different levels of ages. AR applications for children with different ages enable them to learn with fun and increase their interest. In this study, an augmented reality-based mobile application was presented using Unity 3D Platform and Vuforia SDK for preschool children education. This application developed for smartphones with Android operating system consists of three main options. These are color, shape, and number applications. The proposed AR-based application differs from similar apps in the play store with its many features. In general, there are very few mobile applications that combine color, shape and number education for preschool children, and these applications have been developed without AR-based.

# II Software Platform

## A Vuforia SDK

Vuforia is a cross-platform Augmented Reality (AR) and Mixed Reality (MR) application development platform. Vuforia supports many third-party devices (AR/MR glasses), and VR devices with back-facing cameras (Gear VR). Developers can easily add advanced computer vision functionality to any application that allows it to recognize images and objects or reconstruct real-world environments. The Vuforia SDK supports a variety of 2D and 3D target types including 'markerless' image targets, 3D model target. Fig. 2 shows the data flow diagram of the Vuforia SDK in application environment.

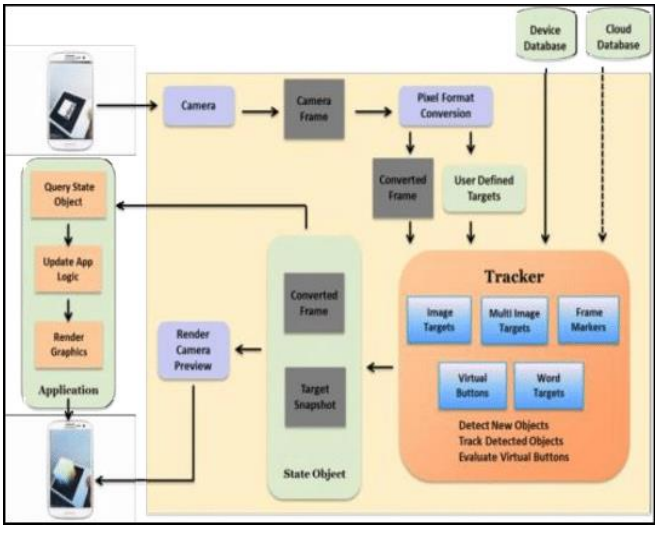



Figure 2 Data flow diagram of the Vuforia SDK [20].

## B Unity 3D Game Engine Platform

Unity 3D is a cross-platform game engine developed by Unity Technologies for making games and simulations for computers, consoles, and mobile devices. Thanks to the Unity Web Player plug-in, games developed by the Unity 3D engine can be operated via a web browser without any installation process. Another ease offered by Unity to game developers is that a game developed with Unity can be compiled for different platforms (PC, Mac, Web, IOS, Android and Windows Phone) without any infrastructure changes.

In recent years, the Unity 3D game engine has been used in different areas in academic studies. Some of these are: testing an AR application that introduces animals for preschool children in kindergartens with children [4], making exercises more interactive with games using a microcontroller-supported glove for hand physiotherapy of paralytic patients [21], developing a game for waist exercises of persons who spend a long time at the office [22], developing a AR-based application to understand of the usage of vowels and numbers for children over 4 years of age [23].

## III AR Mobile Application

In this study, an AR mobile education application has been developed to make the information learned by pre-school children entertaining. This application developed for smartphones with Android OS includes three main learning options. These are color, shape, and number applications.

To develop this application, firstly, the Unity 3D game engine platform was installed. Then, the Vuforia software development kit has been added to the Unity 3D platform in order to make an AR-based application. A wooden clock was designed for the application and a different color, shape, and number was placed on each time zone on it. For color, shape, and number applications, twelve different times were determined on this wooden clock. Fig. 3 shows a clock-shaped practice toy made of wood.


Figure 3. The clock-shaped practice toy for AR Application

In the developed application, the minute hand of the wooden clock is fixed at twelve, and a three-dimensional animation is shown in the value where the hour hand is (1-12) according to the chosen application (shape, color and number). Twelve different clock photos were determined on which the animations will stand, and these were added to the Vuforia database.

The flowchart of the AR based mobile application developed for preschool children is shown in Fig. 4. As seen from this flowchart, the loading view is firstly shown on the AR application and then 3D objects and animations are taken to the device memory according to the application option (color, shape, and number). In the developed AR application, the images are taken from twelve different clock-shaped practice toy's figures. The frames from the camera of the smartphone are sent to the Vuforia SDK. Here, the procedure of the pixel transformation is applied to these frames and the shape images in the Vuforia database are compared with these frames. If taken frames are matched one of the clock images in the database, according to the option of the application, shape, number or color 3D model with the voice is shown on the clock-shaped practice toy.

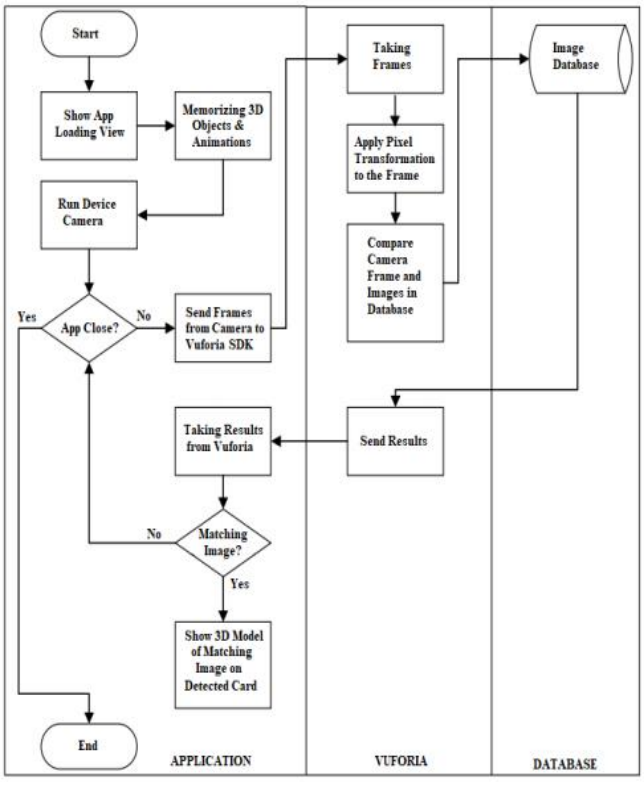


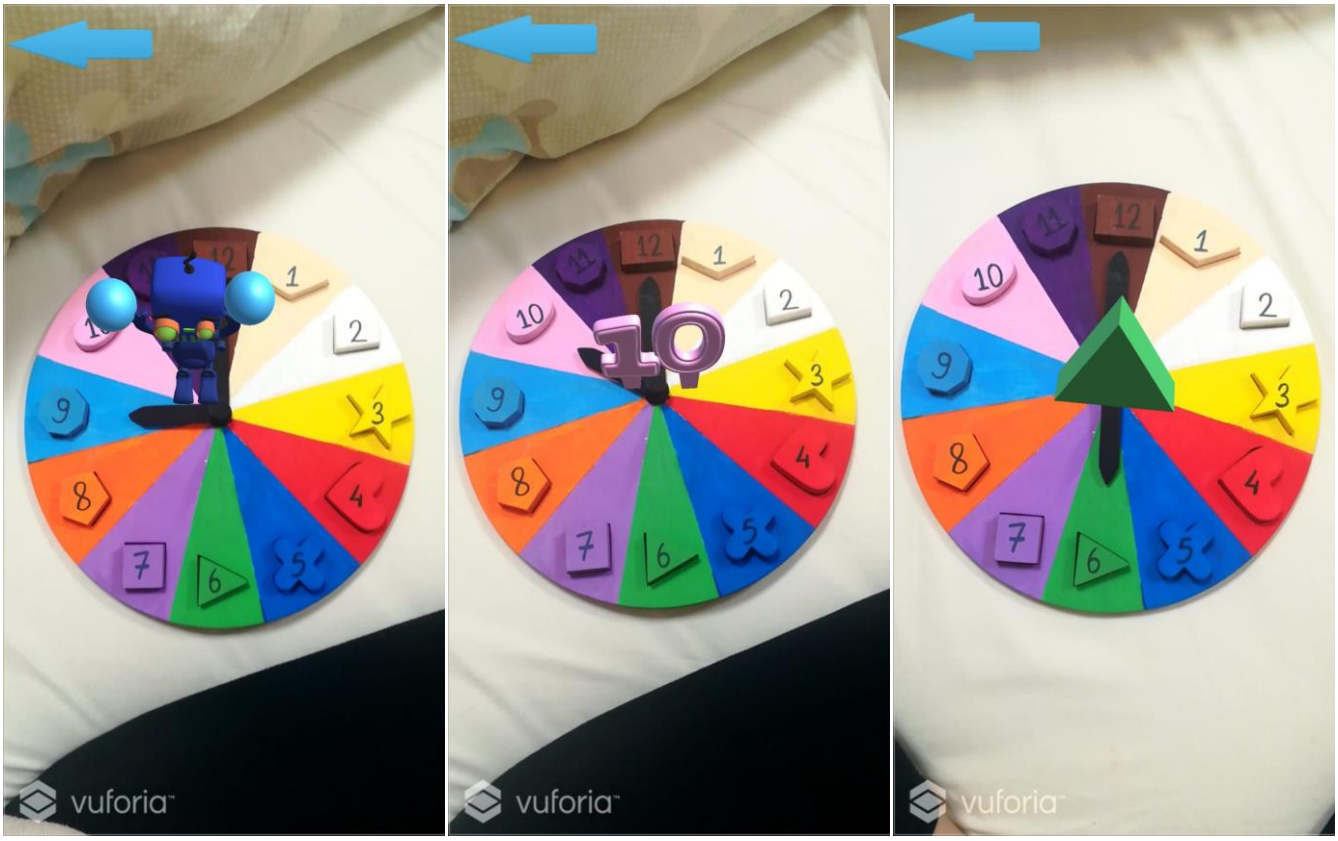

Figure 4. The flowchart of the AR based application [4].

To show outputs of the AR based mobile application, this application was installed on a smartphone with Android OS. Fig. 5 shows the main screenshot of the AR based mobile application.


Figure 5. Main screenshot of the AR based mobile application.

On the right hand of the main screenshot, a welcome screen welcomes users, and there are visually three different learning applications and a close button. On the left, there is a screen view of the sixth shape augmented reality application. From each application, the user can simply return to the main screen (considering preschool children) with the blue back arrow on the top.

In Fig. 6, there are three different screenshots of the AR application. Fig. 6a shows the screenshot of the ninth color learning application. In Fig. 6b, the screenshot of the tenth AR application regarding the number learning is presented. As the last screenshot (Fig. 6c), sixth shape learning application's screenshot is shown.




(a) (b) (c)

Figure 6. Screenshots of the AR application for the color education (a), number education (b) and shape education (c).

## V CONCLUSION

In this study, an Augmented Reality application based on principles of learning fun was developed for preschool children 3-4 years of age in Turkey, for the number and shape education. Unity 3D game engine platform and Vuforia development kit were used in the development of AR application. A wooden clock was designed for the application and a different color, shape and number was placed on each time zone on it. The 3D models of the number, shape and color are simulated by the Unity 3D platform. Using the Vuforia SDK, 3D models with audio are shown according to the selected application option for each detected time zone. The developed AR application is installed on the phone with an Android OS in the tests and the screenshots from AR outputs are presented in this study. In different future studies, AR-based games and applications for preschool children can improve children's learning abilities.

## Acknowledgment

The paper titled "Augmented Reality-Based Mobile Application for Preschool Children Education", presented in this study, was carried out within the scope of project study courses at the laboratories of Computer Engineering Department in Bilecik Seyh Edebali University.

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