Virtual and Augmented Reality Concepts

Mustafa AKIN

Necmettin Erbakan University

Yusuf UZUN

Necmettin Erbakan University

Introduction

The period we live in is a period in which the internet and computer are at the center of our lives. Digital applications are increasing day by day and accordingly people's communication styles are changing (Arslan & Elibol, 2015). Since its existence, human beings have always tended to research and learn. Requirements arising from wanting and needs have further increased this tendency. This cycle that will continue throughout life will never end. Depending on this cycle, technological developments will continue continuously. Other Technologies that develop over time are "Augmented" and "Virtual" reality Technologies. In the past, the concepts of virtuality and reality were referred to as completely separate from each other. The place where people are directly affected is the "real environment"; the environment, which is made up of computers with the laws of physics such as time, equipment, gravity, and has no borders, is called "virtual environment". Today, the concept of virtuality has left its place to new environments that combine virtuality and reality. The virtual environment, which is a computer output, is called "virtual reality", and the environment that is a combination of reality and virtuality is called "augmented reality" (Azuma, 1997).

Technology has been important to every aspect of their lives for people that have adapted to the virtual world quickly. Technology and its elements change people's lifestyles and even their perspectives on events or the world. For example, shopping is one of the indispensable needs of all people, young and old. Although stores and shops come to mind first when it comes to shopping, it is a fact that shopping can be done online nowadays. Thanks to VR and AR technologies, people will feel like they are shopping from wherever they are and will be able to examine products for 3D. It has been observed that virtual shopping has positive effects of production of consumption (Kose & Yengin, 2018).

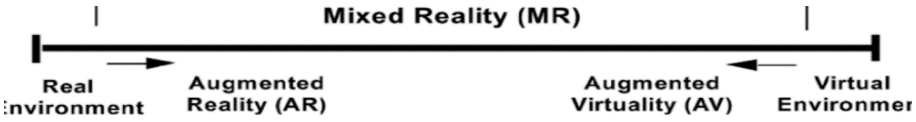

Figure 1. Virtuality-reality continuum

Virtual reality consists of computer-generated animation and 3D models. Through technological tools, people feel themselves in these virtual environments and interact with 3D objects. AR and desktop virtual reality is a technology developed based on VR technology. In Figure 1, the communication between the concepts of virtual, augmented and mixed reality is knitted. On the left is the real world, on the far right is the virtual world. These two media transitions are called "Mixed Reality" (Kucuk Avci, 2018). MR (Mixed Reality) can be defined as the combined form of VR and AR applications. In mixed reality, virtual and real environment objects coexist. Unlike VR and AR, MR technology can be physically supported (Avci & Tasdemir, 2019).

Virtual Reality

Virtual environments realized by using virtual reality technology are formed by the combination of imagination and real world. VR enables people to interact directly with the computer to solve complex problems. Being able to imitate real environments is the main purpose and most prominent feature of VR technology. These technology developers are now able to design very realistic environments thanks to artificial intelligence algorithms. The subject of virtual reality has been used in the past to cover meanings such as 3D simulation, virtual environment, console and computer games. Today, it emerges as systems that can interact with the sphere, which provides 3600 visions of glasses, and where virtual environments can be experienced (Wikipedia, 2020). Another definition of VR is Diemer et al. (2015) gave. According to Diemer et al., virtual reality is environments simulated to reality by computer. In this way, people can communicate not only with the real environment but also in the virtual environment (Diemer & others, 2015). When we look at virtual reality from the framework of the system, we come across the following definition: "A system in which users actively feel and control a real-world situation with the help of equipment and special tools they wear on their bodies on a 3D simulation created in the computer environment." In this plan, virtual reality applications users; It provides the opportunity to enter the virtual world created by the computer, to have various experiences there and to direct it (Deryakulu, 1999).

Virtual Reality Triangle

In order for a computer-generated work to be considered a VR work, it must have the following: These aspects are called "virtual reality triangle" or "virtual reality 3I" or "virtual reality triangle" (Karışma, 2017). Figure 2 shows the virtual reality triangle.

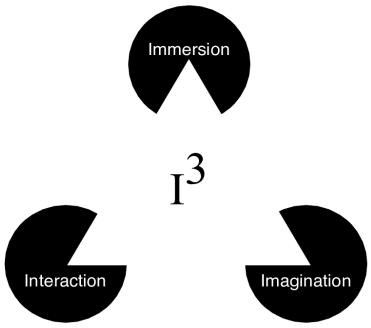

Figure 2. Virtual Reality triangle

Immersion: VR infrastructure takes users with different devices into a virtual environment and cuts off their relations between the real worlds. Wrapping process (Unur, 2001);

- 3D graphics simulations,
- A world with real representation,
- The device allows you to feel as if you are a part of the virtual world.

Wrapping means that users enter the created virtual environment using different devices (tablets, glasses and phone screens, etc.). In addition, immersion is the factor that completes the experiences of individuals. As the variety of senses used by users in the virtual environment increases, the rate of immersion also increases. The fact that there is feedbacks such as images, sounds and smells of the people in the virtual environment increases this rate (Unur, 2001).

Interaction: It appeals to all sense of individuals such as hearing, sight, touch and taste. First of all, a virtual world that is not motionless is required for interaction. A reaction is created in the virtual world to the actions of individuals. Reactions, on the other hand, are verbal, visual, verbal instructions, etc., using various devices (Unur, 2001).

Imagination: Imagination: An individual creates an illusion by imagining non-existent images of the world. Dreaming of individuals depends on the created virtual world, imagination and problem solving efforts in this environment (Ünur, 2001).

Types for Virtual Reality

VR infrastructure is an environment realized by the joint operation of hardware and software components. Virtual reality infrastructure is mainly associated with computer software. There are devices developed to display VR content. The use of these devices affects the Wrapping and interaction characteristics that make up the VR technology. The devices strengthen the wrapping feature of VR technology and increase the wrapping rate. VR types are shown in Figure 3 (Saka, 2019).

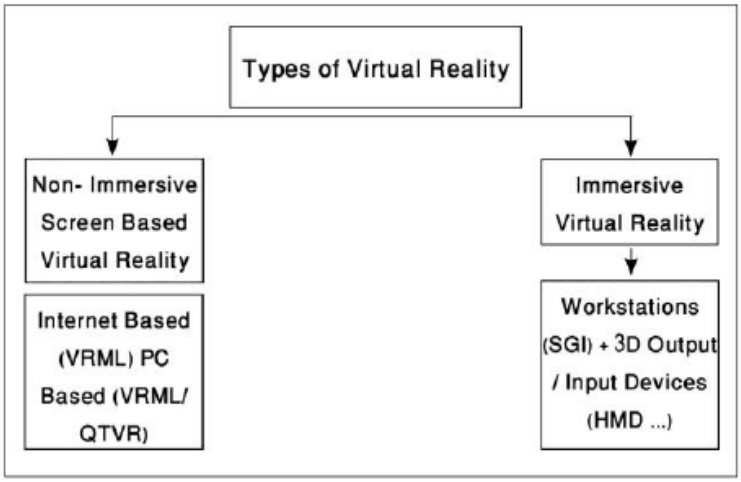

Figure 3. Types for virtual reality

Non-Immersive Virtual Reality: In this virtual reality world, a computer monitor requires a hardware that allows you to enter information in order to control the system, for example, keyboard, mouse, etc.

Compared to immersive VR, it is easy to develop. In addition, they are systems that cost less in terms of hardware. Interaction in the virtual world can be done with modern tools such as mouse and keyboard. As an example of the non-wrapping VR type; computer, internet and image-based virtual reality studies can be given without using an additional device (Kurtulus, 2017).

Immersive Virtual Reality: Immersive VR adds the individual to the system with HMD (Head Mounted Display) or multiple projections in a virtual 3D rendered virtual reality. A sensor in the HMD detects the head movements towards the individual and transmits them to the relevant processor. Thus, it shows the images of the individual according to the head degree (Fig. 4) (Kurtulus, 2017).

Prepared with multiple reflectors, Immersive VR uses its reflectors to create a virtual reality and aims to give the individual a real-life experience.

Figure 4. Head mounted imaging equipment

Examples of Virtual Reality Applications

Virtual reality is a technology that facilitates interaction thanks to the visual system it

provides with objects and events that do not exist in reality (Freina and Ott, 2015). Virtual reality is a 3D simulation model that gives users a sense of reality. The environment designed through a computer provides the opportunity for mutual communication. In this way, the designed systems significantly increase our perception and grasping power. Virtual reality is used in many areas from healthcare to entertainment (Bayraktar & Kaleli, 2007). Virtual reality technology is also used effectively in the field of education. As it gamifies the education given, it increases the students' desire for learning and ensures their more intense participation in the lesson (Freina and Ott, 2015; Bastiaens, 2014). Thus, learning and entertainment processes can be used to support each other through virtual reality. In addition, virtual reality enables students to be in the same virtual environment. In this way, students can interact and work together. Virtual reality technology allows students to explore more different types of learning. With these discoveries, students also increase their tendencies towards different types of learning. In short, virtual reality emerges as a new tool to improve learning, make it fun and more attractive (Simsek & Can, 2019).

With virtual reality, it is possible to visit cities, buildings or a place you have created with your imagination in a virtual environment. For example, with the ancient city tour application with VR technology in Turkey, Zeus, Asklepios, Red Court and Athena temples in Bergama can be visited in 3D. In addition, the Techno Mersin Project has been developed by METAB and Mersin Metropolitan Municipality to promote the province of Mersin. With this project, Mersin can be visited in a virtual environment (Ekici & Guven, 2017).

In the digital age, information flows is experienced very intensely. This situation causes the search for differences in news presentations. The journalism industry has entered into different searches for virtual reality. With VR used in journalism, the audience can think of themselves as in the event and creates empathy towards the event. In other words, the audience will not only watch the news, but will also be able to add their own feelings and thoughts to the news. This journalism is called 'immersive journalism'. Immersive is defined as aiming to draw the audience into the event (Caba, 2018).

Gunes and Dilipak aimed to contribute to the training of people who detect explosive substances with VR in their study. It is known that deactivation of explosive materials is an important issue. It is extremely important to the defense personnel working in this field to detect the substance and destroy it without being damaged. Thanks to the virtual environment created with virtual reality technology, people think of themselves as in the real environment. This increases the realism in training of the personnel and allows them to complete their training carefully (Gunes & Dilipak, 2020).

One of the most important areas where virtual reality is applied is health. Işıklı et al., in their study, aimed to treat people diagnosed with specific phobia with VR technology. In

the study, 11 participants that did not use drugs were exposed to virtual environment scenarios according to their phobias. As a result, the reactions to the participants according to their phobias decreased day by day (Isikli et al., 2019).

Augmented Reality

"Augmented Reality (AR)"; It is defined as a technology that combines real and virtual environments. In this technology, virtual and real objects interact with each other (Azuma, 1997). 3 important features of AR;

- Combination of real and virtual objects
- Provide real-time interaction
- Finding 3D (3D) visuals

In AR technology, a real world image is taken primarily through the camera. On top of the captured image, it is checked whether one of the target impressions introduced to the system exists. If a target impression is found, pre-created virtual objects are placed on this target impression (Azuma, 1997). In applications developed with AR technology, virtual objects such as 3D images, pictures, animations, texts and videos can be used together or separately (Wang and others, 2013). Thus, individuals are provided to communicate naturally with events, objects and information (Woiciechowski & Callery, 2013). In AR technology, glasses and special head-mounted devices were used for the first time. Today, we can use it even only with our mobile devices (Kommera and others, 2016). This technology, which has become increasingly widespread, has become available with different devices such as desktop and laptop computers, smart phones.

Types for Augmented Reality

There are several types of developing applications for AR. Developers need to determine their needs before choosing the type of app they want to use. In this way, the most suitable choice will be made according to the wishes and needs. AR technology is of two types, location-based and image-based. Once the selection is made, the AR system is carried out in 3 steps: recognition (detection of image, image or location), tracking (layout of 3D objects) and merging (Icten & Bal, 2017; Zhou et al., 2008).

Software and SDKs Used in Augmented Reality

While the AR application is being developed, tasks are defined with code to the hardware. Different software is used according to the infrastructure, type and function as the hardware. The use of mobile technologies in AR applications have increased due to convenience and accessibility. Due to this increasing interest, a new sector has emerged. Today, AR applications appear as mobile applications instead of special hardware or

glasses (Craig, 2013). Software development kit (SDK) is used to produce AR applications. Vuforia, ARCore, Wikitude, ARKit are the most used SDKs. SDKs are used a lot when developing mobile games or applications (Craig, 2013). *ARKit*: Apple has acquired Metio, a company that conducts research on augmented reality technology. After working on ARKit for a year, it was released in 2017. ARKit offers very different experiences of Apple devices. It is possible to develop applications with game engines such as Unreal Engine, Unity or SceneKit. (Apple, 2020; Agacayak, 2019). In Figure 5, there is a visual of the interface of the ARKit application.

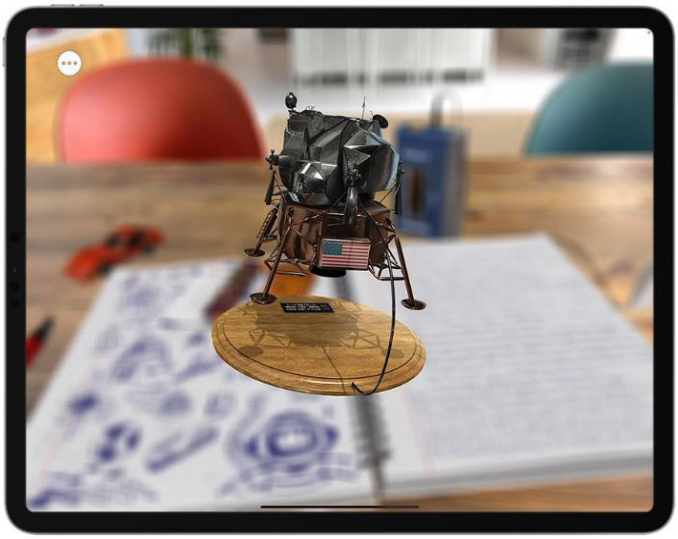

Figure 5. An example for ARKit SDK application

ARCore: It is the SDK developed for the AR application released by Google. With ARCore, applications can be developed for devices with Android and iOS operating systems. The most important features different from the others (Agacayak, 2019; Google, 2020):

- It estimates the application light by reference to the ambient light.
- It can perceive surface maps diagonally, vertically and horizontally. Positioning features is at their best.

Figure 6. ARCore interface

ARCore provides free use to users. Figure 6 shows the image of the ARCore interface. Developers can use platforms such as Unreal Engine, Unity or AndroidStudio (Agacayak, 2019; Google, 2020). *Wikitude*: is a company found in Austria in 2008. It is one of the

augmented reality development SDKs (Figure 7). Its founding purpose is to develop AR application for locations around the world. It has become a general AR application as its popularity has increased from a short time. The most important reason to use Wikitude is that it provides rapid application development. In addition, the technologies it contains are available for Android, Windows and iOS operating systems, allowing developers to choose Wikitude (Agacayak, 2019; Wikitude, 2020).

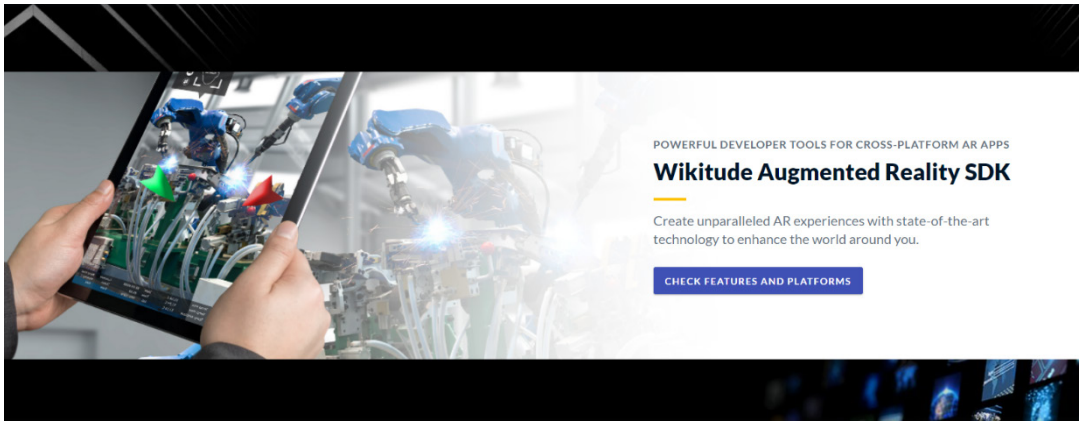

Figure 7. Wikitude interface

Vuforia: Vuforia is an SDK that enables the development of high quality, fast and immersive applications. It can be used in different operating systems. Thanks to the VuMark feature, markings can be made on reference points, thus providing users with the opportunity to develop interactive applications (Figure 8) (Agacayak, 2019; Vuforia, 2020).

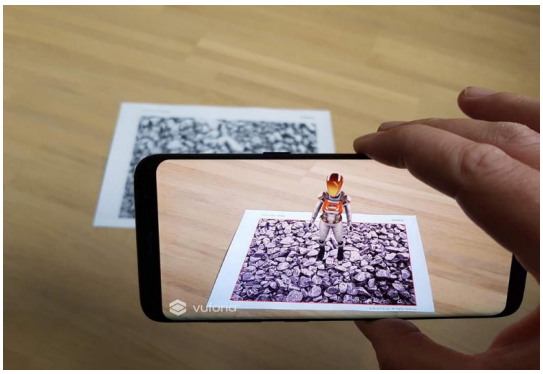

Figure 8. An example for Vuforia SDK application

Examples of Augmented Reality Applications

Augmented reality technology is also used in many areas, just like virtual reality technology. The aim at the developed AR applications is; making life easier, studying, having fun, etc. For this reason, it is widely used today, just like VR. AR applications need to be interesting and impressive in order to be suitable for their purposes (Demirezen, 2019). In this section, a few examples related to augmented reality applications will be explained. Driving a vehicle is an activity that is fun and requires a lot of attention. Accidents occur because of drivers' carelessness or fast driving. And these accidents, un-

fortunately, can result in death. Many applications have been made in order to reduce the accident rates of the automotive sector. Among these applications are Head-Up display analyzers with DLP (Digital Light Processing) imaging system feature. These screens are the most important AR devices in the industry. Head-Up (Figure 9) instantly shows the speed value that the driver must comply with by calculating the distance between the vehicles used and the vehicle in front of it. In this way, drivers will see at what speeds they need to drive the vehicle. distance, speed etc. as a result of calculations, the receipt and processing of information are Emgu CV or Open CV, etc. provided by libraries. An example image of Head-Up is given in Figure 9 (Bradski & Kaehler, 2008; Shi, 2013).

Figure 9. An example head-up application

Traveling and exploring new places is one of the hobbies of people. Travel companies have sought different ways to make this hobby more enjoyable and enjoyable. In this respect; Technological studies based on iOS have been made, such as the ease of introducing important or historical places and finding their addresses. Thanks to AR technology, people can read information about the historical places they have visited and see the old version of a newly built building as a 3D model instead of recreating it in their dreams (Figure 10). It is possible to show applications such as Urban Sleuth (Drupal, 2020), Street Museum (Museum of London, 2020), Metro AR Pro developed for the London museum as examples (Icten & Bal, 2017). In our country, an AR application was made by the Mardin Metropolitan Municipality in order to promote the city and inform the tourists. In this context, the "Mardin AR" application was launched at the Information Culture and Promotion Center (Anadolu Agency, 2020). Figure 11 shows an application example of the archaeological field.

Figure 10. An example of AR for archeology

Another area where AR technology is used is sports applications. It has been used in sports such as cricket, tennis, football. Hawk-eye (Owens and others, 2003) is the most well-known AR application for this field. The purpose of this application is to follow the path of the ball. The purpose of using AR technology in sports applications is to provide more useful training to the athletes by preparing realistic environments, and to improve their performance and abilities (Bozyer, 2015).

Mobile games are indispensable to people, especially young people. There are educational games as well as games that cause us to waste our time. Considering the studies made with AR technology, it is estimated that wearable and Head-Up devices will take the gaming industry to another dimension. The game Pokemon Go (Serino et al., 2016), which almost everyone played a few years ago (Figure 11), is a location-based AR technology game. Although this game allows people to act in the real world, it has created problems in terms of security. In addition, a negative aspect of people's addiction to the game has also emerged.

Figure 11. AR-based Pokemon Go game

With AR technology in marketing, it can be easier to promote and sell customers' products (Bule & Peer, 2013). Because with AR, it is possible to present the customer's product as a picture, text or 3D object. In this way, the customer will have the opportunity to examine the product as if he saw it in the real world. In the studies carried out, customers can remotely control the product with hand movements towards the store or at home. Examples are applications developed by companies such as Kinect (Vimeo, 2020), Smatrix (Vimeo, 2020) and Fitnect (Youtube, 2020). In addition, with IKEA's IKEA AR catalog application, customers can see all kinds of household goods or furniture in their home environment in 3D (IKEA, 2021). Figure 12 shows the image of the IKEA AR application.

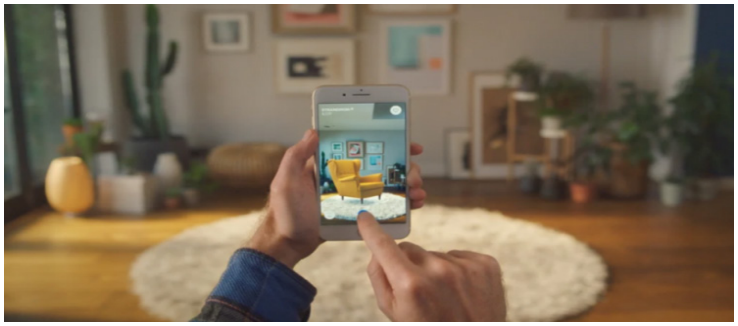

Figure 12. IKEA AR app

One of the most important areas where AR technology is used is education. Signal-based AR technology is generally used in the field of education. The knowledge to be taught with 3D objects, animations and drawings becomes more fun. Quiver (ColAR) application was developed by Quiver Vision Company (Figure 13). With this application, students can view the pictures on the marker papers in 3D according to the colors they paint (Quiver, 2021). Another application for this field is the Brainspace magazine application developed by Blippar Company. Users can view the objects of the magazine pages in 3D or video form with Brainspace (Brainspace, 2021).

Figure 13. Quiver app image

Conclusion

The purpose of augmented and virtual reality is to create virtual environments for users. This technology can be defined as two sides of a coin. With AR, people can interact with 3D objects without breaking away from the real world, while in VR they are completely in the virtual world (Sidiq et al., 2017).

Table 1. Augmented Reality and virtual reality comparison

	Augmented Reality	**Virtual Reality**
Function	AR is the fusion of the real world and the virtual world. Digital content is simulated in the real world.	VR changes reality by immersing the user in a completely imaginary world.
Devices	Presented on Google Glass. HoloLens is the most famous AR device.	VR has been around for a long time. Oculus Rift is the most famous VR device.
Applications	Video games, theme parks, simulation apps, worker training, trading, etc.	Video games, theme parks, entertainment applications, video, collaboration, worker training, simulation applications, etc.
Actors	Epson, Microsoft, Skully, Vuzix	HTC, Oculus VR, Sony, Samsung Gear VR

Key differences between VR and AR (Icten, 2019);

- VR is based on the virtual world, while AR is based on the real world.
- While VR takes the users completely into the virtual environment, AR maintains the connection of the users with the real world.
- While VR transforms the data onto a part of the virtual environment, AR adds this data created with computer software on its real image in the form of layers.
- VR allows to intervene in the virtual environment with data and special tools, while AR also allows to intervene in the real environment manually.
- VR imprisons users in the virtual world. It does not allow seeing depressed objects or events in the virtual environment. AR, on the other hand, allows the user to see the events and objects of them by not detaching them from the real world.
- VR usage tools are airplane, car simulator or glasses. With these tools, the field of view of the users becomes a completely virtual world. AR usage tools are devices such as tablets, smartphones or computers.
- VR receives direction and position information about data onto sensors, AR receives this information through interaction with the real environment.

Figure 14. Comparison of Augmented Reality and Virtual Reality

Figure 14 shows the differences between real, VR and AR environments. When we take the real world as a reference, a three-dimensional computer image can be added to the environment in AR. In the VR environment, the real world has been virtualized and a computer object has been added. As a result, AR can be expressed as virtuality and reality, and VR as virtuality and virtuality (Icten, 2019).

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About the Authors

Yusuf UZUN, PhD, is an Assistant Professor of Computer Engineering at Necmettin Erbakan University in Konya, Turkey. He holds a PhD in Mechanical Engineering from Necmettin Erbakan University. His main areas of interest are artificial intelligence, autonomous systems and augmented reality applications. He also works as the Rector's Advisor at Selcuk University. **E-mail:** yuzun@erbakan.edu.tr, **Orcid:** 0000-0002-7061-8784.

Mustafa AKIN, is studying at Necmettin Erbakan University in Konya, Institute of Science and Technology, as a graduate student in Mechatronics Engineering. He graduated from Fırat University, Department of Mechatronics Engineering. His main areas of interest are hardware design, maker, augmented reality, virtual reality and complex applications. He works as a XR developer in a private company.

E-mail: m.akinronics@gmail.com, **Orcid:** 0000-0001-6358-6369.

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