Kinetik: Game Technology, Information System, Computer Network, Computing, Electronics, and Control
Journal homepage: http://kinetik.umm.ac.id
ISSN: 2503-2267
Vol. 8, No. 1, February, Pp. 429-434

Utilization of AR technology for the development of speech therapy applications by optimizing marked-based tracking method

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Article Info
Keywords:
Augmented Reality, Autism Spectrum Disorder, Marked Based Tracking Method, Speech Delay, Therapy

Article history:
Received: November 04, 2022
Accepted: December 04, 2022
Published: February 28, 2023

Cite:
L. P. Wanti, O. Somantri, and T. Karyati, "Utilization of AR Technology for The Development of Speech Therapy Applications by Optimizing Marked-Based Tracking Method", KINETIK, vol. 8, no. 1, Feb. 2023.
https://doi.org/10.22219/kinetik.v8i1.1584

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Abstract
Autism is a developmental disorder that attacks children mentally and causes difficulties in interacting with the social environment. Therapy that can be done to people with autism to deal with communication disorders is speech therapy. Application usage health or better known as mobile health is easy and fast to help users in accessing information about various health problems, one of which is child development or better known as an autism spectrum disorder (ASD) which was developed using augmented reality (AR) technology. The purpose of the study is to optimizing the marked-based tracking method to augmented reality technology for speech therapy tutorials for children with autism. The results obtained from this study are the SELPY application (Self Autism Therapy) mobile-based speech therapy for people with autism which is a product of the application of appropriate technology in the field of information technology, especially in the health sector. The marked-based tracking method has been successfully implemented in the development of speech therapy AR applications for children with autism spectrum disorder (ASD). This is by the results of the tests that have been carried out, namely distance testing and angle testing. The most ideal distance to detect marker/image targets is 40cm to 50cm with a smartphone tilt angle of 200 to 300.

1. Introduction

The health aspect can utilize augmented reality technology by combining two objects, namely real objects (reality) with virtual objects (virtual) [1], [2]. The application of augmented reality (AR) technology has been widely seen in health applications, one of which is an android application to treat autism in children [3]. The application can be used by parents with children with ASD indications [4].

Usually, children with ASD show symptoms that can be seen from birth until before the patient is three years old. That means the symptoms/disorders occur during the child's growth and development [5], [6]. Parents should be extra focused on accompanying the development of children with ASD [7], [8]. Caring for children with ASD requires energy, time, and a strong enough financial foundation so that children can grow optimally like other normal children [9], [10]. Some therapies that can be given to children with autism include physical therapy, speech therapy, sensor integration therapy, visual therapy, occupational therapy, biomedical therapy, and others depending on the child's condition [11], [12]. Speech therapy is given to children with autism who have problems regarding the ability to speak, understand and express language [13], [14].

To overcome this, it is necessary to use information technology in the field of health, especially to deal with speech delays in children with autism namely augmented reality technology for the development of an application that can help parents/children with autism do independent speech therapy. Through this research, proposed an application of the marker-based tracking method used in technology augmented reality to be developed into an application that can be utilized by children with ASD in speech therapy. Use of marker-based tracking itself based on the therapy that will be developed for children with ASD, namely speech therapy by using a patterned two-dimensional object marker, so that the family able to perform speech therapy independently.

Several previous studies have been conducted by Kamran et al. This research discusses use of augmented reality (AR) for improve children's skills diagnosed with ASD. Research result shows that AR is beneficial for children with ASD in support learning skills. Further research discusses the effectiveness of AR among more participants, share technology supporting AR for intervention, generalization and maintenance of skills learning and evaluation in an inclusive class environment and other settings are guaranteed [15]. Subsequent research by Syahputra et al. This research produces 3D animation social stories by detecting markers which is located in a special book and some simple games that designed for children with autism who done using jumps motion controller that is useful for read hand movements in real-time. Augmented reality implementation for social therapy by packing stories it uses virtual techniques to increase children's intrinsic motivation with ASD because of the child having trouble focusing [16]. The

next research by Liu et al with research results in the form of smart glasses that use augmented reality technology which has an important role in helping to overcome the therapeutic needs of children with ASD. This app provides training to both children and adults for emotion recognition, face-to-face gaze, eye contact, and behavioural self-regulation. The data collection method in this study is quantitative where data is obtained from a system that allows digital phenotyping and social improvement, construction, and communication from the research domain criteria. In conclusion, this study provides evidence about the feasibility, usability and tolerability of smart glasses [17].

The difference between this study and previous research is that this research serves to develop applications that can be used to carry out independent speech therapy for children with ASD by using an application that implements the marker based tracking method on augmented reality technology so that it can overcome speech delays. This research optimizing the marked-based tracking method on augmented reality technology for speech therapy tutorials for children with autism. The data used in this study is student data at SLB Putra Mandiri Kawunganten and SLB Putra Mandiri Gandrungmangu for the period January 2021 to March 2022. The output of this research is a mobile-based application that can be used by people with autism spectrum disorder (ASD) or their families to guide and conduct speech therapy independently.

2. Research Method

This study uses a marker-based tracking method for augmented reality technology used. The marker-based tracking method itself is one of the methods in augmented reality technology [18]. The working system of this method is to display three-dimensional objects when the camera detects a marker which at the beginning of the process positions the marker as a special marker that has special patterns [19], [20]. The pattern will be read by a computer device that has a webcam installed, so that all objects captured/recorded can be stored on the computer [21]. Usually, the pattern is in the form of media which is illustrated in black and white, where the colour is white for the background and black colour is for the border [22]. Stages of marker-based method tracking begin with the user placing the webcam or camera media above the marker, and then the media will identify the marker [23], [24]. If it is appropriate then the object appears 3D, if it is not appropriate, then the marker identification process is repeated until it appears its 3D object [25], [26]. This method is a development of previous research namely an expert system for early diagnosis of autism in children by identifying the symptoms that occur in the child. This study proposes a design information system application by implementing the marker-based tracking method so that can be used for speech therapy for children with ASD who have communication. The marker-based tracking method is a method that combines virtual objects with real objects in augmented reality technology. Marker method workflow-based tracking can be seen in Figure 1 below.

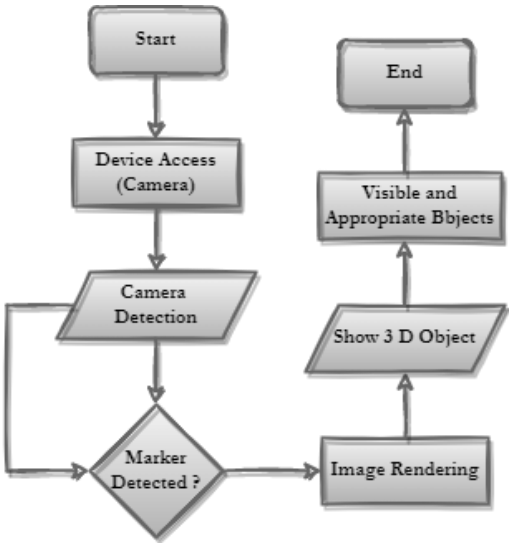


Figure 1. Flowchart Marker-Based Tracking

The stages of the marker-based tracking flowchart process in Figure 1 above are by scanning a sign or marker which is the main component in creating a 3D virtual world on the system [27]. Augmented reality serves to add information and definition of a real object or a place. The ultimate goal of augmented reality for simplify users' lives by delivering virtual information, aimed at knowing firsthand the real-world environment and not just the surrounding environment, for example, live-streaming video [28], [29]. Steps in the method of marker-based tracking start from accessing the device/camera that will look for the marker position as input for executing the next command. When the

marker has been detected then the three-dimensional image/object will be displayed based on the detected marker input by the device/camera [30].

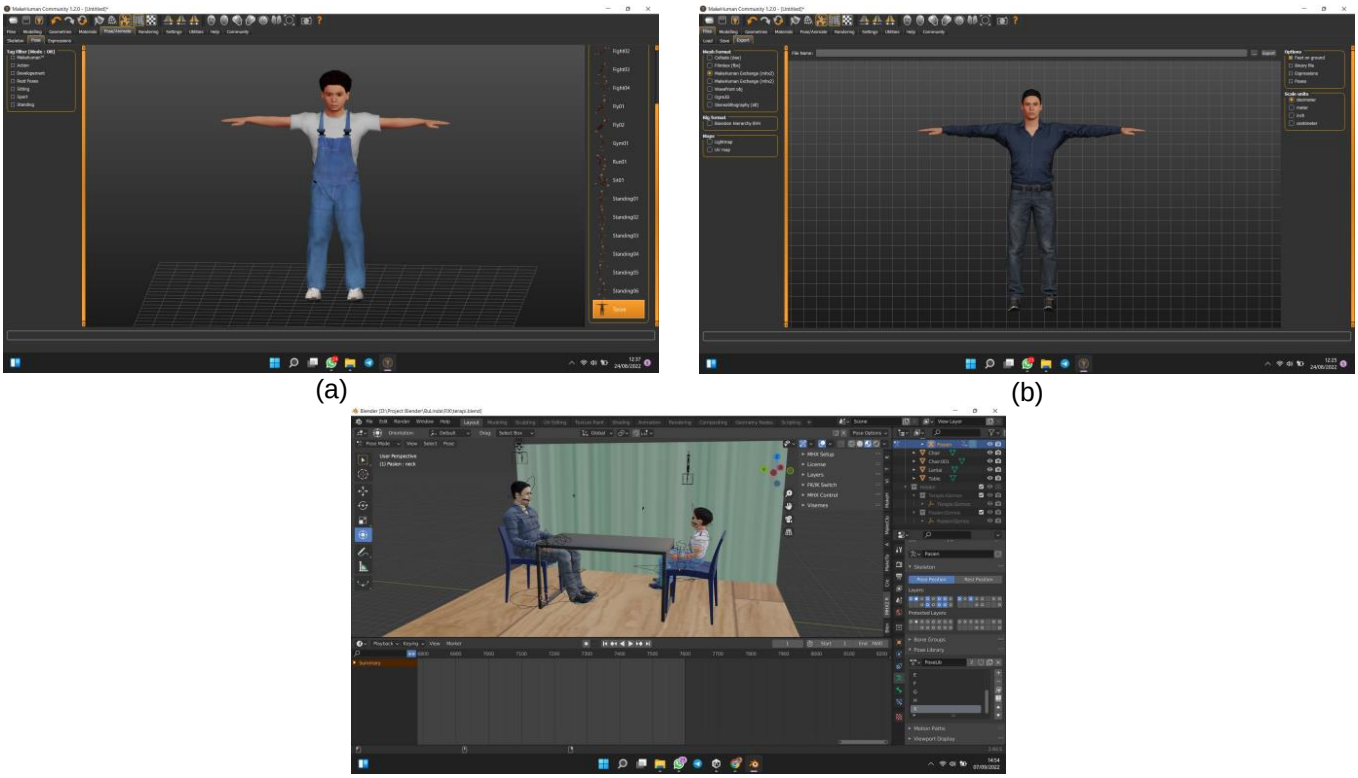
The use of marker-based tracking itself is based on the therapy that will be developed for children with ASD, namely speech therapy that uses markers for two-dimensional objects or object known as a marker that has a pattern so that families can do independent speech therapy. The pattern is recorded by the connected computer device with a webcam or camera media and usually, the pattern is illustrated in black and white, black represents the border while white represents the background [31].

3. Results and Discussion

In the following, we discuss the implementation of the marker based tracking method used in AR applications, starting with the creation of 3D objects in the AR application, the results of the marker/image target scan and continued with testing the marker/image target.

3.1 3D Object Creation

Figure 2 shows the creation of a 3D object for a patient with ASD in Figure 2a, a speech therapist in Figure 2b and the background of a place to perform speech therapy shown in Figure 2c. Making AR application 3D objects using Unity software.



(a) (b)

(c)

Figure 2. Making 3D Objects AR Speech Therapy Application

3.2 Marker Scan Results

The results of the marker scan/target image are shown in Figure 3. Figure 3a shows an AR application marker which, when scanned, will display a video whose screenshot results are in the next image. Figures 3b and 3c show the results of the marker/image target scan, in the image a speech therapist and an ASD pediatric patient are having a speech therapy session.

(a) (b) (c)

Figure 3. Marker/Image Target Scan Results of AR Speech Therapy Application

3.3 Marker Test

To find out whether the independent speech therapy application developed by optimizing the marked based tracking method is successful or not, a marker/image target is tested. The test is carried out in two stages. The first stage is testing the minimum distance, while the second stage is testing the minimum angle. The two stages of testing were tested on three types of marker sizes, namely markers with a size of 10cm x 10cm, 15cm x 15cm and 20cm x 20cm.

The results of the first stage of testing with the minimum distance test items against the three marker sizes can be seen in Table 1. The distance tested starts from 10cm to 100cm. The symbol D indicates that the marker/target image is detected while the symbol L indicates that the marker is not detected.

Table 1. Distance Test Result

Distance (cm)	Marker		
	10cmx10cm	15cmx15cm	20cmx20cm
10	D	L	L
20	D	L	L
30	D	D	L
40	D	D	D
50	D	D	D
60	L	D	L
70	L	L	L
80	L	L	L
90	L	L	L
100	L	L	L

Table 1 explains that the larger the target marker/image size, the farther the smartphone device is to detect the target marker/image. On the other hand, the smaller the target marker/image size, the closer the smartphone device is to detecting the target marker/image. The best distance to detect marker/image targets is between 30cm to 50cm for all marker sizes, both 10cm x 10cm, 15cm x 15cm and 20cm x 20cm.

The results of the second stage of testing with the minimum angle test items for three marker sizes can be seen in Table 2. The tested angle starts from 00 to 900. The symbol D indicates that the marker/target image is detected while the symbol L indicates that the marker is not detected.

Table 2. Angle Test Result

Angle (^{0})	Marker		
	10cmx10cm	15cmx15cm	20cmx20cm
90	L	L	L
80	L	L	L
70	L	L	L
60	L	L	D
50	L	L	D
40	D	L	D

30	D	D	D
20	D	D	D
10	D	D	L
0	D	D	L

Table 2 explains that the ideal angle that can detect the target marker/image is between 20^0 to 30^0. For a marker size of 10cm x 10cm, the smartphone scan angle that can detect markers is between 0^0 to 40^0, while scan angles above 40^0 to 90^0 cannot detect markers. For a marker size of 15cm x 15cm, a smartphone scan angle that can detect markers is between 0^0 to 30^0, while a scan angle above 30^0 to 90^0 cannot detect markers. The size of the marker is 20cm x 20cm, the only marker that is detected is a marker with a scan angle of 20^0 to 60^0. In addition, the marker cannot be detected.

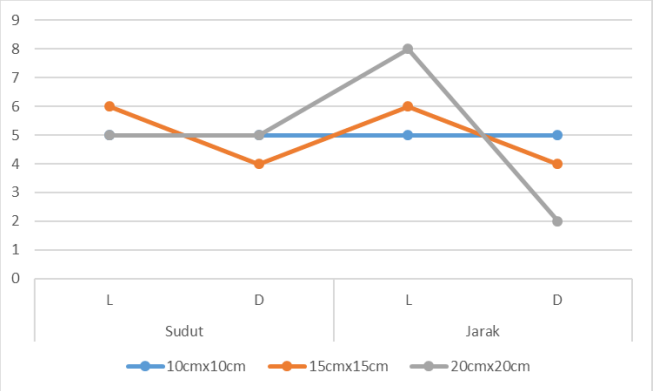


Figure 4. Comparative Results of Distance and Angle Tests for AR Speech Therapy Applications

Figure 4 shows the comparison of distance test results and angle test results. The L symbol indicates the marker image/target image is not detected by the smartphone device camera. The symbol D shows the marker image/target image detected by the smartphone device camera. For the lowest device specifications that can access this AR application, it is a smartphone with an Android 7.0 system with a 5mp camera or above.

4. Conclusion

From all stages of research that have been carried out, it can be concluded that the marked-based tracking method has been successfully implemented in the development of speech therapy AR applications for children with autism spectrum disorder (ASD). This is by the results of the tests that have been carried out, namely distance testing and angle testing. Augmented reality-based speech therapy applications can project speech therapy sessions conducted by speech therapists on children with ASD who experience speech delay. The most ideal distance to detect marker/image targets is 40cm to 50cm with a smartphone tilt angle of 20^0 to 30^0. While for the lowest smartphone specifications that can access speech therapy AR applications are smartphones with Android 7.0 version with a 5mp camera.

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