

# *Analysis of Markerless-Based Tracking Methods of Face Tracker Techniques in Detecting Human Face Movements in 2D And 3D Filter Making*

M. Ilham Arief<sup>1</sup>, Kusrini<sup>2</sup>, Tonny Hidayat<sup>3</sup>

<sup>1,2,3</sup>Faculty of Computer Science, Universitas AMIKOM Yogyakarta, Yogyakarta, Indonesia

<sup>1</sup>ilhamarief@students.amikom.ac.id

<sup>2</sup>kusrini@amikom.ac.id(\*)

<sup>3</sup>tonny@amikom.ac.id

Received: 2022-12-26; Accepted: 2023-01-18; Published: 2023-01-28

**Abstract**—The marker-based tracking method is a method that utilizes markers, while the markerless-based tracking method is a method that does not use markers in making AR. In the markerless-based tracking method, there is a face tracker technique. In previous research, no one has discussed the comparison of effectiveness concerning the success and accuracy of using the face tracker technique. Therefore, this study aims to test the effectiveness of the accuracy and accuracy of success with applying the markerless-based tracking method, the face tracker technique, in detecting facial movements. in 2D and 3D AR with light intensity test parameters of 20 Lux, 40 Lux, and 60 Lux with WRGB light color, Face angle position of 30o and 60o, and face distance from camera 50 cm, 100cm, and 150cm. The results of comparison of superior success accuracy are at a distance of 50 cm; with an accuracy rate for 2D AR of 93.22% and 96.63% for 3D. It was concluded that the face tracker technique's markerless-based tracking method works optimally in 3D compared to 2D. This research finds an attractiveness score of 1.865, a perception score of 1.683, an efficiency score of 1.550, a dependability score of 1.638, a stimulation score of 1.500, and a novelty score of 1.013. Quality with an attractiveness value of 1.68, pragmatic quality of 1.56, and hedonic quality of 1.26. This study concludes that 2D and 3D AR face detection positively evaluates user experience and quality.

**Keywords**— Augmented Reality, Markerless-Based Tracking Method, Face Tracking, Light Intensity, Face Angle Position, Face Distance, User Experience Questioner (UEQ) Method

## I. INTRODUCTION

2D animation and 3D animation serve as important media to help visual media content. Recently 2D and 3D animation emerged as a powerful way to communicate and convey ideas with other people's animated characters through Augmented Reality (AR) Implementation [1].

This section explains in detail the research conducted. Briefly describe the material and methods used in the study, including the subject/material studied, the tools used, the design of the experiment or design used, the sampling technique, the variables to be measured, the technique of data collection, analysis, and statistical models used—successive quotes in parentheses [1]. The technology known as augmented reality (AR), which in the modern era of globalization is experiencing significant progress, is known as the merging of virtual data with the real world. Alternatively, one could call it a merger between the real and virtual worlds, both of which can be seen simultaneously in the same place [2].

The principle is to apply computer-generated virtual information, such as text, images, 2D models, 3D models, music, videos, and others, to the real world. In this way, the two types of information complement each other, resulting in a product called Augmented Reality (AR) [3]. In making Augmented reality, there are two methods: marker-based tracking and markerless-based tracking[4]. The marker-based tracking method is a method that utilizes a patterned image that

is specific and has been recognized by the system with the template library from AR. The marker is read and recognized by the camera and then matched with the FlarToolkit template [5]. The markerless-based tracking method is a method that does not use markers to display virtual objects. These methods are divided into several techniques [6], namely face tracking to recognize facial areas and object tracking, which is a technique for recognizing objects. Motion tracking, namely tracking to detect movement, and GPS-base tracking, namely tracking by accessing the Global positioning System (GPS) and the Compass sensor [7].

The face tracker technique or face tracking is a markerless-based tracking technique used to track the position of the face. The coordinates of the face position are used to control tools or devices embedded in the face-tracking program, making it easier to identify a person [8].

The Deep face algorithm is an algorithm that the largest company is currently developing in the world, namely Facebook, which can quickly and accurately detect human faces, this algorithm is claimed can detect human faces with an average percentage of 97.25% [9]. In 2016 Facebook researchers published another paper on how to implement a new technology called Deep Mask and Sharp Mask which is part of Deep Face used to group objects in a scene and extract the details needed [10]. Sharp Mask as the name suggests performs slightly better and gives a sharp mask overlaid over

the target than Deep Mask, both of which are used in the Spark Studio Meta Software [11].

In the research that Putra conducted in 2019 [12] by applying the marker-based tracking method in 2D and 3D-based augmented reality, namely analyzing 2D and 3D marker-based detection tests with parameters. Namely, speed in displaying objects, light intensity, inclination angle, and application testing carried out on ten different devices. The results of this study are that the marker-based tracking method is superior in 2D compared to 3D.

In research conducted by Arifitama in 2022 [13] in this study, a comparison was made of the effectiveness of the accuracy and accuracy of the use of the two methods, namely marker-based tracking, and markerless-based tracking. This study showed that markerless-based tracking was superior, with an accuracy rate of 93%, while marker-based tracking of 83.3%.

In research conducted by Farianto in 2021 [14], this study aims to compare the two AR methods with a case study, namely the Soesilo Soedirman Museum. The results of this study are that the average marker-based tracking method test results obtain 75%, and the average markerless method test obtains 88%. The markerless method applies the AR method to the Soesilo Soedirman Museum study.

However, many researchers have previously researched markerless-based tracking methods but have not applied them to face tracking. This study aimed to test the markerless-based tracking method with one of the techniques used, namely the face tracker, by adopting an artificial algorithm made by Facebook, namely the Deep face Algorithm in 2D and 3D animation with parameters testing light intensity, tilt angle, and distance. Actor's face from the camera and the UEQ (User Experience Questionnaire) measurement method. The author hopes this research can help AR developers in the future. They are not confused in determining the method they want to use in their manufacture and are expected to contribute to the field of Intelligence animation research.

## II. RESEARCH METHODOLOGY

In this study, using the research and Development (R&D) method, as proposed by Borg and Gall RnD [15] (Research and Development), is one of the research methods used in the development and validation of products that will be used in learning and education in research. This refers to the steps carried out by Borg & Gall in several stages, namely the first is the identification of the research problem, the planning stage, the process stage, and the testing stage.

### A. Method of collecting data

The data collection stage will be summarized as follows:

1) *Experiment*: 2D and 3D modeling. Before making a 2D face blur AR filter, it is necessary to make a 2D blur effect texture model using Adobe Photoshop software, namely in the form of the PNG format, which will later be implemented in the research. Then make a 3D face character with the resulting .fbx file format, which includes eye, face, and mouth objects.

Additional eye pupils in PNG format. for 2D can be seen in Figure 1. and for 3D seen in Figure 2.

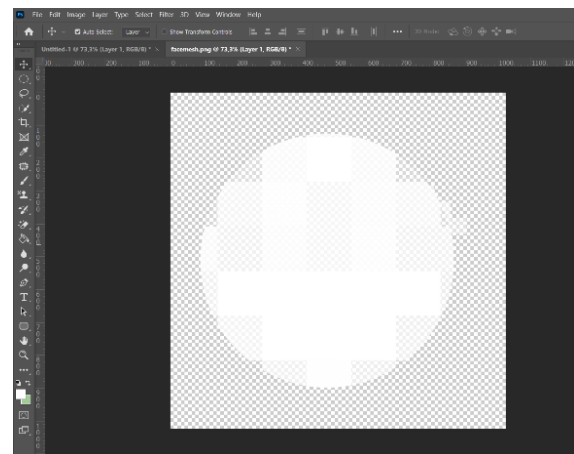


Figure 1. 2D Texture

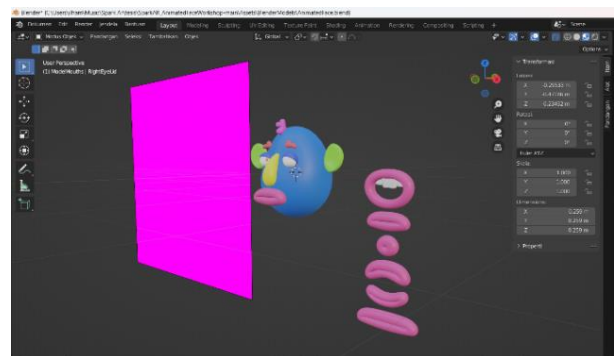


Figure 2. 3D Texture

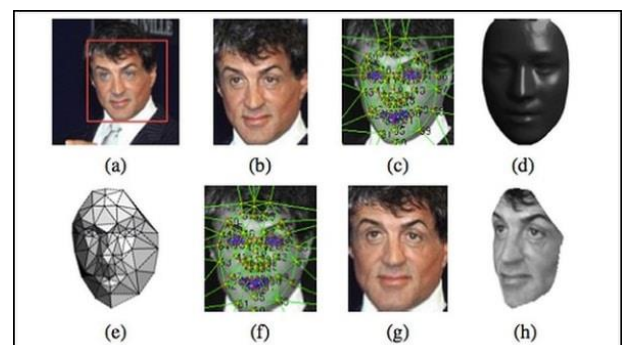


Figure 3. Deep Face

Markerless-based tracking method with the face tracker technique. At this stage, it was carried out with the help of the Facebook software, namely Meta Spark Studio, with the addition of a programming language, namely javascript, the face tracker technique, is basically [11]. The Deep Face Algorithm, the basic part of the Face Tracker Technique, can track facial movements in 2D and 3D.

2) *Data Collection*: As for the research scenario used in data collection, namely sampling the results of AR filter testing of 2D face blur masks and 3D animated character masks from 20 people using the User Experience Questionnaire (UEQ) measurement method.

3) *Testing the Markerless-based tracking method:* The following is the flow of testing on the Marker-based tracking method seen in Figure 4.

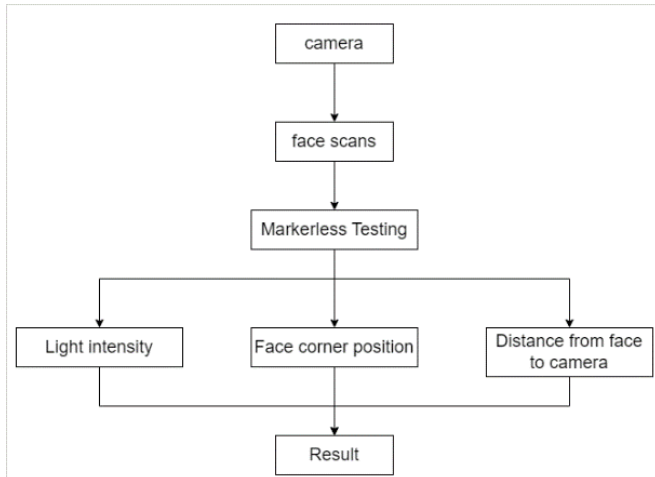


Figure 4. Testing Flow Markerless-based tracking

In Figure 4, the following approach is a test procedure for augmented reality using the Markerless-based tracking method:

- **Camera:** The smartphone camera is used as a marker location scanner for augmented reality objects on people's faces.
- **Face Scan:** At this point, the pattern is in the form of facial landmarks indicating where the augmented reality object appears on people's faces.
- **Markerless Testing:** In this stage, 2D and 3D objects are tested for appearance, namely with the parameters White, red, green, and blue light intensity, face angle position, and face distance to the camera.
- **Results:** In the final stage of testing without a marker, produce 2D and 3D AR results. Accuracy testing was carried out on the markerless-based tracking method with the face tracker technique using a light intensity of 20 Lux, 40 Lux, and 60 Lux with WRGB color light, 30 and 60-degree face angle position, face distance from the camera 50 cm, 100 cm and 150 cm to determine success accuracy. The test parameters used were adopted in previous studies [13]. For novelty in this study, additional testing was carried out on white, red, green, and blue light. Test parameters can be seen in Table I.

TABLE I  
 TEST PARAMETERS

WRGB Light Intensity (Lux)	Face to Camera Distance (cm)	Face Angle Position (°)
25	50	30
25	100	30
25	150	30
25	50	60
25	100	60
25	150	60
25 (Red)	50	30
25 (Red)	100	30
25 (Red)	150	30
25 (Red)	50	60

WRGB Light Intensity (Lux)	Face to Camera Distance (cm)	Face Angle Position (°)
25 (Red)	100	60
25 (Red)	150	60
25 (Green)	50	30
25 (Green)	100	30
25 (Green)	150	30
25 (Green)	50	60
25 (Green)	100	60
25 (Green)	150	60
25 (Blue)	50	30
25 (Blue)	100	30
25 (Blue)	150	30
25 (Blue)	50	60
25 (Blue)	100	60
25 (Blue)	150	60
45	50	30
45	100	30
45	150	30
45	50	60
45	100	60
45	150	60
45 (Red)	50	30
45 (Red)	100	30
45 (Red)	150	30
45 (Red)	50	60
45 (Red)	100	60
45 (Red)	150	60
45 (Green)	50	30
45 (Green)	100	30
45 (Green)	150	30
45 (Green)	50	60
45 (Green)	100	60
45 (Green)	150	60
45 (Blue)	50	30
45 (Blue)	100	30
45 (Blue)	150	30
45 (Blue)	50	60
45 (Blue)	100	60
45 (Blue)	150	60
60	50	30
60	100	30
60	150	30
60	50	60
60	100	60
60	150	60
60 (Red)	50	30
60 (Red)	100	30
60 (Red)	150	30
60 (Red)	50	60
60 (Red)	100	60
60 (Red)	150	60
60 (Green)	50	30
60 (Green)	100	30
60 (Green)	150	30
60 (Green)	50	60
60 (Green)	100	60
60 (Green)	150	60
60 (Blue)	50	30
60 (Blue)	100	30
60 (Blue)	150	30
60 (Blue)	50	60
60 (Blue)	100	60
60 (Blue)	150	60

Table I describes the contents of the measuring values of the 3 test parameters, namely WRGB light intensity, face angle position, and face distance to the camera. For the test, score parameters can be seen in Table II.

TABLE II  
 PARAMETERS (TEST SCORE)

Information	Score	Criteria
Very good	5	Points Appear, Objects Are Very Stable, and Points Are Detected Quickly
Good	4	Points Appear, Stable Objects, Points Detected Quickly
Enough	3	Points appear, objects are quite stable, and points are detected normally
Not Good	2	Points Appear, Unstable Objects, Slow to Appear
Very less	1	Points do not appear, and objects are not clear. 2D and 3D objects do not appear

Table II. is the augmented reality object detection level that will be applied during the object detection process on the face. The measurement parameters used in this test are derived from those used in previous studies [16]. Each statement is given a score between 1 and 5, and the assessment is made on that basis. The results of a markerless-based tracking approach with 2D and 3D face tracker techniques are then calculated using Equation (1) to detect augmented reality objects.

$$T_n = \frac{\sum ob}{\sum n} \times 100 \quad (1)$$

Where, the  $T_n$  variable is total accuracy, the  $\sum ob$  variable is the number of detected objects, and the  $\sum n$  variable is the total number of objects experimented on. The total accuracy of the object detected in the perfect face is divided by the total number of experiments (total scores) contained in each component.

4) *Testing the User Experience Questionnaire (UEQ) Method:* UEQ Items can be seen in Figure 5. UEQ is a tool that uses a questionnaire to quickly and effectively determine UX value [17]. UEQ design is highly compatible with UX research frameworks. Utilizing UEQ, user feedback can be collected effectively [18]. The UEQ scale is divided into three aspects, including aspects of Attractiveness, aspects of pragmatic qualities, and hedonic qualities. The Attractiveness aspect is a pure variable, and the pragmatic quality aspect is the user's perceived benefits, effectiveness, and ease of using the product. Perspicuity, efficiency, and dependability aspects are classified as pragmatic qualities. Meanwhile, hedonic quality relates to stimulation and novelty [19]. The UEQ method contains 26 questions covering the six variables [20], namely:

- Attractiveness is the user's enthusiasm for the product or their opinion about it.
- Perspicuity is using the product or how simple it is to understand
- Efficiency, namely the usefulness and speed of the product when used.
- Dependability is how much the user controls the interaction with the product.
- Stimulation, namely how much fun the product is for users and whether they are interested in using it.
- Novelty is how innovative in using the product.

After the data results from the respondents, the data is processed using the data processing provided by UEQ to produce results.

	1	2	3	4	5	6	7		
menyusahkan	○	○	○	○	○	○	○	menyenangkan	1
tak dapat dipahami	○	○	○	○	○	○	○	dapat dipahami	2
kreatif	○	○	○	○	○	○	○	monoton	3
mudah dipelajari	○	○	○	○	○	○	○	sulit dipelajari	4
bermanfaat	○	○	○	○	○	○	○	kurang bermanfaat	5
membosankan	○	○	○	○	○	○	○	mengasyikkan	6
tidak menarik	○	○	○	○	○	○	○	menarik	7
tak dapat diprediksi	○	○	○	○	○	○	○	dapat diprediksi	8
cepat	○	○	○	○	○	○	○	lambat	9
berdaya cipta	○	○	○	○	○	○	○	konvensional	10
menghalangi	○	○	○	○	○	○	○	mendukung	11
baik	○	○	○	○	○	○	○	buruk	12
rumit	○	○	○	○	○	○	○	sederhana	13
tidak disukai	○	○	○	○	○	○	○	menggembirakan	14
lazim	○	○	○	○	○	○	○	terdepan	15
tidak nyaman	○	○	○	○	○	○	○	nyaman	16
aman	○	○	○	○	○	○	○	tidak aman	17
memotivasi	○	○	○	○	○	○	○	tidak memotivasi	18
memenuhi ekspektasi	○	○	○	○	○	○	○	tidak memenuhi ekspektasi	19
tidak efisien	○	○	○	○	○	○	○	efisien	20
jelas	○	○	○	○	○	○	○	membingungkan	21
tidak praktis	○	○	○	○	○	○	○	praktis	22
terorganisasi	○	○	○	○	○	○	○	berantakan	23
atraktif	○	○	○	○	○	○	○	tidak atraktif	24
ramah pengguna	○	○	○	○	○	○	○	tidak ramah pengguna	25
konservatif	○	○	○	○	○	○	○	inovatif	26

Figure 5. UEQ Items

### III. RESULT AND DISCUSSION

This stage tests the 2D and 3D augmented reality filters. Where in this stage, the parameters of light intensity testing are used from white, red, green, and blue with units (lux). Distance from face to the camera in (cm), and Position angle of the face with units (°).

#### A. Test Results from Markerless-based tracking method, 2D face tracker technique

The following is a test carried out on 2D face Augmented Reality in the form of a face blur filter, as seen in Figure 6.

Figure 6. 2D Object Detection



In Figure 6. at this stage, the Augmented reality test with the markerless-based tracking method of the face tracker technique was carried out on the face. A total of 72 times. The tests were carried out on 2D AR in white, red, green, and blue light, distance and face angle.

It tests the detection of AR objects on faces using the markerless-based tracking method. It will later be divided into

three face-to-camera distance components (50, 100, and 150) to make it easier to calculate the accuracy of success, as seen in Table III, Table IV, and Table V.

TABLE III  
 RESULTS OF 2D MARKER-BASED TRACKING TEST SCORES, COMPONENT  
 DISTANCE 50 CM

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	50	30	5	5
25	50	60	5	5
25 (Red)	50	30	5	5
25 (Red)	50	60	4	-
25 (Green)	50	30	5	5
25 (Green)	50	60	5	5
25 (Blue)	50	30	5	5
25 (Blue)	50	60	5	5
45	50	30	5	5
45	50	60	5	5
45 (Red)	50	30	5	5
45 (Red)	50	60	5	5
45 (Green)	50	30	5	5
45 (Green)	50	60	5	5
45 (Blue)	50	30	5	5
45 (Blue)	50	60	5	5
60	50	30	5	5
60	50	60	5	5
60 (Red)	50	30	5	5
60 (Red)	50	60	5	5
60 (Green)	50	30	5	5
60 (Green)	50	60	5	5
60 (Blue)	50	30	5	5
60 (Blue)	50	60	4	-

In Table III. In testing with a face distance component of 50 cm, the highest score obtained was 110 (Number of perfectly detected objects), and the number of experiments was 118 (score). Therefore, an accuracy of 93.22% was obtained

TABLE IV  
 RESULTS OF 2D MARKER-BASED TRACKING TEST SCORES, COMPONENT  
 DISTANCE 100 CM

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	100	30	4	-
25	100	60	5	5
25 (Red)	100	30	5	5
25 (Red)	100	60	4	-
25 (Green)	100	30	5	5
25 (Green)	100	60	5	5
25 (Blue)	100	30	4	-
25 (Blue)	100	60	5	5

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
45	100	30	5	5
45	100	60	4	-
45 (Red)	100	30	5	5
45 (Red)	100	60	5	5
45 (Green)	100	30	5	5
45 (Green)	100	60	5	5
45 (Blue)	100	30	5	5
45 (Blue)	100	60	5	5
60	100	30	5	5
60	100	60	5	5
60 (Red)	100	30	5	5
60 (Red)	100	60	5	5
60 (Green)	100	30	5	5
60 (Green)	100	60	4	-
60 (Blue)	100	30	5	5
60 (Blue)	100	60	5	5

In Table IV, in the test with the face distance component of 100 cm, the highest score obtained was 95 (Number of perfectly detected objects), and the number of experiments was 115 (score). Therefore, an accuracy of 82.60% was obtained.

TABLE V  
 RESULTS OF 2D MARKER-BASED TRACKING TEST SCORES, COMPONENT  
 DISTANCE 150 CM

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	150	30	2	-
25	150	60	2	-
25 (Red)	150	30	5	5
25 (Red)	150	60	5	5
25 (Green)	150	30	1	-
25 (Green)	150	60	1	-
25 (Blue)	150	30	3	-
25 (Blue)	150	60	1	-
45	150	30	4	-
45	150	60	1	-
45 (Red)	150	30	5	5
45 (Red)	150	60	1	-
45 (Green)	150	30	1	-
45 (Green)	150	60	2	-
45 (Blue)	150	30	4	-
45 (Blue)	150	60	1	-
60	150	30	5	5
60	150	60	1	-
60 (Red)	150	30	5	5
60 (Red)	150	60	1	-
60 (Green)	150	30	5	5
60 (Green)	150	60	1	-

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
60 (Blue)	150	30	5	5
60 (Blue)	150	60	1	-

In Table V, in the test with the face distance component of 150 cm, the highest score obtained was 35 (Number of perfectly detected objects), and the number of experiments was 63 (score). Therefore, an accuracy of 55.56% was obtained

**B. Test Results from Markerless-based tracking method, 3D faces tracker technique**

The following is a test that has been carried out on Augmented Reality 3D faces in the form of facial characters, as seen in Figure 7.



Figure 7. 3D object detection

At this stage, Augmented reality testing was carried out with the markerless-based tracking method, the face tracker technique on the face, a total of 72 times tests were carried out on AR 3D in white, red, green, and blue light, distance, and face angle. The detection of AR objects on faces using a markerless-based tracking method, which will later be divided into three face-to-camera distance components (50, 100, and 150) to make it easier to calculate the accuracy of success. The results of this testing can be seen in Tables VI, VII, and VIII.

TABLE VI  
 THE RESULTS OF THE 3D MARKER-BASED TRACKING TEST SCORES, 50 CM DISTANCE COMPONENTS

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	50	30	5	5
25	50	60	5	5
25 (Red)	50	30	5	5
25 (Red)	50	60	5	5
25 (Green)	50	30	5	5
25 (Green)	50	60	5	5
25 (Blue)	50	30	5	5
25 (Blue)	50	60	5	5
45	50	30	5	5
45	50	60	5	5
45 (Red)	50	30	5	5

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
45 (Red)	50	60	5	5
45 (Green)	50	30	5	5
45 (Green)	50	60	5	5
45 (Blue)	50	30	5	5
45 (Blue)	50	60	5	5
60	50	30	5	5
60	50	60	5	5
60 (Red)	50	30	5	5
60 (Red)	50	60	5	5
60 (Green)	50	30	5	5
60 (Green)	50	60	5	5
60 (Blue)	50	30	4	-
60 (Blue)	50	60	5	5

In Table VI, in the test with the face distance component of 50 cm, the highest score obtained was 115 (Number of perfectly detected objects), and the number of experiments was 119 (score), therefore an accuracy of 96.63% was obtained.

TABLE VII  
 THE RESULTS OF THE 3D MARKER-BASED TRACKING TEST SCORES, 100 CM DISTANCE COMPONENTS

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	100	30	5	5
25	100	60	5	5
25 (Red)	100	30	5	5
25 (Red)	100	60	5	5
25 (Green)	100	30	5	5
25 (Green)	100	60	5	5
25 (Blue)	100	30	5	5
25 (Blue)	100	60	5	5
45	100	30	5	5
45	100	60	5	5
45 (Red)	100	30	5	5
45 (Red)	100	60	5	5
45 (Green)	100	30	5	5
45 (Green)	100	60	5	5
45 (Blue)	100	30	5	5
45 (Blue)	100	60	4	-
60	100	30	5	5
60	100	60	5	5
60 (Red)	100	30	5	5
60 (Red)	100	60	5	5
60 (Green)	100	30	5	5
60 (Green)	100	60	5	5
60 (Blue)	100	30	5	5
60 (Blue)	100	60	4	-

In Table VII, in the test with the face distance component of 100 cm, the highest score obtained was 110 (the number of perfectly detected objects) and the number of experiments was 118 (score), therefore an accuracy of 93.22 was obtained.

TABLE VIII  
 THE RESULTS OF THE 3D MARKER-BASED TRACKING TEST SCORES, 150 CM  
 DISTANCE COMPONENTS

Light intensity	Face distance	Face angle	Score	Objects are detected perfectly
25	150	30	5	5
25	150	60	1	-
25 (Red)	150	30	3	-
25 (Red)	150	60	1	-
25 (Green)	150	30	1	-
25 (Green)	150	60	1	-
25 (Blue)	150	30	2	-
25 (Blue)	150	60	1	-
45	150	30	5	5
45	150	60	5	5
45 (Red)	150	30	5	5
45 (Red)	150	60	4	-
45 (Green)	150	30	5	5
45 (Green)	150	60	5	5
45 (Blue)	150	30	5	5
45 (Blue)	150	60	4	-
60	150	30	5	5
60	150	60	4	-
60 (Red)	150	30	5	5
60 (Red)	150	60	4	-
60 (Green)	150	30	5	5
60 (Green)	150	60	4	-
60 (Blue)	150	30	5	5
60 (Blue)	150	60	5	5

In Table VIII, in testing with a face distance component of 150 cm, the highest score obtained was 60 (Number of perfectly detected objects), and the number of experiments was 90 (score). Therefore, an accuracy of 66.67% was obtained. Comparison results of 2D and 3D AR with the Marker-based tracking method The face tracker technique can be seen in Table IX.

Table IX compares superior success accuracy for each component where there are three components, namely the distance of 50, 100, and 150 cm. The high accuracy value will be taken, and the highest accuracy of the three components is at a distance of 50 cm, with an accuracy rate for 2D AR of 93.22% and 96.63% for 3D. So it can be concluded that the markerless-based tracking method with the face tracker technique works more optimally in 3D than in 2D.

TABLE IX

COMPARISON RESULTS OF 2D AND 3D AR WITH THE MARKER-BASED TRACKING METHOD FACE TRACKER TECHNIQUE

Distance (components)	2D success accuracy	3D success accuracy
50	93,22%	96,63%
100	82,60%	93,22%
150	55,56%	66,67%

B. Results of the User Experience Questionnaire (UEQ)

This study uses the UEQ method to measure user experience in Augmented reality with the face tracker technique markerless method. The UEQ method has six variables containing 26 question items. In this study, researchers tested Augmented reality on 20 respondents. Table X shows the results of 20 respondents' answers.

TABLE X  
 ANSWERS FROM RESPONDENTS

No	1	2	3	.	.	25	26
1	7	7	1	.	.	1	6
2	4	7	2	.	.	1	7
3	1	1	2	.	.	1	1
4	4	6	4	.	.	3	5
5	6	5	3	.	.	2	6
6	4	4	3	.	.	3	3
7	6	7	1	.	.	1	7
8	5	6	4	.	.	4	4
9	7	6	6	.	.	2	6
10	6	6	7	.	.	3	5
11	7	6	2	.	.	1	7
12	5	6	3	.	.	3	3
13	6	7	1	.	.	1	6
14	2	2	1	.	.	3	2
15	6	7	1	.	.	2	7
16	4	5	6	.	.	4	6
17	6	6	4	.	.	2	2
18	7	7	1	.	.	1	7
19	7	7	1	.	.	1	7
20	6	7	2	.	.	2	7

1) Data Transformation

Table X. is the result of the assessment of 20 respondents, but in the assessment, it is still on a scale of 1-7, then it will be transformed from -3 to +3. The results are seen in Table XI, and the data is transformed in the second stage in Table XII. When you have done the data transformation in stage 1, then do the data transformation in stage 2.

TABLE XI  
 STAGE 1 DATA TRANSFORMATION

No	1	2	3	.	.	25	26
1	3	3	3	.	.	3	2
2	0	3	2	.	.	3	3
3	-3	-3	2	.	.	3	-3

4	0	2	0	.	.	1	1
5	2	1	1	.	.	2	2
6	0	0	1	.	.	1	-1
7	2	3	3	.	.	3	3
8	1	2	0	.	.	0	0
9	3	2	-2	.	.	2	2
10	2	2	-3	.	.	1	1
11	3	2	2	.	.	3	3
12	1	2	1	.	.	1	-1
13	2	3	3	.	.	3	2
14	-2	-2	3	.	.	1	-2
15	2	3	3	.	.	2	3
16	0	1	-2	.	.	0	2
17	2	2	0	.	.	2	-2
18	3	3	3	.	.	3	3
19	3	3	3	.	.	3	3
20	2	3	2	.	.	2	3

TABLE XII  
 STAGE 2 DATA TRANSFORMATION

Scale means per person					
DT	KJ	EF	KT	ST	KB
3,00	3,00	2,75	3,00	3,00	2,75
2,33	2,25	2,50	2,75	2,50	1,25
-0,17	0,00	-0,25	-0,25	-0,25	-0,50
1,33	0,75	0,75	0,00	0,75	0,50
1,17	1,25	1,75	1,75	1,25	1,00
0,17	0,25	0,00	2,00	1,00	-0,25
2,50	2,50	2,25	2,00	2,25	2,75
0,50	0,25	0,00	0,50	0,50	0,00
2,00	0,75	1,50	2,25	1,25	-0,25
1,50	0,50	0,75	1,50	-1,00	-0,50
3,00	2,75	2,75	2,00	2,50	2,50
0,67	1,00	0,00	0,75	0,50	0,25
2,83	3,00	2,75	2,75	2,75	2,00
-0,17	-0,25	0,25	0,75	0,00	-0,25
2,33	2,25	2,50	1,75	2,50	1,50
0,83	0,25	1,50	0,50	1,00	0,50
1,50	1,00	1,00	0,50	1,50	-0,25
3,00	3,00	3,00	3,00	3,00	3,00
3,00	3,00	3,00	3,00	2,75	3,00
2,33	2,25	2,25	2,25	2,25	1,25

In Table XII. Finding the average scale per individual is the second step in transforming the data. The result will be used in the next calculation. Each variable's average (mean) value and variance will be determined (variance). The mean is equal to the average score of all respondents, while the variance is equal to the distribution of the respondents' scores. The study findings are shown in Table XIV, while the mean, standard deviation, and variance for each item are shown in Table XIII.

TABLE XIII  
 MEAN, VARIANCE, STD DEVIATION

Item	Mean	Variance	Std. Dev
1	1,3	2,9	1,7
2	1,8	2,8	1,7
3	1,3	3,6	1,9

Item	Mean	Variance	Std. Dev
4	1,3	3,0	1,7
5	1,7	3,0	1,7
6	1,0	3,9	2,0
7	1,2	3,8	2,0
8	1,0	2,5	1,6
9	1,5	1,5	1,2
10	1,0	3,6	1,9
11	1,9	2,8	1,7
12	2,2	1,4	1,2
13	1,0	3,2	1,8
14	1,2	3,0	1,7
15	0,6	4,1	2,0
16	1,4	3,2	1,8
17	1,8	2,3	1,5
18	2,3	0,7	0,9
19	2,0	1,1	1,1
20	1,4	3,4	1,8
21	1,9	1,4	1,2
22	1,3	2,8	1,7
23	2,1	0,7	0,9
24	2,2	0,8	0,9
25	2,0	1,1	1,1
26	1,2	4,0	2,0

Table XIII shows the average, variance, and std deviation values per item. In UEQ, "mean" is used to measure the quality of the response from the model. "variance" is used to measure how far the model's response score on each question is determined from the calculated average score. Standard deviation measures how far the model's response scores are from the calculated average score on each specified question. These results were obtained from the sum of all respondents grouped per item. Then the mean and variance values of all variables are contained in Table XIV.

TABLE XIV  
 MEAN AND VARIANCE OF ALL VARIABLES

Variable	Mean	Variance
Attractiveness	1,683	1,21
perspicuity	1,488	1,36
Efficiency	1,550	1,32
Dependability	1,638	1,10
Stimulation	1,500	1,39
Novelty	1,013	1,61

It can be seen in Table XIV that the attractiveness variable (Attractiveness) gets a score of 1.683, which is in the positive category, which means the respondent is interested in or likes 2D and 3D AR face detection. The clarity variable (Perspicuity) gets a score of 1.488, which is also in the positive category, meaning that 2D and 3D AR face detection can be understood and easily understood. The efficiency variable (Efficiency) scores 1.550, also in the positive category.

Respondents think that 2D and 3D AR face detection is efficient and clear. The dependability variable gets a variable score of 1.638. This means that 2D and 3D AR face detection is still easily controlled by respondents and belongs to the positive category because the average value is > 0.8. The stimulation variable (Stimulation) gets a score of 1.500, meaning that respondents feel that 2D and 3D AR face detection is useful, belonging to the positive category. The last variable, novelty, obtained a score of 1.013, meaning that 2D

and 3D AR face detection is a creative and new innovation and is categorized as positive. What is said to be a positive category if  $> 0.8$  and said to be a negative category if  $< 0.8$  [21]

From the six scales above, it can be adjusted and reprocessed to calculate and determine the quality of Pragmatic and Hedonic AR face detection in 2D and 3D. The following is an assessment of Attractiveness, pragmatic quality, and hedonic quality in Table XV.

TABLE XV  
QUALITY VALUE

Pragmatic and Hedonic Qualities	
Attractiveness	1,68
Pragmatic Quality	1,56
Hedonic Quality	1,26

Table XV shows that the respondent's assessment of the quality of Attractiveness is 1.68, which is included in the positive category. This means that the quality of 2D and 3D face detection AR is classified as pleasant and good. Pragmatic quality gets a value of 1.56, included in the positive category. Then the hedonic quality gets a value of 1.26, which is also included in the positive category, because it is more than  $> 0.8$  [21].

2) Benchmark Datasets

Benchmarks are data presentations in graphical form. All variables will be presented in graphical form based on the values obtained and the benchmarks in Figure 8.

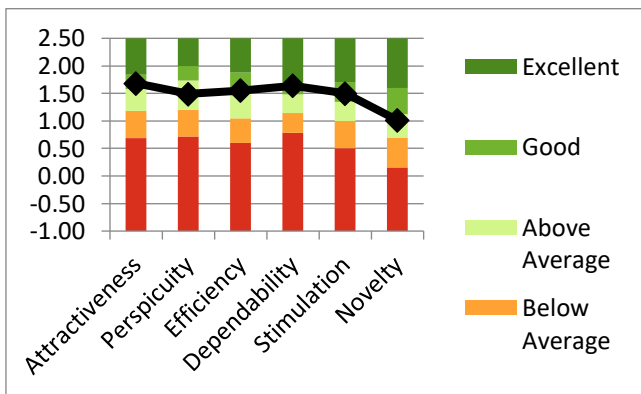


Figure 8. Benchmark UEQ

It can be seen in Figure 8 that the user experience assessment on 2D and 3D AR face detection got 4 Good scores, including the variables of Attractiveness, efficiency, accuracy, and stimulation, and Above Average values on the variables of clarity and novelty. All ratings are in a positive category. Meanwhile, the quality can be seen in Figure 9.

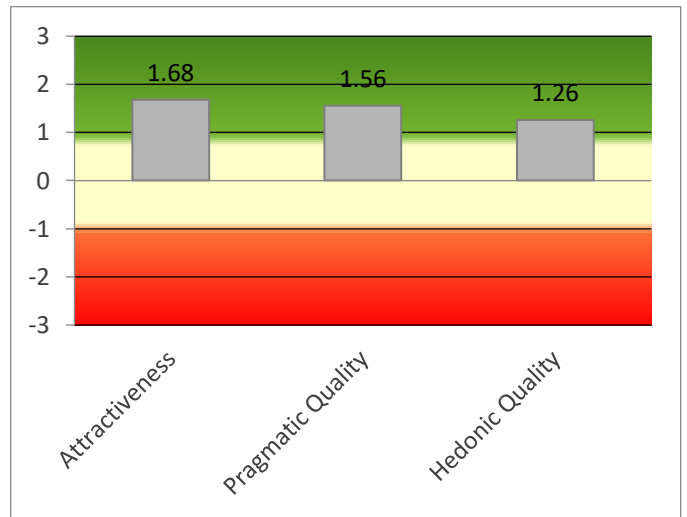


Figure 9. Quality chart

Figure 9. is a quality assessment based on user experience measurements, quality divided into attractiveness, hedonic and pragmatic qualities. The quality of Attractiveness gets a value of 1.68, a pragmatic quality of 1.56, and a hedonic quality of 1.26. All variables get a positive assessment, with the quality of Attractiveness being the highest value and hedonic quality being the lowest value, but all are still in the positive category.

3) Distribution of Respondents' answers.

The distribution of answers will be known on a single item if there are items that show a polarization of answers (many negatives, many positives, not many neutral judgments). The following is the distribution of respondents' answers in Figure 10.

In Figure 10, the distribution of respondents' assessment answers belongs to the positive category, seeing the distribution of respondents' answers at number 5,6,7 which are positive categories.

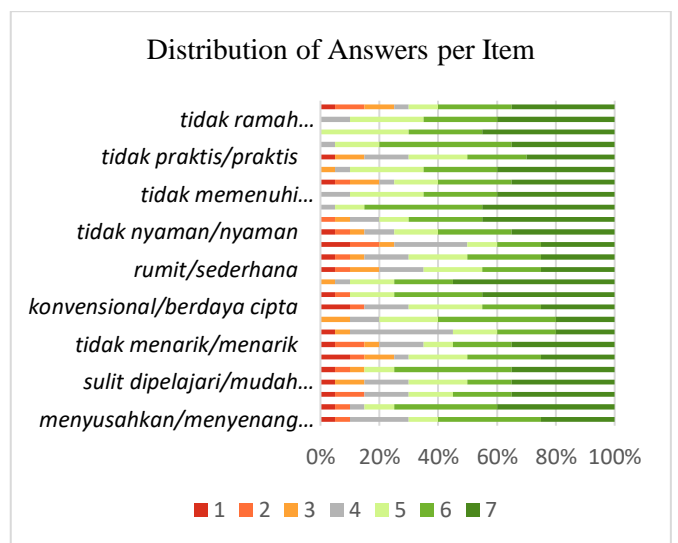


Figure 10. Distribution of Answers per Item

#### IV. CONCLUSION

At a distance of 50 centimeters, the markerless-based tracking method had a superior success accuracy of 93.22%, while the face tracker techniques had a success accuracy of 96.63%. The study's results were determined by comparing the markerless-based tracking method with face tracker techniques in 2D and 3D from the results of comparisons of superior success accuracy. Comparing the performance of the markerless-based tracking approach with the face tracker methodology in 3D to its performance in 2D leads to the conclusion that 3D provides the best results.

For the UEQ measurement method, the responses from respondents were positive because this was shown in the data that 20 respondents successfully collected, showing the average value in each variable, namely Attractiveness, clarity, efficiency, accuracy, stimulation, and novelty, which is at the number above 0.8. and what if seen from the benchmark of all four variables, the score is Good, including the attractiveness variable obtaining a value of 1.68, efficiency obtaining a value of 1.55, accuracy obtaining a value of 1.64, and stimulation obtaining 150, and the Above average value on the clarity variable obtaining 1.49, and novelty obtaining 1.01. All ratings are in a positive category. While in terms of the quality of Attractiveness, hedonic and pragmatic. The quality of Attractiveness gets a value of 1.68, a pragmatic quality of 1.56, and a hedonic quality of 1.26. All variables get a positive assessment, with the quality of Attractiveness being the highest value and hedonic quality being the lowest value, but all are still in the positive category. In this case, with the UEQ measurement method in the analysis of the markerless-based tracking method, the face tracker technique in detecting human facial movements in making 2D and 3D filters gets positive evaluations in terms of user experience and quality from 2D and 3D AR face detection

#### REFERENCES

- [1] L. H. Ho, H. Sun, and T. H. Tsai, "Research on 3D painting in virtual reality to improve students' motivation of 3D animation learning," *Sustainability (Switzerland)*, vol. 11, no. 6, 2019, doi: 10.3390/su11061605.
- [2] P. Diah, "KONSEP AUGMENTED REALITY DAN MOBILE MARKETING SEBAGAI USAHA PENGEMBANGAN PARAWISATA YOGYAKARTA DI ERA PANDEMI COVID 19," 2021.
- [3] Y. Chen, Q. Wang, H. Chen, X. Song, H. Tang, and M. Tian, "An overview of augmented reality technology," in *Journal of Physics: Conference Series*, Jul. 2019, vol. 1237, no. 2. doi: 10.1088/1742-6596/1237/2/022082.
- [4] Nurhadi and Mulyadi, "Rancang Bangun Aplikasi Augmented Reality Berbasis Face Tracking untuk mendeteksi Wajah Peserta Wisuda," 2018.
- [5] M. E. Apriyani *et al.*, "Analisis Penggunaan Marker Tracking Pada Augmented Reality Huruf Hijaiyah," *Jurnal Infotel*, vol. 8, no. 1, 2016.
- [6] R. Gusman, M. Eka Apriyani, J. Teknik Informatika, P. Studi Teknik Multimedia dan Jaringan, P. Negeri Batam, and J. Ahmad Yani, "Analisis Pemanfaatan Metode Markerless User Defined Target Pada Augmented Reality Sholat Shubuh," *Jurnal Infotel*, vol. 8, no. 1, 2016.
- [7] M. Hasyim, N. Rokhmatulloh, M. Imron Rosadi, F. Arief Zakaria, U. Yudharta Pasuruan, and S. Artikel, "Jurnal Explore IT|28 Implementasi Teknologi Augmented Reality Sebagai Media Pembelajaran Bahasa Arab Berbasis Android Menggunakan Metode Markerless Tracking INFO ARTIKEL ABSTRAK," 2021, doi: 10.35891/explorit.
- [8] M. Fernando, *Android Augmented Reality*. Buku AR Online, 2013.
- [9] Y. Taigman, M. Y. Marc', A. Ranzato, and L. Wolf, "DeepFace: Closing the Gap to Human-Level Performance in Face Verification," 2014.
- [10] K. Hazelwood *et al.*, "Applied Machine Learning at Facebook: A Datacenter Infrastructure Perspective," in *Proceedings - International Symposium on High-Performance Computer Architecture*, Mar. 2018, vol. 2018-February, pp. 620–629. doi: 10.1109/HPCA.2018.00059.
- [11] A. Moin, L. Kolli, V. Sistla, V. Krishna, and K. Kolli, "International Journal of Computing and Digital Systems Planet Adventures: An Augmented Reality Game using Facial Emotion Recognition," 2021. [Online]. Available: <http://journals.uob.edu.bh>
- [12] D. K. Putra, A. Putra Aldya, R. N. Shofa, and A. P. Aldya, "Analisis Performa Marker 2D dan Marker 3D pada Augmented Reality Korespondensi," *Scientific Articles of Informatics Students*, vol. 2, no. 1, pp. 60–68, 2019, [Online]. Available: <https://publikasi.unsil.ac.id/index.php/sais>
- [13] B. Arifitama, A. Syahputra, K. Bayu, and Y. Bintoro, "Analisis Perbandingan Efektifitas Metode Marker dan Markerless Tracking pada Objek Augmented Reality," 2022.
- [14] W. Farianto, N. A. Prasetyo, and A. Raharja, "AUGMENTED REALITY OBJEK BERSEJARAH MUSEUM SOESILO SOEDARMAN MENGGUNAKAN METODE MARKER BASED DAN MARKERLESS," 2021.
- [15] I. Andi, H. Asrul, Madi, Baharuddin, A. Muhammad, and Darmawati, "BUKU METODOLOGI," 2018.
- [16] W. Ramadhan, B. Arifitama, and S. D. H. Permana, "Mobile augmented reality for furniture visualization using Simultaneous Localization and Mapping (SLAM)," *IOP Conf Ser Mater Sci Eng*, vol. 1098, no. 6, p. 062008, Mar. 2021, doi: 10.1088/1757-899x/1098/6/062008.
- [17] S. Putro, Kusriani, M. P. Kurniawan, and K. Kunci -Lapor Bantul, "Penerapan Metode UEQ dan Cooperative Evaluation untuk Mengevaluasi User Experience Lapor Bantul Implementation Methods of UEQ and Cooperative Evaluation to Evaluate User Experience Lapor Bantul," *Citec Journal*, vol. 6, no. 1, 2019.
- [18] K. Kusriani, S. Suputa, A. Setyanto, I. Made Artha Agastya, H. Priantoro, and K. Chandramouli, "User Evaluation of Mobile based Smart Mango Pest Identification," 2020.
- [19] A. Muhammad, Y. Amak, and E. Alexius, "ANALISIS USER EXPERIENCE PADA AUGMENTED REALITY ORGANOLGY MENGGUNAKAN USER EXPERIENCE QUESTIONNAIRE (UEQ)," 2022.
- [20] K. Teguh Martono, "Analysis on User Experience Using UEQ Method in the Information System of Web-Based Child Development Monitoring," 2020. [Online]. Available: <https://ssrn.com/abstract=3953323>
- [21] Dr. Martin Schrepp, "User Experience Questionnaire Handbook," 2019. [Online]. Available: [www.ueq-online.org](http://www.ueq-online.org)

This is an open-access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.

