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Recognition Of Historical Building Using Augmented Reality Application Using Feature From Accelerated Segment Test (Fast) Algorithm

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Abstract
Augmented reality (AR) is a technology that combines two- dimensional or three-dimensional virtual objects into the real world that presents in real-time form. The AR implementation in this study will be applied to the introduction of historical buildings that are expected to provide information and attract tourism interest that choose Aceh Tamiang as a tourist choice, AR will use markers as a tool to display a 3D building object using a feature from accelerated segment test algorithm (FAST), the way the FAST method works is to detect natural point values contained in a marker, to get a good tracking result, we need a marker that has many point values, the more point values are in the marker, the faster the tracking process is done. To find out whether the application can work properly then several tests are carried out, from the test results obtained different accuracy values on the results of the test data that is, the marker detection test obtained 100% accuracy value, testing at a distance with an accuracy value of 83%, testing on 50% light intensity, testing on the detection of marker slope 80%, and Application Test Results at 4 Devices is 100%.
Keywords— Augmented Reality, Natural Features Tracking, FAST Corner Detection

I. INTRODUCTION
Evidence of the existence of the city of Tamiang is sourced from historical data, such as in the Sriwijaya Inscription, Wee Pei Shih book which records Kan Pei Chiang (Tamiang), and the book Nagarakretagama which mentions "Tumihang", with the royal data proving that Aceh Tamiang has been established for a long time and certainly has a heritage of historical buildings from the ancientkingdom (Permata, 2018).

With the historical story above, it can be ascertained that Aceh Taminag has a historic place that was built in the kingdoms. To introduce historical buildings that are still standing in Aceh Tamiang, an interesting information technology is needed. One technology that can be applied in the introduction of historic buildings is the use of Augmented Reality (AR) technology. AR technology is one of the popular technologies, AR is defined as technology that can combine the real world with cyberspace, is interactive according to real time, and in the form of 3D animation.

The development of AR technology has contributed a lot to various fields, one of which is to promote tourism in a region. In this study the design that will be built is to make historical building objects contained in Aceh Tamiang in the form of 3D animation which can later be used to introduce the form of historical buildings using only smartphones and utilizing AR technology using markers that will implement images of building objects in the real form, the method that will be used for marker detection is using the Natural Features Tracking (NFT) method. And the Android smartphone operating system will be chosen because it is already widely used by students, the public from the young to the old, so anyone can operate the system to see the model of the introduction of historic buildings. Therefore, it is expected that the introduction of historic buildings using augmanted reality technology can introduce historical buildings in Aceh Tamiang that can be used to promote one of the places that can be used as a reference destination for Aceh tourists to develop.

II. RESEARCH METHODOLOGY
A. Historic Building

Cultural heritage as a cultural resource has a fragile, unique, rare, limited, and not renewable nature, so in order to maintain cultural heritage from the threat of physical development, both in urban areas, rural areas, and those in the water environment, protection, development and utilization (Runa, 2016).

B. Augmaented Reality

The workflow of the AR application generally starts from markerless shooting with a camera or webcam. Markerless is recognized based on the features that are owned, then entered into the tracker object provided by the Software Development Kit (SDK). On the other hand, the markerless has been registered and stored in the database. The object tracker will then track and match the markerless so that it can display the appropriate information. The marker tracking output is immediately displayed on a computer screen or smartphone screen. The information displayed is attached to the relevant marker in real time (Vitono et al., 2016).

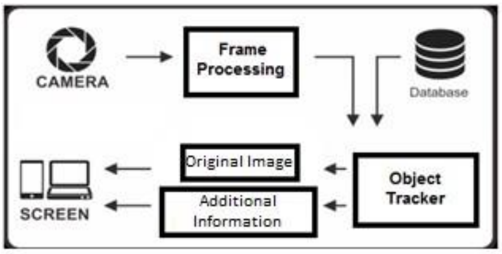


Figure 1. Workflow of Augmented Reality Applications

C. Marker

The marker is a pattern created in the form of an image that the webcam will recognize. Marker is the key to AR. Marker information will be used to display an object. Markers are also images that consist of the border outline and pattern image. Object Marker is an object that is used as a based tracking or marker that is used as a reference to bring up an augmented reality, and from each marker object will display a form of augmented reality that is different from one another (Hikmaturokhman et al., 2015).

D. Natural Features Tracking

In general, Natural Features Tracking (NFT) is a vision-based approach. A vision-based approach can be classified into model-based tracking techniques and feature-based techniques. This classification considers the amount of prior knowledge that a tracking system needs about its occurrence, NFT is part of a feature-based technique that relies on natural features. This tracking feature is a step in the initial process that is needed from the problem of the structure of motion that finds 3D structures taken from the image time after time. Because matching features are the only initial information for further vision based inference, conventional point-based tracking schemes try to find as many feature points as possible. In vision the application based on Augmented Reality purpose Natural Features Tracking is to calculate homography between planar scenes and projected images. To ensure the existence of a pattern, there must be a large number of feature points for the planar pattern and also a sufficient number of feature points must be adjusted to the points in the projected image. To identify the area of the projected pattern, homograms calculated from the tide point are matched (Ershad, 2016)

E. General Architecture

The general architecture of running Augmented Reality can be seen in the following picture.

Figure 2. General Augmented Reality Architecture

Based on Figure 2, it can be explained that:

1. To run augmented reality, the user must use a smartphone that has been installed, the application for the introduction of this historic building.
2. The smartphone camera will scan the desired marker and the process of tracking the object is done.
3. After the scann marker, the next process is requesting data or matching markers with images stored in the databases, if the scanned marker matches the markers on the databasse, the application provides feedback on the data requests.
4. If the marker with images stored in the database is suitable, the user can see 3D objects according to the marker being tracked.

F. FAST Algorithm

The method used in the introduction of markers is Natural Features Tracking using the FAST Corner Detection algorithm, which is detection by looking for points (interest points) or corners (corners), FAST (Feture Form Accelerated segment Test) is an algorithm developed by Edward Rosten , Reid Porter, and Tom Drummond. FAST corner detection is made with the aim of accelerating computing time in real-time with the consequence of reducing the accuracy of angle detection. FAST corner detection starts by specifying a point p on the coordinates (xp, yp) in the image and comparing the intensity of the p point with 4 points around it. The first point lies in the coordinates (x, yp-3), the second point lies in the coordinates (xp + 3, y), the third point lies in the coordinates (x, yp + 3), and the fourth point lies in the coordinates (xp-3, y). If the intensity value at point p is greater than or smaller than the intensity of at least three surrounding points plus an intensity threshold (Threshold), it can be said that point p is an angle. After that point p will be shifted to position (xp + 1, yp) and do the intensity of the four points around it again. This iteration continues until all points in the image have been compared. And below is the process flow diagram of the NFT method using the FAST algorithm. The following is the FAST detection process flowchart :

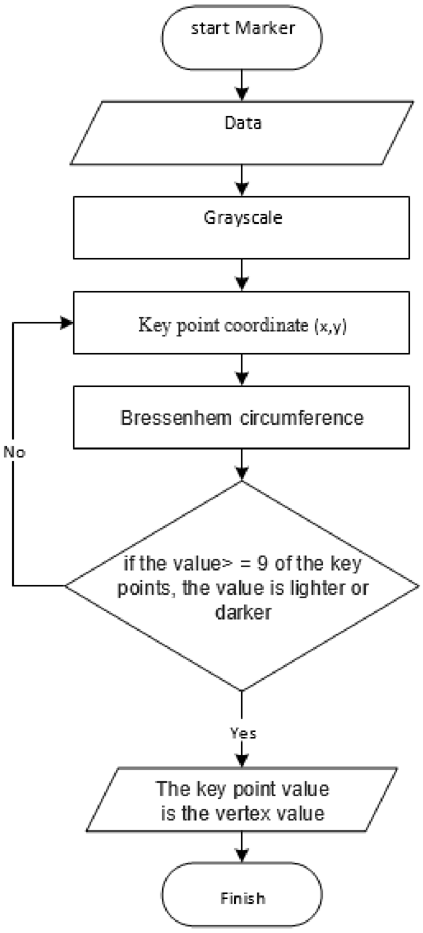


Figure 3. Flowchart of FAST Algorithm

The FAST algorithm that is applied to the application is found in the detection of object data that is used as a reference target image. In figure 3 there is a FAST algorithm flowchart and the explanation is as follows :

1. Start Starting is the first step to start a marker recognition process.
2. Data Marker The marker data is inputted as a step in grayscale processing.
3. Grayscale The grayscale process is carried out at the pre-process stage of the image, ie the original image is made of gray scale with intensity values of 0-255.
4. Key point angle The process of the key point corner of the x coordinate, y on the pixel of the image is done to find the point points.
5. Bressenhem Circle circumference bressenhem is the process of comparing values to neighboring pixels, where the circumference process that surrounds the target point has a point of 16 pixels, at this stage comparison data from the nearest 16 pixels will be produced.
6. If the value> = 9 of the key points the value obtained from the circumference process that surrounds the target of the key point used as a parameter has a minimum of 9 closest values that have a dark or bright value, the point value of the key point is an angle, if the process is not obtained, the point will be re-determined.
7. Finish.

G. Marker Detection

The flow of marker detection process in the application of the introduction of historical buildings in Aceh Tamiang can be seen in the picture below.

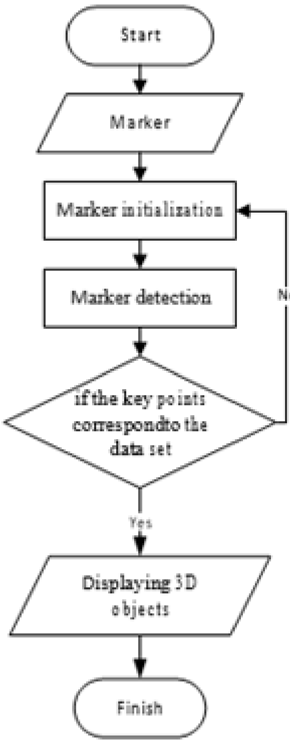


Figure 4. Flowchart of the Marker Detection Process

In Figure 4 there is a marker detection process and the explanation is as follows :

1. Start
   Starting is the first step to start a marker detection process.
2. Marker
   Use marker data that has been made the process of determining point points.
3. Marker Initialization
   Marker initialization is the process of forming values at the introduction of markers, which then the camera will detect the marker by initializing the marker being tracked, if the marker is detected, the system will display building 3D objects, otherwise the camera will identify the marker, the process will continue until marker detected.
4. The program is complete.

III. RESULTS AND DISCUSSION

A. Research Results

The results of the study of the application of augmented reality on the introduction of historic buildings were obtained from several tests conducted to find out how much the success rate of the application, the following are the results of the research conducted.

B. Marker Testing

Marker testing is done to see the accuracy of the output of the object whether it matches the marker that is being detected. The FAST corner detection algorithm works on an image as follows: The process stage of the FAST algorithm carried out on a marker image data is to obtain a good recognition of a marker. The image image used is in the format extension .jpg and .png with a color model so that the detection of key points can be recognized properly, then the grayscalling process is performed. The FAST corner detection algorithm works on an image as follows :

1. Determine the target key point in the marker image with the initial position (xp, yp)

Figure 5. Determining the Point Point of the Image

2. Determined 4 coordinate points. The first point lies in the coordinates (n = 1), second point (n = 2), third point (n = 3), fourth point (n = 4).

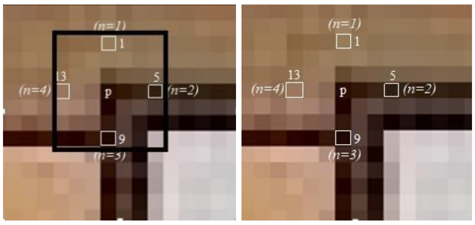


Figure 6. Specifies 4 Coordinate Points

Detection of the approach of this vertex is used for special values of object recognition such as detection, angles are directions between two edges with an angle value as the dominant point. In the FAST algorithm a vertex is determined by assuming the prospective variable point p by inputting 16 pixel data around p. The following is a piece of pixel value of the original image marker to determine the point of p which is represented by 3 bytes, namely red, green, blue.

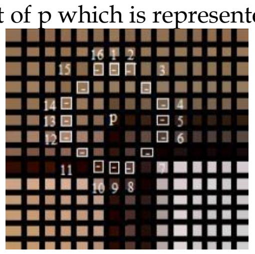


Figure 7. Image Marker Pieces

R=150 G=117 B=82	R=165 G=110 B=100	R=155 G=130 B=127	R=131 G=103 B=83	R=185 G=202 B=100	R=165 G=148 B=104	R=165 G=148 B=85
R=155 G=133 B=127	R=125 G=148 B=124	R=146 G=152 B=97	R=125 G=150 B=124	R=132 G=184 B=114	R=109 G=184 B=119	R=152 G=201 B=128
R=160 G=143 B=87	R=172 G=133 B=122	R=155 G=136 B=127	R=104 G=99 B=76	R=145 G=127 B=102	R=145 G=125 B=102	R=145 G=127 B=97
R=131 G=120 B=77	R=128 G=135 B=95	R=125 G=159 B=86	R=101 G=94 B=88	R=108 G=102 B=88	R=108 G=102 B=88	R=118 G=109 B=85
R=118 G=132 B=84	R=127 G=148 B=81	R=132 G=155 B=66	R=111 G=115 B=86	R=119 G=138 B=113	R=132 G=132 B=133	R=144 G=152 B=82
R=125 G=133 B=127	R=146 G=152 B=97	R=132 G=184 B=114	R=119 G=110 B=87	R=155 G=133 B=102	R=122 G=112 B=90	R=120 G=112 B=90
R=151 G=104 B=85	R=151 G=104 B=85	R=143 G=111 B=68	R=113 G=101 B=88	R=155 G=133 B=102	R=130 G=112 B=90	R=216 G=216 B=216

Np R=101 G=94 B=88	N1 R=131 G=103 B=83	N2 R=185 G=202 B=100	N3 R=109 G=184 B=119	N4 R=145 G=127 B=97
N5 R=118 G=109 B=85	N6 R=144 G=152 B=82	N7 R=122 G=112 B=90	N8 R=155 G=133 B=102	N9 R=113 G=101 B=88
N10 R=143 G=111 B=68	N11 R=146 G=152 B=97	N12 R=118 G=132 B=84	N13 R=131 G=120 B=77	N14 R=160 G=143 B=87
N15 R=125 G=148 B=124	N16 R=155 G=130 B=127			

Figure 8. pixel samples RGB

Values with coordinates of points aimed at the Np value, and to calculate pixel values are used

formula R + G + B namely:

$$101 + 94 + 88 = 283$$

Use the same method from calculating other pixel values with the following results:

283	317	487	412	369
312	378	324	390	303
322	395	334	328	390
397	412			

Figure 9. Results of Pixel Value Calculation

After obtaining RGB values, the grayscale process is done. the RGB process is changed to the grayscale process by calculating the average

RGB color elements in the following ways :

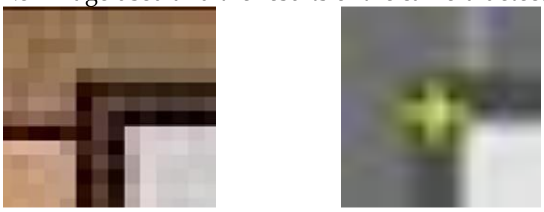
$$\text{Grayscale} = (R + G + B) / 3 = (101 + 94 + 88) / 3 = 94$$

Use the same calculation method from other RGB color values with the following results :

94	105	162	137	123
104	126	108	130	101
107	131	111	109	130
132	137			

Figure 10. Results of the Key Points Determination Process

From figure 10 after the results obtained from the comparison of the target point key at 16 pixels rotation and the comparison data from the nearest 16 pixels with pixel values as the data parameter, the pixel point darker than the neighboring pixel is determined as the point value, the process will continues to repeat until all the vertices in the marker image are detected. Next is the marker image used and the results of the camera detection test on the marker.



(a) (b)

Figure 11. (a) Original Marker Image (b) Image Marker as key point

The following is a marker that is used as the target image to see the building object:

Table 1. Image Markers Used

Marker of the building of the karang baru	Marker of the building of the benua king	Marker of the building of the seruwai king
		

Based on the results of testing, the program output successfully displays 3D objects that match the markers detected by the camera. The level of accuracy of the success of the program based on the marker is as follows :

$$Accuracy = 3/3 \times 100 = 100\%$$

So, the level of accuracy of success to get the accuracy of historical 3D objects in accordance with the marker being detected is 100%.

C. Distance Testing

In distance testing is done by bringing the marker closer to the device's camera according to the distance tested. The following is the result of testing marker distances with the camera.

Table 2. Results of Tracking Speed

No	S	t	V
1.	0.15 m	0.032 s	4.68 m/s
2.	0.3 m	0.046 s	6.52 m/s
3.	0.45 m	0.058 s	7.75 m/s
4.	0.55 m	0.076 s	7.23 m/s
5.	0.75 m	0.145 s	5.17 m/s
Total	2.2 m	0.357 s	31.35 m/s
Average	0.44 m	0.071 s	6.27 m/s

Based on the results of table 3, the tracking speed value based on distance and time values is obtained by using the following equation :

$$v = s / t$$

To get the average speed, average distance and average time, use the equation:

Average value = (Value value) / (Number of data)

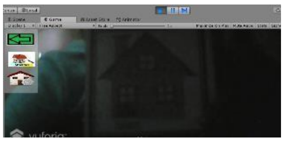
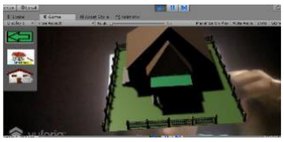
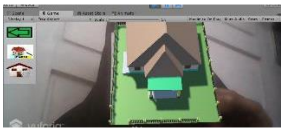
a. Average distance = (2.2 m) / 5 = 0.44 m (meters)
b. Average time = (0.357 s) / 5 = 0.071 s (second)
c. Average speed = (9.08 m / s) / 5 = 6.27 m / s

And the average value of the marker shift distance is 0.44 m, the average value of the marker shift time is 0.071 s, and the average speed of marker shift based on distance is 6.27 m/s.

D. Testing of Light Intensity

Light intensity testing is done in order to find out a good level of lighting to detect markers. And if it is small or too large the light captured by the camera can cause the marker not to be detected properly. Here are the results of trying out the light intensity.

Table 3. Results of Light Intensity Testing

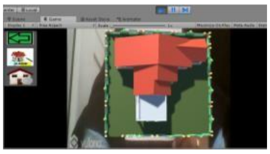
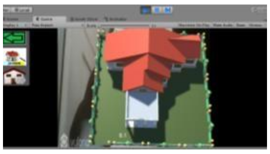
No	Light (Lux)	Display	Description
1.	0,03		Undetectable
2.	0,52		Detected
3.	15,8		Detected
4.	2130		Undetectable

From the test results in table 3 The level of accuracy of the success of the program based on light is as follows: Accuracy = 2/4 x 100% = 50% So, the success rate based on light is 50%, with presentation 2 the data is successfully detected, namely light and light. Two data did not work, namely dark and very bright light.

E. Marker Slope Detection Limit Test

Testing the marker detection slope is done to determine the deadline for the appearance of the object to detect marker slope, slope boundary testing is taken with the distance between the marker and the camera as far as 25 cm. The following are the results of the trial.

Table 4. Test Marker Slope Testing Results

No	Slope	Output	Description
1.	0^0		Succeed
2.	15^0		Succeed
3.	30^0		Succeed
4.	45^0		Succeed
5.	60^0		not successful

From the test results in table 4 The level of accuracy of success based on the slope of the marker detection is as follows:

Accuracy = 4/5 x 100% = 80%

So, the level of accuracy of success based on the slope of marker detection is 80%, from 5 trial data with a percentage of 4 data successfully and 1 data unsuccessful.

F. Comparison of Time Tracking Tests on the Device

Testing the comparison of tracking time on the device will be done by detecting markers alternately with 4 different devices, namely using a 2gb Asus laptop, Oppo A37 cellphone, Samsung Grand Prime 1GB cellphone, and Red_me Xiaomi cell phone 3GB, and here is the test result table try.

Table 5. Results of Time Tracking Comparison On the device

No	Device Used			Marker Name	Time
	Device Name	RAM	Camera Resolution		
1.	Laptop Asus X453M	2 gb	2 mp	Karang Baru Benua king's palace	00.85 ms
				Benua king's palace	00.63 ms
				seruwai king's palace	00.55 ms
2.	HP Oppo a37	2gb	8 mp	Karang Baru Benua king's palace	00.51 ms
				Benua king's palace	00.47 ms
				seruwai king's palace	00.42 ms

3.	HP Samsung Grand Prime	1 gb	8 mp	Karang Baru Benua king's palace	00.72 ms
				Benua king's palace	00.88 ms
				seruwai king's palace	00.82 ms
4.	HP Xiomi Red_me	3 GB	13 mp	Karang Baru Benua king's palace	00.32 ms
				Benua king's palace	00.31 ms
				seruwai king's palace	00.29 ms

Based on the results of testing from table 5 the results of marker detection time are different, the object rendering process on Samsung grand prime cellphones with 1 gb RAM has the longest time compared to the other 3 testers, while the fastest detection results are obtained from red_me xiomi devices with RAM 3 gb.

The results of detected objects also have differences, because the camera resolution of the display is also different, the results of the Oppo A37 and Samsung Grand Prime with the resolution of the 8 MP camera produce a good display of objects, the Xiaomi mobile phone with 13 MP camera resolution displays very good texture , and on laptop devices with a 2 mp camera resolution displaying the results of an object texture that is not good. Testing the application on 4 devices is successful and gives a table of test results.

Table 6. Application Test Results On 4 Devices

No	Device Used	Description
1.	Laptop Asus X453M	succeed
2.	HP Oppo a37	succeed
3.	HP Samsung Grand Prime	succeed
4.	HP Xiomi Red_me	succeed

From table 6 the application testing on laptop and android devices is successfully executed. And the level of accuracy of the success of the program based on testing on 4 devices is as follows :

$$Accuracy = 4/4 \times 100\% = 100\%$$

So, from the results of this study the success rate of testing on the 4 devices used is 100%.

V. CONCLUSION

Based on the results of the research that has been done, some conclusions are obtained, namely as follows:

1. Detection of markers using the natural feature tracking method can work well, where the results of camera testing on markers get a level of accuracy of success for the accuracy of historic 3D objects in accordance with the marker being detected is 100%. In the results of the marker distance testing can no longer be detected at a distance of 85 cm (0.85 m), the accuracy rate of success is based on a distance of 83%, testing at 50% light intensity and testing on the detection of marker slope 80%.
2. In Augmented Reality using markers, the process of initialization or introduction to the target image is done by detecting the angles that have been processed by the FAST corner detection method, when the marker detected by the camera matches the data set in the AR system, the object will appear above markers in accordance with the markers of historical buildings that you want to see. From the results of testing the camera for markers, an accuracy value of 100% was detected.
3. The introduction of the marker pattern using the FAST algorithm is very influential with the number of angles possessed by markers, easily recognizable markers will have 5 stars on vuforia, the more the vertex values are in the marker, the faster the marker is detected, and if the vertex is in markers only have one or two stars then markers will be difficult to recognize.

The system designed can simulate historical building objects in Aceh Tamiang in an interactive three-dimensional (3D) form that can make it easier for people to see buildings using only Android.

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