Advances in Intelligent Systems Research, volume 172
Sriwijaya International Conference on Information Technology and Its Applications (SICONIAN 2019)

Image Processing of Hand Gesture for Augmented Reality Systems

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ABSTRACT.
Advances in HCI technology have an effect on user interaction with AR system. The hands are the limbs that are often used for interaction. In this research make hand detection system for Human Computer Interaction (HCI) on system between user and object. In this study focused on image processing for hand shape and AR object response analysis to detectable hand form. The method used is convex-hull and center of gravity (COG). This method produces the Euclidean finger value which is a feature of the finger shape. Tests conducted in this study are 2 forms of hands that work to zoom + and zoom - to zoom in and out the AR object. The results obtained from testing Euclidean values appear in accordance with the number of fingers detected. Hand detection is influenced by light and distance disturbance, so calibration of segmentation is required. While the 3D object response to the form of zoom + and zoom - reaches 95%.
Keywords: *hand gesture, COG, augmented reality*

Introduction

Augmented Reality (AR) is a computer science that inserts virtual objects into the real world such as a furniture advertisement on television that utilizes catalogs/brochures as triggers to bring up furniture objects that are desired by users that are adjusted to the color of the walls around the house. Interactions between AR systems and users associated with virtual objects through mouse interaction are thus less natural and realistic. Advances in vision technology and Human-Computer Interaction (HCI) have influenced the interaction in AR systems. Interactions between AR objects and users also experience development where interactions with objects directly through limbs, for example, hands. The hand is one of the main body parts that is often used to interact in the real world. Hands are also often used to interact between computers and users in moving an AR object on a computer. With the development of vision technology, HCI also influences the development of HCI using hands detected by vision technology.

On research[1] interaction between AR objects and users by using AR glove that is used in the hands as a tool to facilitate hand interaction in AR chess games. On research [2] an interaction system was developed that is hand detection based on skin color segmentation and feature point finding that is used to detect hand position, hand direction calculation is used to get direction from the user's hand, then simple collision detection is used to get the function of finger ray casting. In other studies carried out by [3] [4][5] hand detection has been developed based on skin color but in displaying objects still requires a marker image as a trigger to bring up AR objects, then this study develops research from [3] [4] [5] that is making AR systems without marker images, interactions between AR objects and users through hand. This is done by hand detection method based on skin color segmentation, where the hands function directly as markers without images. This research is focused on image processing of hand gestures, besides detecting hand gestures, this research also implements hand gestures into the AR system, namely hand gestures for zoom + and hand gestures for zoom - AR objects. The function is used to zoom in and out of AR objects. In this paper discusses designing and implementing a hand gesture detection system for the zoom + or zoom-3D AR object function, finding the Euclidean value which is the value of the finger feature.

Research Methodology

The design in this study is shown in the figure 1,

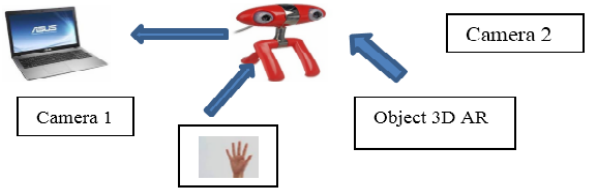

Figure 1. Hand Geture Detection System For AR

Input Data

Capture data input using a stereo vision camera with a resolution of 800 x 600. Data input from this system is done directly on the hand taken by the camera 1. The hand taken is the right hand palm, because in general humans interact with the right hand. The input data taken consists of 2 hand gestures, the zoom + and zoom functions for large-small 3D objects of the AR system. AR system hand gestures for zoom + and zoom- are shown in figure 2.

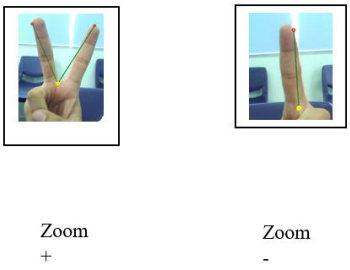

Figure 2. Geture Hands for Zoom + and Zoom –

Process Data on the Camera 1

In this study, the input data taken by camera 1 is processed in stages shown in block diagram figure 3,

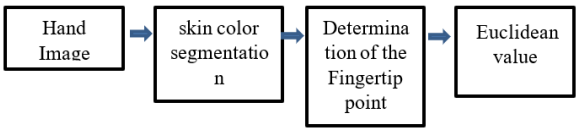

Figure 3. System Detection Hand Gesture On Camera 1

In the picture, hand image is input data in this system which is processed through YCrCb skin color segmentation from RGB to separate between foreground and background using formula 1[6],

$Y = (0{,}29900 \times R) + (0{,}58700 \times G) + (0{,}11400 \times B) + 16$
$Cr = (0{,}50000 \times R) - (0{,}41869 \times G) - (0{,}08131 \times B) + 128(1)$
$Cb = (-0{,}16874 \times R) - (0{,}33126 \times G) + (0{,}5000 \times B) + 128$

After that, a thresholding is carried out to separate the background and the hand object. The next process of calculating euclidean values, the stages for calculating euclidean values, are shown in Figure 4.

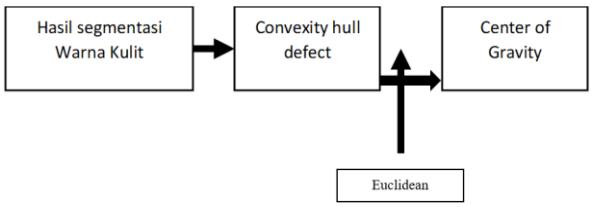

Figure 4. The Process of Determining the Euclidean Value of the Hand

The result of skin color segmentation is then determined the fingertip points using the convexity ull defect method, then determine the center of gravity (COG) to determine the midpoint of the palm of the hand using formula 2. COG formula [7]:

$$\bar{x} = \frac{\sum_{i=0}^{k} x_i}{k} \quad and \quad \bar{y} = \frac{\sum_{i=0}^{k} y_i}{k} \tag{2}$$

Calculate the distance from the midpoint to the fingertip point using Euclidean formula 3. Euclidean formula [8]:

$$d(\mathbf{q},\mathbf{p}) = \sqrt{(q_1-p_1)^2+(q_2-p_2)^2+\cdots+(q_n-p_n)^2} = \sqrt{\sum_{i=1}^{n}(q_i-p_i)^2} \tag{3}$$

Process Data on the Camera 2
In-camera 2 used for AR systems, the process in camera 2 is shown in figure 5.

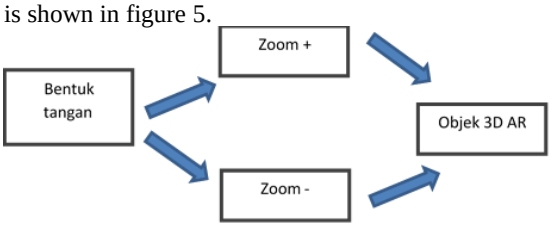

Figure 5. Process system on camera 2

Figure 5 shows that after initializing the hand shape on camera 1 which is then applied to the AR system for zoom + and zoom - on 3D objects.

RESULT

The test in this study consisted of 2 testing methods namely the testing method for camera 1 and the testing method for camera 2.

Testing On Camera 1

In this test the conditions of light intensity and distance of data collection are 40 lux and 25 cm from the camera. The initialization step is performed on camera 1 in order to get the YCrCb hand image segmentation value. The YCrCb segmentation values for initialization are shown in table 1.

Table 1. Segmentation Value

Nilai Y	Min = 60 Max = 217
Nilai Cr	Min = 122 Max = 187
Nilai Cb	Min = 97 Max = 134

The thresholding results are shown in Figure 6.

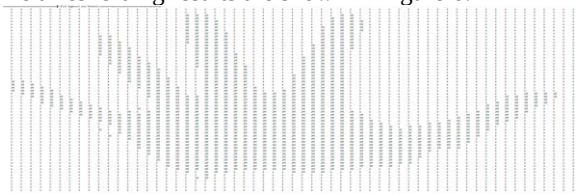

Figure 6. Thresholding Results

The picture shows the result of thresholding, if the output from the system is correct, then the result will be a detected hand. Whereas the Euclidean value is done by testing by detecting the five fingers of the palm. The results are shown in table 2. The minimum limit of Euclidean values by the author of 250, if the results are correct then a 5-finger palm produces 5 Euclidean values.

Table 2.

No	Distance from Center Of Grafity (Pixel)	Jari
1	381,435446701011	Thumb
2	355,375857367942	Index finger
3	339,613015062733	Middle finger
4	386,120447529006	Ring finger
5	408,461748515084	Pinkie

The testing phase is carried out to see the value of Euclidean that appears at the time of detection or is not detected by the hand of the camera one. This testing phase is carried out on 2 hand gestures zoom + and zoom -.

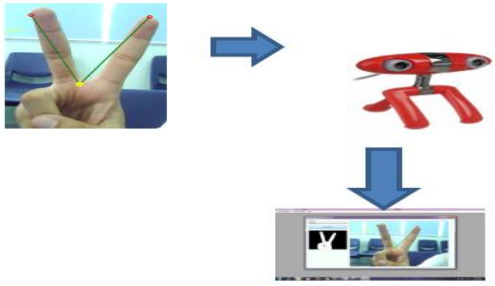

Figure 7. Testing the Zoom + Hand gesture

In figure 7 shows the test for zoom + hand gestures. Euclidean lines can be seen forming on 2 fingers namely the index and middle fingers. Test results,

```
Titik Tengah X 386,Titik Tengah Y : 267

Titik 1 (348,1)  =>Jarak dari COG : 268.700576850888

Titik 2 (545,29)  =>Jarak dari COG : 286.225435627234
```

In the hand gesture zoom- test shown in figure 8 which consists of the index finger.

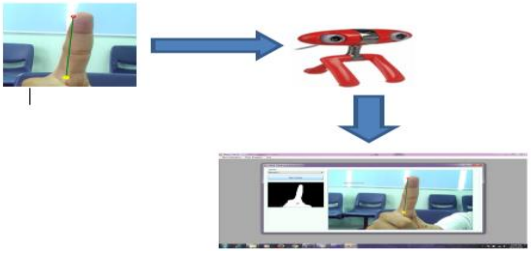

Figure 8. Testing of Hand Gesture Zoom -.

In figure 8 shows the test for hand gestures for zooming -. Euclidean lines are formed on one finger, the index finger. The results of the test,

```
Titik Tengah X 448,Titik Tengah Y : 278

Titik 1 (466,16)  =>Jarak dari COG : 262.617592708486
```

Testing On Camera 2

The test scenario on camera 2 is shown in figure 9, camera 2 functions as an augmented reality system. Tests on camera 2 are carried out with 40 light intensity conditions with a distance of 10-15 cm. Then the hand is directed to the camera so that the ball object appears in the hand, then the hand gesture is changed according to Figure 7 and Figure 8, for zoom + and zoom-.

Figure 9. The Appearance Of The Ball

Testing of AR objects was carried out based on the hand gestures of figure 7 and figure 8. The test results are shown in figure 10 for the zoom + object.

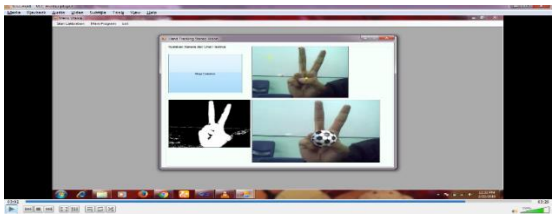

Figure 10. Ball Object Enlarges

In figure 10 the object enlarges when given a hand gesture from Figure 7 , it can be concluded that the object successfully responded to the given hand gesture.

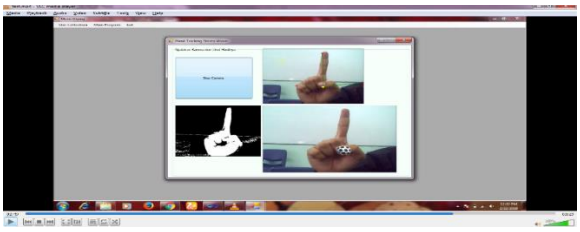

Figure 11. Shrinking Ball Objects

In Figure 11 the object shrinks when given a hand gesture from Figure 8, it can be concluded that the object successfully responded to the given hand gesture. For the results of testing the response of the ball object to the hand gestures of figure 7 and figure 8, shown in table 3.

Table 3. Test results on AR Objects

No	Zoom +	Zoom -	Object Respon
1	√		enlarge
2		√	small
3	√		enlarge
4		√	small
5	√		small
6		√	small
7	√		enlarge
8		√	small
9	√		enlarge
10		√	small
11	√		enlarge
12		√	small
13	√		enlarge
14		√	small
15	√		enlarge
16	√		small
17	√		enlarge
18		√	small
19	√		enlarge
20		√	enlarge

Based on the test results obtained zoom + accuracy equal to 95%, and zoom- equal to 95%.

In research [3] and [4] still use marker images on the hands to bring up the object, whereas in this study do not require drawing markers on the hands to bring up AR objects. In the study [2] for the detection of hand gestures did not show the value that affects the detection of hand gestures, whereas in this study showed the value that influences in the detection of hand gestures that is euclidean values.

CONCLUSION

Based on testing, objects can respond well to given hand gestures.But the system in this researches has not been so stable in capturing hand gestures this is influenced by the experimental environment.

To make the system more stable, additional tools and methods such as motion sensors and deep learning are needed to detect hand gestures. But this is enough to prove that hand gestures can replace traditional HCI such as mouse, keyboard and joystick.

This hand gesture implementation is not only for augmented and virtual reality systems, but also can control the motion of mobile robots and drones.

REFERENCES

[1] Dorfmüller-Ulhaas K and Schmalstieg D, 2001 Finger tracking for interaction in augmented environments *Proc. - IEEE ACM Int. Symp. Augment. Reality, ISAR 2001* p. 55–64.

[2] Lee B and Chun J, 2010 Interactive manipulation of augmented objects in marker-less AR using vision-based hand interaction *ITNG2010 - 7th Int. Conf. Inf. Technol. New Gener.* p. 398–403.

[3] Chun J and Lee S, 2012 A vision-based 3D hand interaction for marker-based AR *Int. J. Multimed. Ubiquitous Eng.* **7**, 3 p. 51–58.

[4] Lee S and Chun J, 2014 A stereo-vision approach for a natural 3D hand interaction with an AR object *Int. Conf. Adv. Commun. Technol. ICACT* **2**, 5 p. 315–321.

[5] Lee S Lim Y and Chun J, 2013 3D interaction in Augmented Reality with stereo-vision technique *Adv. Commun. Technol. (ICACT), 2013 15th Int. Conf.* p. 401–405.

[6] Billinghurst M Piumsomboon T and Bai H, 2014 Hands in space: Gesture interaction with augmented-reality interfaces *IEEE Comput. Graph. Appl.* **34**, 1 p. 77–81.

[7] Algorithm A F Hand F O R V and Control F O R R, 2006 A FAST ALGORITHM FOR VISION-BASED HAND GESTURE RECOGNITION FOR ROBOT CONTROL circle ,/ I Grere G @ e Sarleliles Skin *Hand, The* p. 6–9.

[8] Deza M M and Deza E, 2009 *Encyclopedia of distances* .