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The Implementation of Augmented Reality Hairstyles at Beauty Salons Using the Viola-Jones Method (Case Study: Eka Salon)

Graha Virgian Gustira Putri[1*)], Ade Syahputra[2], Silvester Dian Handy Permana[3]
[123]Program Studi Teknik Informatika, Fakultas Industri Kreatif dan Telematika, Universitas Trilogi
email: [1]grahaputri@trilogi.ac.id, [2]adesyahputra@trilogi.ac.id , [3]handy@trilogi.ac.id

Abstract **– Augmented reality is the technology that superimposes a computer-generated digital content on a user's view of the real world in a real time in which users can experience the real virtual objects. The use of augmented reality has spread into various industries, for an example in the fashion industry. One of the fashion industry type is hairstyle industry. Eka Salon is a beauty salon that provides beauty treatments for women's hair care. This salon has a problem that the customer is not satisfied with the results of their new haircut because that does not match with their expectations. This can be seen from the results of observations at Eka Salon resulted that 8 out of 15 interviewed customers were not satisfied with their new haircuts because it did not match the appearance in the catalog. In this research, an augmented reality hairstyle will be made that can visualize how the shape of the selected hairstyle by the customer without having to cut their hair first. The Viola-Jones method was chosen as the method used in this study because it has a high accuracy of 90% in face detection. The result of this research is that the Viola-Jones method can detect facial surfaces and generate a 3D hairstyle model distance to 100 cm properly. The acceptance tests level of this application is carried out by Eka Salon customers with an average percentage of 84.3%.**

Keywords – Augmented reality, Viola-jones, Simulation, Hairstyles

I. INTRODUCTION

Augmented reality is becoming popular these days because of the use of augmented reality which is very interesting and easier for users to project virtual objects into the real world. Augmented reality is a multimedia technology where a two-dimensional or three-dimensional virtual object is combined into a three-dimensional real-world form then projects a virtual object in real-time. As time goes by, today's technology allows the development of applications in various fields including industrial fields [4]. Currently, the use of AR has spread to various industrial fields, for example the fashion industry. One of the applications of augmented reality in the fashion world can be applied to beauty salons.

Eka Salon is a beauty salon that provides beauty treatments for women's hair care. This beauty salon has many customers who visit every day to get beauty care services. This salon has a problem that customers are not satisfied with the results of their new haircut because that doesn't match with their expectations. This can be seen from the results of observations at Eka Salon is resulted that 8 out of 15 interviewed customers were not satisfied with their new haircuts because they did not match the appearance in the catalog. This salon will be a place to research cases that will be raised by the author.

In connection with the problems discussed earlier, Augmented reality technology can be implemented to help customers minimize the disappointment that occurs after cutting hair. Augmented reality will present a virtual hairstyle for women that will become the image of the customer before making changes to his hairstyle. With the existence of Augmented Reality Hairstyles, customers will be able to choose and see to match the results of the hairstyle change they want before their hair is changed and can choose a hairstyle that suits their face to minimize feelings of disappointment when changing their hairstyle. The application will describe the selected hairstyle using the face detection method.

Face detection or face tracking has experienced considerable development in the field of computer vision. Many methods and algorithms have been applied in making face detection. This is supported by the wider benefits that can be obtained from the development of face detection. Application of face detection usually uses a video camera and the user's face as the input media. One of the methods used in face detection is the Viola-Jones method. In the implementation of augmented reality hairstyles, the Viola-Jones method will be used for face detection.

In face detection, several methods can be used, namely the Eigenface, AdaBoost, Fisherface, Haar Cascade, and Viola-Jones methods. Based on a literature study conducted from 5 face detection methods, the Viola-Jones method has a high accuracy rate of 90% and has fast computation. The Viola-Jones method uses the Haar feature in the descriptor combined with the image integral and Adaboost to search for selected feature values then form the Cascade Classifier. The classifier that is formed will be used to detect faces in the image. This study also evaluates the level of system accuracy by modifying the parameter values in the Viola-Jones method. This research will explain about how Viola-Jones works and its application in a simple face detection system using OpenCV and SparkAR libraries. This implementation is made in the form of an Instagram filter so that customers can choose the desired hairstyle easily through their respective smartphones.

II. RESEARCH METHODOLOGY

The completed application contains an overview of the flow of the processes that will be carried out from the initial stage to the results. This is done so that the stages in conducting this research run in a structured manner, to

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maximize the control that will be carried out if an obstacle occurs. The stages of the research methodology are as follows:

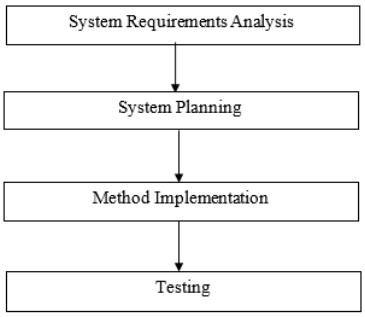

Figure 1. Methodology Research Flow.

A. Identification of problems

The problem discussed in this study is that there is often disappointment faced by a person after changing their hairstyle because it does not match the desired expectations. With this research, it will be discussed how to implement augmented reality using the viola-jones method into a hairstyle application. The aim is to present an idea of how the hairstyle will look after cutting without having to change hairstyles directly.

B. Data Collection

This research requires some data to be collected with 2 study stages, namely:

1. Study Literature

   Collecting data and studying theories related to the Viola-jones method by referring to articles, books and data from the internet.
2. Field Study

   In this stage, observations are made to identify problems that exist at Salon Eka. Observations are made by visiting directly to the location Collecting data related to the salon and materials such as what types of hairstyles will be displayed in the augmented reality hairstyles application.

C. System planning

The system design stage consists of input, process, and output using the viola-jones method.

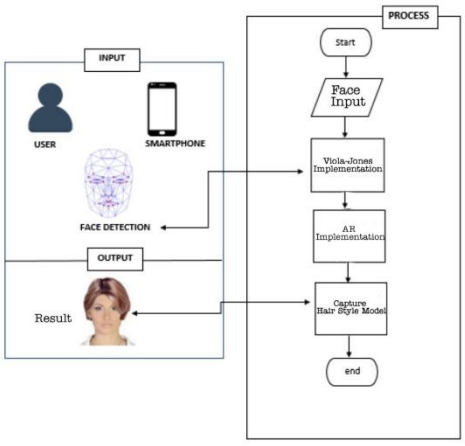

Figure 2. System Design Flow.

1. Input

   At this input stage, there are several steps, namely the user opens the application via a smartphone then the application will then the user selects the desired hairstyle.
2. Process

   At the process stage, there are several stages, namely;
   a. Start: The first stage of Start, namely the system starts running.
   b. Face input stage: At this stage, the user will face the face to the smartphone camera.
   c. AR implementation stage: The user selects the desired hairstyle.
   d. Method implementation stage: After the hair model is selected the 3D model will be right on the detected face
   e. Capture stage: After selecting the desired hairstyle, the user can take the results of applying this virtual hairstyle.
   f. The program end-stage indicates the program is complete.
3. Output

   The results that will be generated from this application are in the form of an augmented reality hairstyles application. To make it easier for salon users and owners to use AR hairstyle, it will be inputted into the Instagram story feature found on the Eka Salon Instagram account so that customers can try it on their smartphone without having to install other applications.

D. Implementation of Augmented Reality

In this study, the making of a 3D Hairstyle model was made totaling 9 medium and short hairstyles. This hairstyle is taken from interviews with salon owners picking up the types of haircuts that are often chosen by customers. The types of hairstyle that will be displayed on the augmented reality hairstyle of Eka Salon. The types of hair in the image above include bob haircuts, layer hair, mullet haircuts, and volume haircuts that are made for medium and short haircuts. The process of making this 3D model using a blender application can be seen in Figure 3.

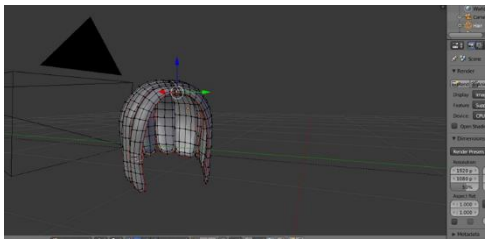

Figure 3. The process of making a 3D model of a hairstyle.

The hairstyles made are 9 medium and short hairstyles. This hairstyle is taken from interviews with salon owners picking up the types of haircuts that are often chosen by customers. The types of hairstyle that will be displayed on the augmented reality hairstyle of Eka Salon. The following

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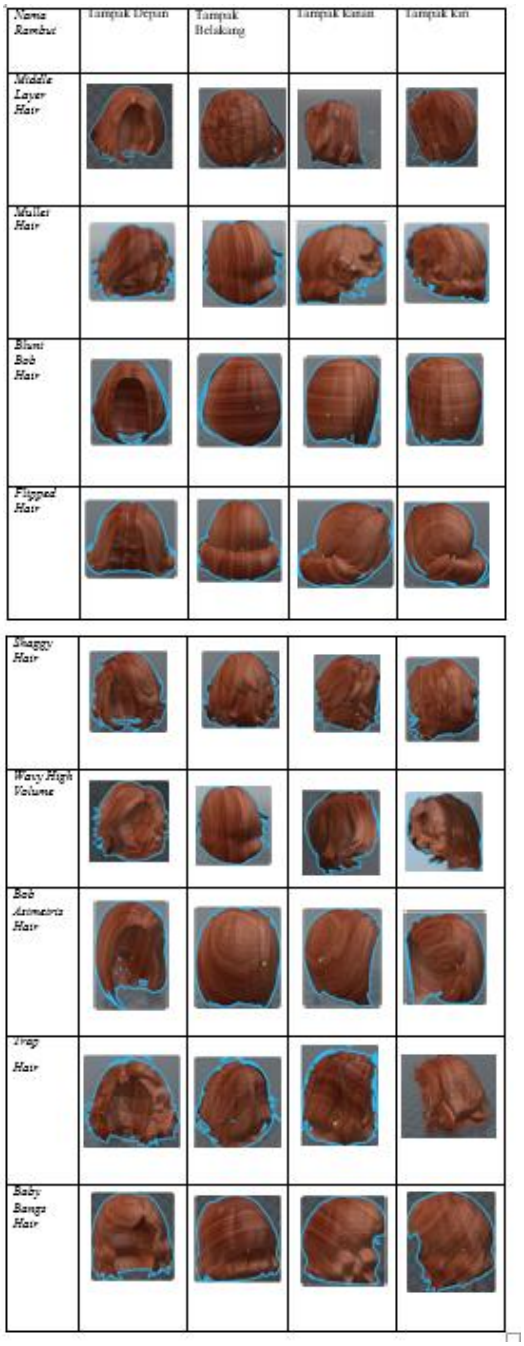
types of hairstyle that will be displayed in Eka Salon's augmented reality hairstyle can be seen in the table 1 below.

Table 1. AR Hairstyle Samples.



E. Implementation of the Viola-jones Method

In this case, the method used to detect faces is the Viola-Jones method. Viola-Jones is a method of detecting faces. In analyzing and designing the need to solve the problems in this study, a facial detection process scheme is needed using the Viola-Jones method. In Figure 4 below, you can see the Viola-Jones system process flow.

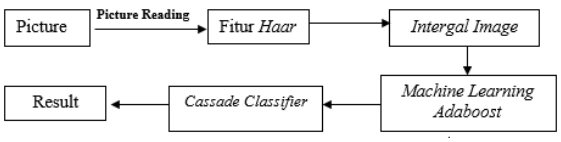


Figure 4. Viola-Jones system process flow.

1. Image Reading Stages.

   The first step that occurs in the Viola-Jones implementation process is that the system will read the image, before detecting the presence of facial features in an image. The first step that will be taken by the Viola-Jones algorithm is to change the image to grayscale.
2. Haar Feature Stage

   Once the image is converted into a grayscale image, then the system enters into the reading stage Haar features using OpenCV library. The way to call the Haar feature is to use the help of the existing library in OpenCV 2.2, namely Haarcascade_frontalface_alt. The Haar feature can also be referred to as a single square wave feature because it has one high and one low interval, while for two dimensions it is referred to as one light and one dark. If the value of the difference between the bright areas to dark areas produces an equilibrium value (threshold), then the area is declared features Haar.
3. Intergal Image Stage

   Integral image is performed to determine whether or not the haar feature is present in the image. In this stage, there is the integration of adding small units together. The small units in question are pixel values. The integral value for each pixel is the sum of all the pixels from top to bottom. The process starts from the top left to the bottom right, then the total image is added up by several integer operations per pixel. The results of these pixel values are the results of the input image passed by the Haar feature during the facial feature search stage. In each type of feature used, the boxes consist of several pixels.
4. Adaboost Stage (Adaptive Boosting) and cascade classifier

   Adaptive boosting is used to combine many weak classifiers to form a better classifier mix. The process of adaptive boosting will produce a strong classifier from a basic classifier called the weak learner. Before selecting the Haar feature, the feature AdaBoost algorithm in an image will be detected again. The aim is to determine whether there are facial features in areas with weak feature classification. If there is an area that has a weak feature classification, then that area is not included in the facial feature. If a weak classifier is found, the calculation will then be compared with the classifier. Following the series of this process, it will get face detection results

F. Interface Design and Architectural Design

1. Interface Design (GUI)

   This design is done after so that application design can be easily used. The following is an example of the interface that will be implemented.

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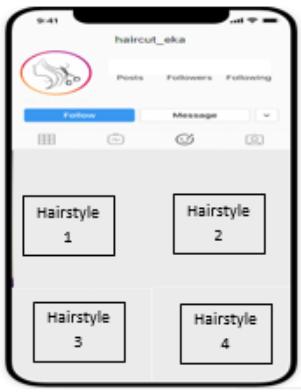

Figure 6. Interface Application

2. Architectural Design

After the Augmented Reality Hairstyle is successfully made, the AR implementation will be inputted and displayed into the Instagram story feature on the Eka Salon Instagram account so that customers can try it on their smartphone without having to install other applications.

III. RESULTS AND DISCUSSION

A. Results and Discussion of Applications

The results and discussion here discuss the viola-jones method used in the application and several displays of hairstyles objects.

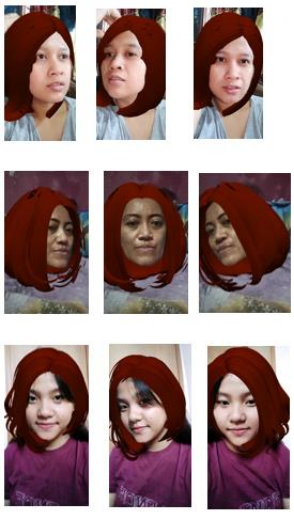

Figure 7. Samples result of the applications

1. Face detection test based on light intensity

This test is carried out to prove that when the user performs a simulation, whether the user's face is detected by the system in different light conditions.

a) Dark lighting, carried out in a room with minimal lighting intensity of 5-watt lamps (closed room). The face test results are detected 100%.
b) Medium lighting, done in a medium lighting room with a light intensity of 15 watts of light (closed room). The face test results are detected 100%.
c) Bright lighting, done in a bright lighting room with a light intensity of 20 watts of light (open space). The face test results are detected 100%.

2. Face detection test based on distance

The parameter that is also very influential in the face detection section this time is the distance between the user and the camera used. However, in this test, it is only carried out on users whose detection is right in the face area which is perpendicular and the height is parallel to the webcam's height.

a) A distance of 30 cm, the test results are detected by the percentage 100% success.
b) 60 cm distance, the test results are detected faces with a success percentage of 100%.
c) Distance of 100 cm, the test results are detected with a success percentage of 100%.

3. Face detection test based facial movement speed

This test is conducted to test the frame per second (fps) sensitivity of the webcam in capturing and detecting the movement of a moving face. This movement detection test is carried out by changing the facial movement from one position to another.

Table 2. AR test based on movement.

No	Facial Motion	Result
1	Stay	Detected
2	Slowly Movement	Detected
3	Fast Movement	Delay 1s

Table 2 explains that the faster the movement is carried out, the lower the sensitivity of the face detection system will be, and vice versa if the facial movements are slower.

4. Face detection test based on face position

Table 3 below explains that the face detection accuracy reaches 100%, the time for detection is less than 0.5 seconds.

Table 3. AR test based on face position

No	Facial Motion	Result
1	Up	Detected
2	Right	Detected
3	Left	Detected
4	Under	Detected

B. Testing results to salon customers about application satisfaction.

This study provides an assessment and analysis of the questionnaire given to 15 salon customers. The following are 6 summaries of the questionnaire questions distributed through Google Form regarding the results of the analysis.

After the questionnaire has been filled in by eka salon customers, the value of this research questionnaire is calculated using a Likert scale. The Likert scale is a scale technique that only measures single traits naturally with a score scale of more than two [13]. If the percentage reaches ≥ 80%, it can be said that the application is well received by the customer.

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1. Customers are confused about choosing a hairstyle that wants to change their hairstyle?

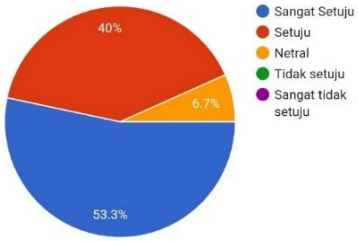

Figure 8. The results of the questionnaire analysis on question No. 1

Figure 8 shows that 33.3% of respondents (5 people) strongly agree with statement number 1, 60% (9 people) agree and 6.7% (1 person) are neutral.

The percentage calculation for statement number 1 is
= (5x5) + (9x4) + (1x3) + (0X2) + (0x1)
= 64

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{a}{b} \times 100\%$$

Note:

P = Percentage
a = Total score
b = The maximum total score ideal

$$P = \frac{64}{75} \times 100\%$$

P= 85,33%

The results of the user testing for question number one gave a percentage of 85.33%. This shows that customers agree that they often feel confused about choosing the right hairstyle for themselves.

2. Customers often feel disappointed because the hairstyle they chose was not what they wanted.

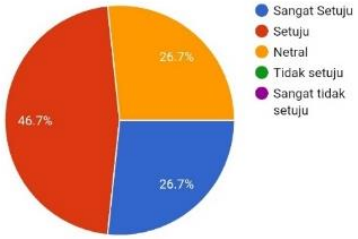

Figure 9. The results of the questionnaire analysis on question No. 2

Figure 9 shows 26.7% of respondents (4 people) strongly agree with statement number 2, 46.7% (7 people) agree and 26.7% (4 people) are neutral.

The percentage calculation for statement number 2 is
= (4x5) + (6x4) + (4x3) + (0X2) + (0x1)
= 56

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{a}{b} \times 100\%$$

$$P = \frac{56}{75} \times 100\%$$

P = 74,667% = 75%

The results of the user testing for question number two give a percentage of 75%. This shows that the results of their haircuts at their salon often do not match customer expectations.

3. Customers need a new visualization media apart from the hairstyle catalog media in the salon.

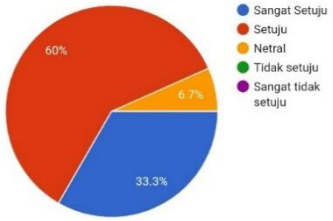

Figure 10. The results of the questionnaire analysis on question No. 3

Figure 10 shows that 53.3% of respondents (8 people) strongly agree with statement number 3, 40% (6 people) agree and 6.7% (1 person) are neutral.

The percentage calculation for statement number 3 is
= (8x5) + (6x4) + (1x3) + (0X2) + (0x1)
= 67

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{67}{75} \times 100\%$$

P = 89,3%

The results of the user testing for question number three give a percentage of 89.3%. This shows that customers agree that they need other visualization media besides the catalog books in the salon.

4. 3D Augmented reality model that is displayed simply describes the desired hairstyle.

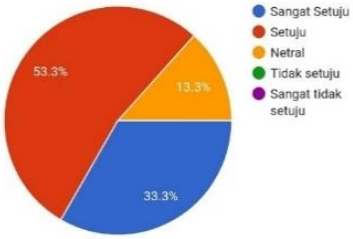

Figure 11. The results of the questionnaire analysis on question No. 4

Figure 11 shows that 33.3% of respondents (5 people) strongly agree with statement number 4, 53.3% (8 people) agree and 13.3% (2 people) are neutral.

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The percentage calculation for statement number 4 is
= (5x5) + (8x4) + (2x3) + (0X2) + (0x1)
= 63

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{64}{75} \times 100\%$$
$$P = 84\%$$

The results of the user testing for question number four give a percentage result of 84%. This shows that the customer agrees that the 3D augmented reality model shown is sufficient to describe the hairstyle desired by eka salon customers.

5. The augmented reality that is displayed is located right on the customer's head.

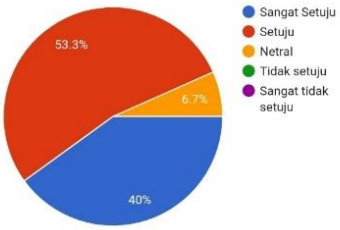

Figure 12. The results of the questionnaire analysis on question No. 5

Figure 12 shows that 40% of respondents (6 people) strongly agree with statement number 5, 53.3% (8 people) agree and 6.7% (1 person) are neutral.

The percentage calculation for statement number 5 is
= (6x5) + (8x4) + (1x3) + (0X2) + (0x1)
= 65

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{65}{75} \times 100\%$$
$$P = 86{,}6667\% = 87\%$$

The results of user testing for question number five give a percentage of 87%. This shows that the customer agrees that the 3D augmented reality model is right on the customer's head and gives an idea of the hairstyle you want to try.

6. With the Augmented reality hairstyle increases satisfaction from the results of changing customer hairstyles.

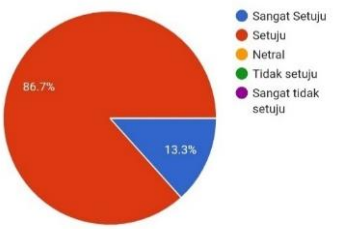

Figure 13. The results of the questionnaire analysis on question No. 6

Figure 13 shows that 40% of respondents (6 people) strongly agree with statement number 5, 53.3% (8 people) agree and 6.7% (1 person) are neutral.

The percentage calculation for statement number 5 is
= (6x5) + (8x4) + (1x3) + (0X2) + (0x1)
= 65

The calculation of the percentage of the average score with the Likert scale is:

$$P = \frac{62}{75} \times 100\%$$
$$P = 85{,}333\%$$

The results of the user testing for question number six give a percentage of 85%. This shows that the customer agrees that the augmented reality hairstyle increases the satisfaction of the salon customers' haircut results.
After getting the percentage of each question, all the results are added up to find the average of the user test results. The resulting average percentage is
= 85.33% + 75% + 89.3% + 84% + 87% + 85.3%
= 84%

IV. CONCLUSION

Based on the result of this study, the augmented reality system can function properly during testing parameters of distance, light, motion, and position. The Viola-Jones method is successful in detecting faces that are inputted from the camera. The 3d model is not implemented perfectly on the user's neck. The results of testing customer opinions about the implementation of 3D hairstyle models in augmented reality produce an average percentage of 84.3% Thus, it can be said that the application was well received by salon customers because it has exceeded the expected figure, which is 80%.

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