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Digital Image Processing Using *YCbCr Colour Space and* Neuro Fuzzy to Identify *Pornography*

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ABSTRACT (10 PT)

Pornography is a severe problem in Indonesia, apart from drugs. This can be seen based on data from the Ministry of Communication and Informatics in 2021 which found 1.1 million pornographic content online. The increasing number of access to pornographic content sites on the internet can prove this. Several studies have been conducted to produce preventive formulas. However, this research flow has not been effective in solving the problem. This is because the results of the identification value in the output image obtained are not quite right. This study proposes a procedure for identifying pornographic content in digital images as an alternative approach for the early stages of a destructive content access prevention system. The formulation uses the YCbCr color space to analyze human skin on image objects that represent exposed body parts and the classification process with the Neuro Fuzzy approach. The performance of this formula was tested on 100 digital images of random categories of human objects (usually covered, skimpy, and naked) taken from the internet. The test results are at a relatively good level of accuracy, with a weight of 70% for the entire test data.

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1. INTRODUCTION

Based on pornography law No. 44 of 2008, pornography is gestures, conversations, cartoons, animations, moving images, sounds, voices, writing, sketches, pictures, or other messages through various communication tools and public performances. , which contains obscene acts or sexual exploitation that is against the norms of decency in society [1]. Types of pornographic media can be television, telephone, newspapers, magazines, radio, and the internet [1][2]. Statistically, there are at least 200 new sites that contain pornography, increasing every day [3]. Even porn sites are the first to be blocked by Kominfo [4]. Surprisingly, Indonesia has become the third country in the world to access porn sites, especially among junior high and high school students, whose percentage is 97% [5].

In the context of religion, Islam prohibits pornography for its followers. This prohibition has been stated in the Qur'an Surah Al-Ahzab (33) verse 59. Where there is the expression "... so that they stretch out their headscarves over themselves (all over their bodies...." [6]. This expression explains that Muslims should cover their nakedness to make women respectable and independent. In addition, covering nakedness can also protect women from disturbance or danger. This verse is one of the references to the prohibition of pornography in Islam. The pornography itself is an act that shows all genitalia to people who are not mahrams, giving rise to an element of adultery which is prohibited (haram) in religion. However, there are exceptions in several cases, which means that private parts can

be shown if there is an unavoidable interest, such as teaching aids for the human body or studying the anatomy of the human body in health sciences, medicine, biology, and so on.

Pornography was chosen as one of the many significant problems in Indonesia besides drugs, evidenced by the increasing cases of pornography every year. According to the official Kominfo website, pornographic content has the first highest statistical order. With a total of 854876 complaints about pornography. Where every month this complaint has increased.

Other people enjoy different types of pornographic media. Some of the press include photos, videos, audio, or comics. Most photos containing pornographic content are photos of naked women. Naked comes from KBBI (Big Indonesian Dictionary), which means not wearing the slightest clothes or being naked. Pornographic photos can circulate easily among the public. These photos can be spread on social media networks such as WhatsApp, Facebook, Instagram, and others. Usually, photos can be shared privately or through WhatsApp chat groups.

Some researchers use the neuro-fuzzy algorithm to solve existing problems because fuzzy has a concept similar to human thinking. Examples of research related to fuzzy concepts are s[8][9]. Thus, Neuro-Fuzzy is one of the algorithms that can be used in multi-dimensional scientific research because it has a modeling structure that combines fuzzy and artificial neural network systems.

Many academics are researching pornography. One is the research conducted [10]. The results of his research proved that the ten subjects studied had accessed pornographic sites, and nine of them felt aroused by only viewing pornographic images. The ten objects agree that pornography can be obtained easily online rather than by buying magazines and VCDs. This means that pornography is inherent in society, from small children to adults.

Several studies on image processing have been carried out. For example, [11][12][13], especially [14], researched the detection of harmful content in digital images based on vital human organs using GLMC and YCbCr color feature extraction. Negative content detection is done by detecting the essential tool, the breast nipple. The proposed method is to perform face detection and replace the face first, aiming to reduce the error percentage. Then classify the images containing the body's vital organs, the results of which are the YCbCr colour feature extraction process. As a result, from the 158 object data obtained, especially prospective nipples, from the research process that was carried out, the research detected nipple content with an accuracy value of 90.3%, a specificity value of 84.60%, and a sensitivity value of 92.4%. This data shows that the addition of YCbCr color feature extraction can increase the accuracy value by 0.9% and then the sensitivity value is obtained by 1.04%.

The following research is [15], namely by detecting pornographic content using the YCbCr Color Model and C4.5 Improvement Method and Shape Descriptor for social media upload filters. This research uses the YCbCr Color Model to detect human skin and then classifies it with the C4.5 algorithm. This system is used to filter pornographic content on social media. Accuracy results reach 65%, the error rate is 35%, the precision is 0.615, the recall is 0.8, and the Root Mean Squared Error (RMSE) value is 0.59.

Other researchers [16] examined skin detection using PCA-KNN and the HSCbCrAB Color Model. Skin detection uses chrominance components derived from the HSV, YCbCr, and CIELAB color spaces, with the name HSCbCrAB. Meanwhile, PCA is used to reduce dimensions, and KNN is used to classify them. The results showed good performance in the HSCbCrAB color space for skin detection. Alternatively, other researchers [17][18][19] use several methods with the same goal, namely, to detect pornography.

Pornography can be handled in various ways. One was carried out by Kominfo, namely by blocking porn sites on the internet. Abroad, some software can identify pornography. Moreover, they have already started much research on porn. It started from the identification of sites and text containing pornography to the identification of pornographic videos. However, pornographic identification software in Indonesia is still lacking. Even though Kominfo has blocked pornographic sites, that does not include pornographic media found on devices owned by the public.

Previous research shows that pornographic image identification systems can be detected based on skin color, pattern detection, and artificial nervous system networks. At the same time, this research will combine the YCbCr and Neuro Fuzzy color models. The YCbCr model will analyze human skin color in the photo, then extracts the color, and Neuro Fuzzy will classify it.

Based on the background of the problems stated above, two points are the questions of this research. First, what is the process of converting RGB colors into the YCbCr color model for each pixel in the image? The second is How is the process of classifying skin color using Neuro-Fuzzy? Then the focus of this research is: Convert the resulting value from RGB into YCbCr color extraction for each pixel in an

image which will later be classified as a color value. Then, Implement the Neuro Fuzzy Algorithm for skin color classification. Then the results of the contribution of this study. First can identify pornographic content contained in an image. Both can be used as references or scientific treasures related to extracting RGB colors in the skin to become YCbCr colors using the Neuro Fuzzy algorithm to classify colors.

2. METHOD

The methodology is used to answer questions and research objectives due to the research conducted to build a system designed systematically in the form of an application. Then the research method is combined with software design manifested in flowcharts, DFD, and interfaces. For the methodology and research system design can be seen in the picture. 1. From Figure 1, it can be explained:

a) Study of literature
Literature studies are based on theory by the research conducted and, for example, related to the theory of digital image processing, the concept of detection, RGB color, YCbCr, Neuro-Fuzzy, and its application.

b) Method of Collection Data
The data collection method was carried out through pornographic images and supporting data to support research. Data were obtained from various sources and were used as data sources in this study.

c) Need Analysis
System requirements in implementing the built application are divided into software requirements (Windows 7 64 bit, Matlab) and hardware (i5 Processor, 1366 x 768 Display, 500GB, 4GB memory).

d) Interface System
System design is carried out to facilitate the process of running system activities. The system design in this study uses the Balsamiq mockup.

e) Implementation
This stage is a unit of system design that has been determined to become an application that uses the Neuro Fuzzy method.

f) Testing
Testing is carried out on the application that is made, and the aim is to ensure that the application runs according to its needs. Suppose testing is carried out on several modules that are made. If an error occurs, the module will be repaired.

g) Analysis of Test Result
This stage is a discussion of the applications made and the methods used, namely Neuro Fuzzy, YCbCr, and their processes.

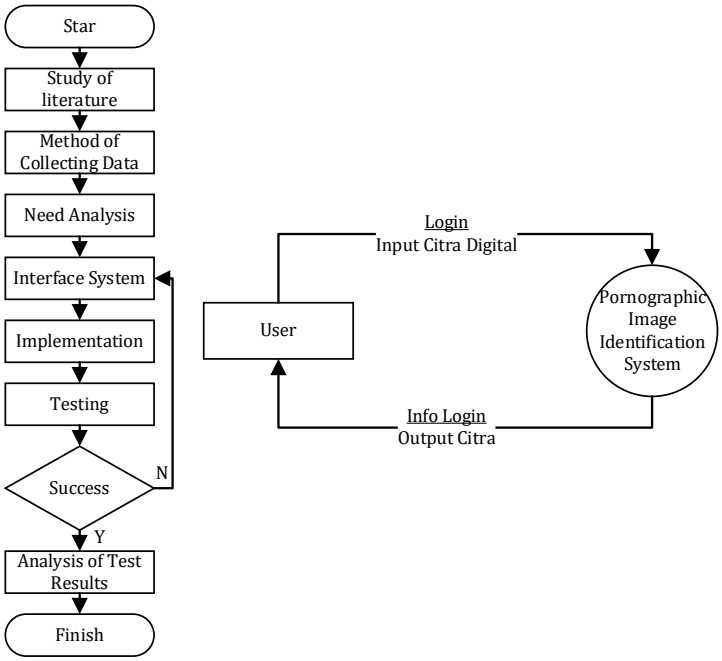

Figure 1. Flowchart Methodology and DFD System

3. RESULT AND DISCUSSION

3.1. Calculation Analysis of the Weighted Sum Model Method

In this calculation stage, the analysis application runs using the YCbCr Color Model. For example, in this calculation, using the image of women. The first process of testing through the RGB color becomes the YCbCr color. The image of the woman to be tested is shown in Figure 2.

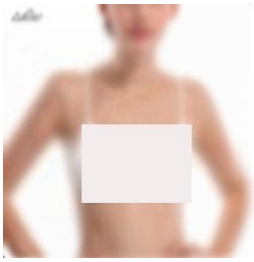

Figure 2. The Image of the Woman to be Tested

Then the RGB value is taken for the image to be tested and converted into a YCbCr value. The method of this system is to extract the RGB value in an image into the YCbCr value. The RGB values entered have the numbers 254, 254, and 254.

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \frac{1}{256} \begin{bmatrix} 65.738 & 129.057 & 25.064 \\ -37.945 & -74.494 & 112.439 \\ 112.439 & -94.154 & -18.285 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \frac{1}{256} \begin{bmatrix} 65.738 & 129.057 & 25.064 \\ -37.945 & -74.494 & 112.439 \\ 112.439 & -94.154 & -18.285 \end{bmatrix} \begin{bmatrix} 254 \\ 254 \\ 254 \end{bmatrix}$$

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \frac{1}{256} \begin{bmatrix} 55844.186 \\ 112.439 \\ -94.154 \end{bmatrix} \begin{bmatrix} 254 \\ 254 \\ 254 \end{bmatrix}$$

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 234.12 \\ 128 \\ 128 \end{bmatrix} + \frac{1}{256} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 218..12 \\ 0 \\ 0 \end{bmatrix}$$

The YCbCr value obtained will be processed to be classified using the neuro-fuzzy method. This method has several stages, including Fuzzification, product layer, normalization layer, defuzzification, and output layer [21]. The value obtained from YCbCr extraction, then this value will go through the first stage of neuro-fuzzy, namely Fuzzification. Fuzzification here is intended to calculate the value of the degree of membership.

a. Y Membership Degree

$$\text{High} = \frac{(b-x)}{(b-a)} = \frac{(235-234.12)}{(235-16)} = \frac{0.88}{219} = 0.004$$

$$\text{Low} = \frac{(b-x)}{(b-a)} = \frac{(234.12-16)}{(235-16)} = \frac{218.127}{219} = 0.996$$

b. Cb Membership Degree

$$\text{High} = \frac{(b-x)}{(b-a)} = \frac{(240-128)}{(240-16)} = \frac{112}{224} = 0.5$$

$$\text{Low} = \frac{(b-x)}{(b-a)} = \frac{(128-16)}{(240-16)} = \frac{112}{224} = 0.5$$

c. Cr Membership Degree

$$= \frac{(240 - 128)}{(240 - 16)}$$
$$= \frac{112}{224}$$
$$= 0.5$$

$$= \frac{(128 - 16)}{(240 - 16)}$$
$$= \frac{112}{224}$$
$$= 0.5$$

After obtaining the membership degree value, enter the next step, namely calculating the weight (w) of the high and low linguistic values.

$W_{(high)}$ $= W_y \times W_{cb} \times W_{cr}$

$= 0.004 \times 0.5 \times 0.5$

$= 0.001$

$W_{(low)}$ $= 0.996 \times 0.5 \times 0.5$

$= W_y \times W_{cb} \times W_{cr}$

$= 0.249$

Then normalize

$$O_{3.0} = \frac{wi}{W1 + W2}$$
$$= \frac{0.001}{0.001 + 0.249}$$
$$= \frac{0.001}{0.25}$$
$$= 0.004$$

The next stage is defuzzification. The formula calculates the defuzzification output of this layer:

$(\alpha 0x) = (234.12\ x\ 0.004)$
$= 0.93$

$$O_{3.0} = \frac{wi}{W1 + W2}$$
$$= \frac{0.93}{0.93 + 233.18}$$
$$= \frac{0.93}{234.11}$$
$$= 0.003$$

$(\beta 0y) = 128\ x\ 0.5$
$= 64$

$(\aleph) = 0.004\ x\ 0.003\ x\ 64$
$= 64.007$

$(\alpha 1x) = (234.12\ x\ 0.996)$
$= 233.18$

$$O_{3.0} = \frac{wi}{W1 + W2}$$
$$= \frac{233.18}{0.93 + 233.18}$$
$$= \frac{233.18}{234.11}$$
$$= 0.996$$

$(\beta 1y) = 128\ x\ 0.5$
$= 64$

$(\aleph) = 0.996\ x\ 0.996\ x\ 64$
$= 65.992$

$$\text{High} = \frac{64.007}{64.007 + 65.992} = \frac{64.0007}{129.999} = 0.49$$

$$\text{Low} = \frac{65.992}{64.007 + 65.992} = \frac{65.992}{129.999} = 0.5$$

The final step is the total coating.

$$\text{High} = \frac{\sum WiYi}{\sum} = \frac{0.001\ x\ 049}{0.12499} = \frac{0.00049}{0.12499} = 0.003$$

$$\text{Low} = \frac{\sum WiYi}{\sum} = \frac{0.249\ x\ 0.5}{0.12499} = \frac{0.1245}{0.12499} = 0.996$$

From the results above, the image identification process begins by changing the RGB color to the YCbCr color. The process is carried out by taking the RGB value in an image which is entered and then extracted into the YCbCr value with the formula. The resulting extraction values are then classified using the Neuro Fuzzy (Fuzzification) method. The purpose of Fuzzification is to calculate the degree of membership. Based on the extraction results, there are three groups of membership degrees, namely Y, Cb, and Cr. Each group has high and low scores.

After obtaining the membership value, the value is processed to obtain the weight value (w) of the high and low linguistic values. The value of w is obtained by multiplying the same group. The result is W(high) = 0.001 and W(low) = 0.249. Next is normalization. Normalization is done so that the resulting value is not too large. This can be seen from the results obtained at 0.004 and 0.996. The next step is the defuzzification stage, which aims to convert every result expressed into a fuzzy set. The result of defuzzification is 129,999 for high and low. The last is the total layer. The resulting layer synthesizes the information sent by layer 4 (defuzzification) and returns the entire output, resulting in a value of 0.003 for high and 0.996 for low.

3.2. Interface Implementation

Interface implementation is a step-by-step process in a design implemented into an application form the user will use. The following shows the application page for a pornographic image identification system using the YCbCr color model and the neuro-fuzzy algorithm. The main display when the application is run, as shown in Figure 3

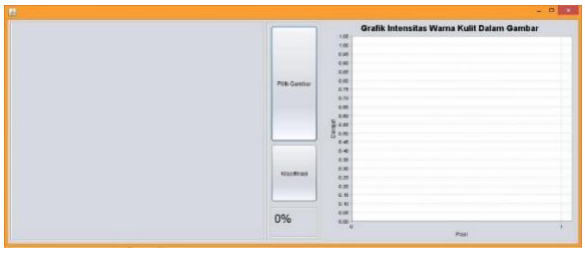

Figure 3. System View

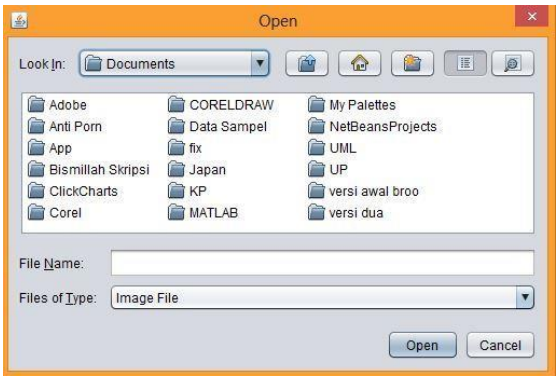

Figure 4. File Selection

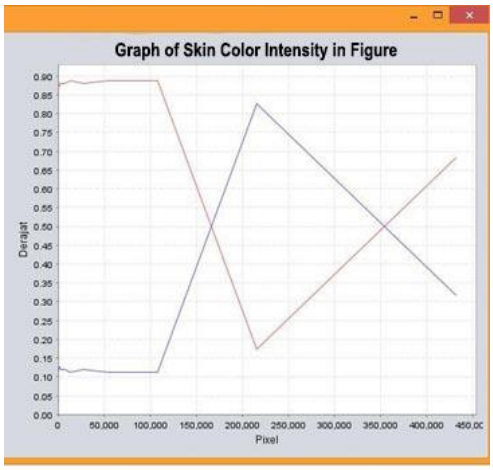

Figure 5. Chart

4. CONCLUSION

Based on the research results, the neuro-fuzzy method based on YCbCr in identifying digital images produces an accuracy of 70% of the 100 images tested. Hence, using the neuro-fuzzy method is suitable for identifying digital images. From a scientific point of view, research conducted using the neuro-fuzzy method can be used as a reference and validation with the same study. It is different if the research is in a different context. Other methods are needed. This is, of course, the use of assessment parameters that can affect the value of the identification process.

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