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Identification of Skin Color Images in Humans Using Principal Component Analysis Method

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ABSTRACT

Skin detection is an important process for classifying human skin color. Some phone cameras produce images in RGB (Red, Green, Blue) format. Various cases of skin detection often perform a transformation from the RGB color space to another color space, such as YCbCr or HSV, to improve detection accuracy. In this journal, we conduct research on skin detection using Teachable Machine, a platform that utilizes machine learning to teach computers to recognize visual patterns. The term "accuracy per epoch" refers to how well the model is at telling which pixels in an image are skin color during each training iteration (epoch) when skin color identification using the Principal Component Analysis (PCA) method on a teachable machine is being done. PCA helps reduce the dimensionality of data, enabling more efficient analysis and increased model accuracy. Teachable Machine makes this process simple by providing a user-friendly interface for training models without requiring in-depth knowledge of code or algorithms. Measuring accuracy per epoch is crucial in the training process because it shows the development of the model's ability to detect human skin over time. We expect the model to improve its accuracy in identifying skin-color pixels with each epoch, thereby enhancing the overall performance of the skin detection system. This research shows the great potential of the teachable machine in skin detection applications, providing a more efficient and accurate solution than traditional methods.

Keywords: Skin Color Images, Principal Component Analysis, Teachable Machine, Skin Detection.

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INTRODUCTION

Digital image processing technology's rapid development makes it simple to process images for use in various fields. A digital image is a representation of an image in digital form that is expressed in the form of a matrix consisting of pixels, where each pixel has a numerical value that represents the color and intensity of light. We will use digital image processing in this research to identify color images on human skin[1]. Because it allows for quick and direct processing, resists geometric variations in skin patterns and textures, resists changes in image resolution, and lessens the need for specialized tracking equipment, skin serves as a good initial source of information. Apart from that, skin also has color characteristics, which makes things easier because color is one aspect that humans can easily and quickly recognize.

A person's skin color type can provide initial information about their race. Skin identification is the process of finding colored skin pixels in images or videos. Using digital image processing techniques, we can perform in-depth analysis of skin color and texture to identify and classify human skin color types with high accuracy. This method utilizes technological advances in the field of digital image processing to provide an efficient and effective solution for identifying human skin color. As a result, the use of digital image processing in skin color detection opens up opportunities for the development of systems that can help in various fields, such as individual identification based on skin color, facial recognition, and health applications that require skin color analysis. This shows the great potential of digital image processing technology to make positive contributions in various aspects of human life.

The aim of this research is to apply digital image processing technology to identify and classify human skin color with a high level of accuracy. By combining the concepts of digital images and skin color recognition, this research aims to create a system that can effectively and efficiently identify skin color in a variety of different situations and conditions.

LITERATURE REVIEW

Identification of skin color images in humans is a topic that has attracted the attention of many researchers in the field of digital image processing. Principal component analysis (PCA) is a widely used and tested method in this context. According to [1], PCA is an effective technique for reducing data dimensions and extracting important features from images. Using PCA, previous research has succeeded in identifying human skin color patterns with a high degree of accuracy. For example, research by [2] describes the use of PCA to classify skin color in medical images with a satisfactory success rate.

In addition, research by [3] highlights the usefulness of PCA in dealing with lighting variations that often affect skin color identification results. This method has succeeded in producing a model that can recognize skin color consistently in various lighting conditions. Critics also criticize PCA for skin color identification. Some studies, such as those described by [4], suggest that PCA may be less effective in treating complex variations in skin texture. Therefore, even though PCA has proven to be a reliable method for identifying human skin color, further research is still necessary to optimize its use, particularly when dealing with texture variations and complex lighting conditions. This research aims to provide a new contribution to the development of more accurate and reliable skin color image identification techniques using PCA as the main analytical method.

METHODOLOGY

This research method uses principal component analysis (PCA) analysis to identify skin color in arm images. The first step in this research is to collect a dataset. This dataset consists of a collection of arm images with varying skin colors, backgrounds, and lighting conditions. We designed this dataset to encompass a wide range of skin types and skin color variations that one may encounter in real-life situations. Furthermore, this study uses the “accuracy per epoch” metric to evaluate the model's performance in identifying skin color in arm images. Accuracy per epoch refers to measuring how well the model is able to classify pixels in an image as skin color or not during each training iteration (epoch) of the model. In order to significantly contribute to the field of digital image analysis, particularly in the identification of skin color, this research uses the PCA method to leverage a large dataset and develop a model that can recognize and classify skin color in arm images with a high level of accuracy.

RESULTS AND DISCUSSION

In this chapter, we perform a comparison using a teachable machine to determine skin color from images taken with 50 datasets. We divide this dataset into three categories: white skin, brown skin, and black skin.

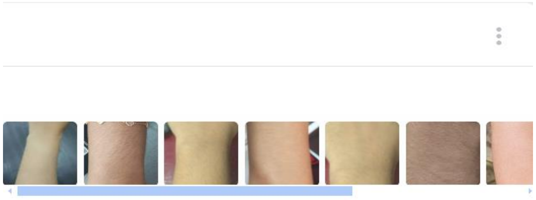

Figure 1. White Skin Dataset

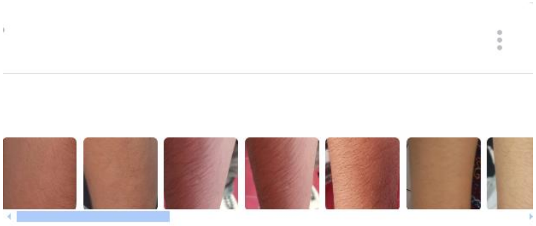

Figure 2. Brown Skin Dataset

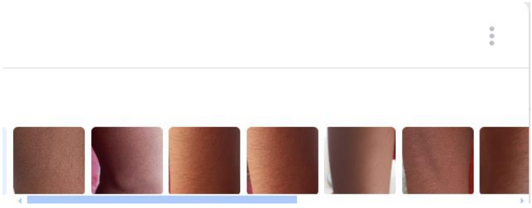

Figure 3. Black Skin Dataset

White skin generally has a lighter color and may tend to have pinkish or bluish undertones. The images in this dataset will likely show characteristics such as high brightness and a tendency towards lighter colors. The model training process, which uses images of white skin, aims to teach the model how to identify and differentiate skin color characteristics that are typical of this skin type.

Brown datasets are typically warmer colors with brownish yellow or olive nuances. The images in this dataset will show characteristics such as darker skin tones and may have warmer tones. When training the model with this dataset, the main focus was teaching the model to recognize skin color variations typical of tan skin types.

Black skin datasets generally have darker colors with deeper nuances, such as dark brown, purplish, or bluish. The images in this dataset tend to have high levels of darkness and perhaps richer or deeper color tones. The training process teaches models to comprehend the typical skin tone variations of black skin types, often characterized by lower lightness and deeper undertones.

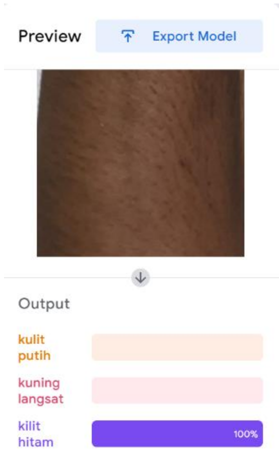

Figure 4. Black Skin Test Results

Figure 4 displays the results of a meticulously processed and analyzed test image, using either the developed model or the test data. The model successfully identified the characteristics of black skin

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within the image through its analysis. This identification process requires the model to recognize specific attributes and nuances associated with black skin, such as darker pigmentation and deeper tonal variations. As a result, Figure 4 illustrates the model's effectiveness in accurately detecting and classifying black skin from the test image, demonstrating its ability to handle various skin tones with precision.

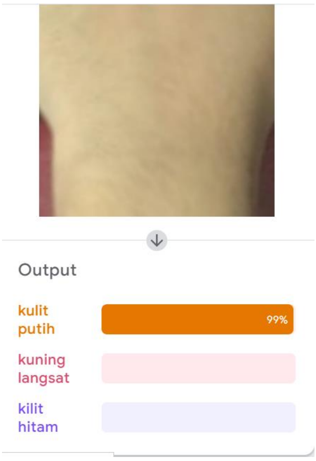

Figure 5. White Skin Test Results

Figure 5 presents the comprehensive analysis of the image test, utilizing either the developed model or the test data. Through this meticulous process, the model was able to identify and classify the presence of white skin in the image. This result demonstrates the model's ability to accurately distinguish and recognize the unique characteristics of white skin, such as lighter pigmentation and specific tonal qualities. Consequently, Figure 5 serves as evidence of the model's precision and effectiveness in processing and identifying white skin from the test data.

Figure 6. Brown Skin Test Results

Figure 6 displays the meticulous analysis of a test image using the developed model or test data, resulting in the identification of brown skin. The model has successfully recognized and classified the unique characteristics of brown skin, such as its warm tones and varying shades of brown. This outcome highlights the model's ability to accurately differentiate and identify brown skin from the test image, showcasing its effectiveness in handling and processing diverse skin tones. Consequently, Figure 6 serves as a testament to the model's precision and reliability in detecting brown skin based on the provided data.

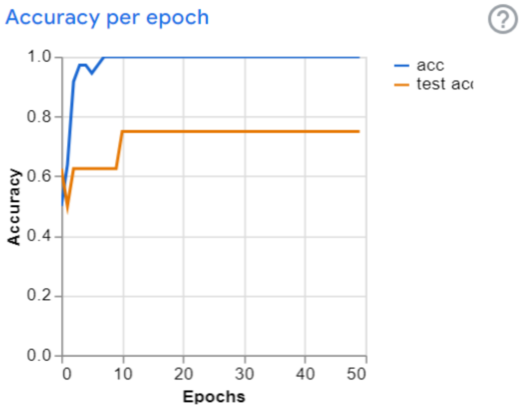

Figure 7. Accuracy per epoch

Figure 7 shows the results of calculating the accuracy of the training dataset that was presented to the network for learning. This figure showcases the model's performance in accurately classifying and identifying the training data. The accuracy metric offers valuable insights into the model's learning from the training dataset, demonstrating its ability to generalize and make accurate predictions based on the patterns and features it encountered during the training process. Consequently, Figure 7 serves as an important indicator of the model's effectiveness and reliability in processing and analyzing the training data.

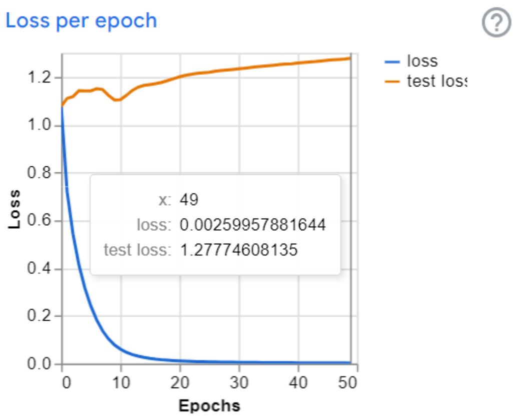

Figure 8. Loss per epoch

Figure 8 presents the result of calculations using a loss function that evaluates how well the model predictions compare to the actual values. This figure illustrates the effectiveness of the model in terms of minimizing the difference between its predicted outputs and the true values from the dataset. The loss function provides a quantitative measure of the model's performance, indicating how accurately the model is learning and adjusting its parameters during the training process. Consequently, Figure 8 serves as a critical indicator of the model's ability to improve and refine its predictions, highlighting the overall effectiveness and reliability of the model in aligning its outputs with the expected results.

CONCLUSION

The analysis and research results conclude that using the Principal Component Analysis (PCA) method and platforms like Teachable Machine to identify skin color images is an innovative approach to understanding skin color variations and automatically classifying them. The PCA method allows reducing the dimensions of skin color image data to lower dimensions, which still reflect significant variations in skin color, thereby enabling the creation of models that are efficient and accurate in identifying various skin colors. The use of a teachable machine as a platform for building skin color image identification models provides greater accessibility to users who do not have a deep technical background. With a user-friendly interface, individuals can easily train their own models, upload skin image datasets, and classify skin tones with high accuracy after the training process. The platform bridges the gap between advanced technology and lay users, enabling them to effectively utilize digital image processing technology in a variety of applications, from security to health analysis.

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