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COMPARISON OF SIFT AND ORB METHODS IN IDENTIFYING THE FACE OF BUDDHA STATUE

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Abstract—*The statue is part of the heritage facial recognition process which is immobile and artistically stylized. Identifying the similarities between the statues can help provide an important reference for tourism in recognizing the faces of the statues which are different and have almost the same characteristics in every country, especially in Indonesia, among the facial recognition of the statues based on the condition, color, and shape of the face. The purpose of this study is to apply the original images that have characteristics, partially done manually to various types of transformations and calculate matching evaluation parameters such as the number of key points in the image, the level of matching, and the required execution time for each algorithm. To confirm the efficiency of the proposed method, experiments were carried out on private data sets obtained from statues under low light conditions and in different poses. The data was taken based on the image of the Buddha's face and matched with the facial image of the Buddha statue available in the database using comparisons resulting from data processing using the Sift and ORB methods with various types of transformations. The result will be seen in the image that is matched with the best algorithm for each type of distortion. The faces tested are images of the faces of the Buddha statues that are recognized, and photos of some of the original statues that were not saved due to unclear lighting and camera distance factors. The results show that the number of key points generated is the number of key points, the ORB method gives fewer results compared to the SIFT method and the average SIFT recognition and processing time shows better performance for an average of 100% at a SIFT matching rate of 2% with time 0.400285 and the ORB method is 1% for the time 0.400961.*

Keywords: *images matching, face recognition, SIFT, ORB, statue, face buddha.*

Intisari— Arca merupakan bagian dari proses pengenalan wajah warisan yag tak bergerak serta bergaya artistik. Dalam mengidentifikasi kesamaan antara arca dapat membantu memberikan referensi penting untuk pariwisata dalam pengenalan wajah arca yang berbeda dan memiliki ciri khas yang hampir sama disetiap negara khususnya di Indonesia, diantara pengenalan wajah arca berdasarkan kondisi, warna, serta bentuk wajah. Tujuan penelitian ini untuk menerapkan gambar asli yang memiliki ciri khas, sebagian dilakukan secara manual ke berbagai jenis transformasi dan menghitung parameter evaluasi pencocokan seperti jumlah titik kunci dalam gambar, tingkat pencocokan, dan waktu eksekusi yang diperlukan untuk setiap algoritma. Untuk menguatkan efisiensi metode yang diusulkan, percobaan dilakukan pada kumpulan data private yang diperoleh dari arca dengan kondisi pencahayaan rendah dan pose berbeda. Data diambil berdasarkan citra wajah buddha dicocokkan dengan citra wajah arca budha yang tersedia dalam basis data menggunakan perbandingan yang dihasilkan dari pengolahan data dengan metode sift dan ORB dengan berbagai jenis transformasi. Hasilnya akan terlihat pada gambar yang dicocokan dengan algoritma terbaik untuk setiap jenis distorsi. wajah yang diuji adalah citra wajah arca buddha yang dikenali, dan foto beberapa arca asli yang tidak disimpan karena faktor pencahayaan yang kurang jelas dan faktor jarak kamera. Hasil menujukkan banyaknya key point yang dihasilkan jumlah poin kunci, metode ORB memberikan hasil yang lebih sedikit dibandingkan dengan metode SIFT dan rata-rata waktu pengenalan dan pemrosesan SIFT

menunjukkan kinerja yang lebih baik untuk rata rata 100 % pada tingkat pencocokan SIFT sebesar 2 % dengan waktu 0,400285 dan metode ORB sebesar 1 % untuk waktu 0,400961.

***Kata Kunci**: pencocokan gambar, pengenalan wajah, SIFT, ORB, arca, wajah buddha.*

INTRODUCTION

Technology assisting the face is currently growing, where aid research is still a big theme and involves many disciplines. Several face-matching applications will continue to develop and mastery of this technology will be indispensable for identifying the faces of intact or damaged statues in museums or Indonesian temples or various countries[1][2].

At present, the relief of Buddha statues with similar artistic models is still lacking in empirical assistance, and scientific quantitative relief methods are still lacking[3]. This research provides quantitative evidence for repairing virtual and physical statues using pictures or photographs, so that people can quickly judge the similarities between different Buddha statues, accurately find common feature points, and assist experts in repairing Buddha statues. Some examples of these Buddha statues are considered very similar and can be chosen as a reference for other Buddha statues[4][1][5].

Currently, facial recognition of statues or artifacts relies on traditional workers to repair or recognize statues due to the lack of available science and technology. In recent years, the protection of the temple has focused on keeping the building in good condition, but a quantitative assessment of the similarity of the Buddha statues inside the temple stupas has not received much attention from researchers[6][7]. The best evidence for cultural heritage is ideally original documentation, such as survey data and photographs. However, these documents have been largely lost to time. cultural heritage, especially temples, and statues, of the same period tend to have a uniform style. Therefore, searching for similar objects can provide an economical and scientific way to recover damaged relics[8][9].

This identification is necessary in order to distinguish the characteristics of the Buddha statues which have a high degree of facial resemblance in each country[10][7]. The process of numbering points is used to express the similarity index of matching feature points between two similar Buddha statues[11]. It is therefore necessary to identify and match the feature points of similar Buddha statues[12][13].

SIFT (Scale-Invariant Feature Transform) is a feature recognition technique that is often used for facial recognition. In this method, facial images are analyzed to look for unique features such as edges, points, and paths that distinguish one face from another[14]. Once these features are discovered, they can be used to compare new faces with a database of known faces to estimate the identity of those faces. SIFT has the ability to handle scaling and rotational changes in facial images, making it suitable for facial recognition under different conditions[8][15][16].

The SIFT method on facial images consists of several stages[17][18]:

a. Key Point Detection
   The SIFT algorithm uses a key point detection technique to find unique feature points in facial images.
b. Keypoint Descriptor
   Once the key points are found, SIFT generates a feature description of each key point which involves measuring the distribution of pixel intensity around that point.
c. Matching
   The feature description of the face image is compared with the feature description of the reference image to determine the degree of similarity.
d. Verification
   After the matching process is complete, the results are confirmed through a face verification algorithm to ensure that the recognized face matches the owner's face.
e. Identification
   If the verification is successful, the facial image is recognized and associated with the corresponding owner's identity.

SIFT has the ability to handle orientation and scale changes in facial images, making it an effective algorithm for face recognition[17].

The Scale-Invariant Feature Transform (SIFT) algorithm is a method that is widely used in face recognition. Experts consider SIFT to be an effective method because of its ability to handle differences in scale and orientation of facial images, as well as having a high degree of accuracy in recognizing faces[18]. However, SIFT has drawbacks in terms of execution time which is quite long and requires a lot of computational resources. Therefore, some experts are also looking for

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alternative methods that are more efficient in terms of time and resources[19].

Researchers have opinions on improvements to the SIFT algorithm for facial recognition. These improvements include adding steps to the process of selecting facial features, thereby increasing accuracy in facial recognition. He also pointed out that the improvements yielded better results than the original SIFT method when applied to multiple facial datasets. Therefore, it can be said that SIFT improvements are very helpful in increasing facial recognition accuracy[20].

The SIFT algorithm is still effectively used in facial recognition even though the facial image has been manipulated. He proposed adding a validation step to the face recognition process with SIFT so that it can filter manipulated images and improve facial recognition accuracy. Therefore, the SIFT method is very helpful in facial recognition even though the image has been manipulated[21].

ORB (Oriented FAST and Rotated BRIEF) is a feature recognition technology that is often used in face recognition. In this method, facial images are analyzed to look for unique features such as edges, points, and paths that distinguish one face from another[22]. Once these features are discovered, they can be used to compare new faces with a database of known faces to estimate the identity of those faces. ORB has advantages in terms of research speed and efficiency compared to other feature recognition techniques such as SIFT. This makes ORB suitable for facial recognition applications on low-speed devices. ORB combines FAST key point detection techniques with BRIEF feature descriptions to create a unique representation of each feature in an image[23].

In general, ORB follows the same steps as SIFT in facial recognition, including key point detection, feature description, matching, verification, and identification. However, ORB uses different techniques for each of these stages[24].

Use of the ORB-PCA feature extraction technique for facial recognition. ORB-PCA is a combination of ORB and PCA (Principal Component Analysis) algorithms used to extract facial features. This technique has a faster execution time and requires fewer computational resources compared to the SIFT method. In addition, ORB-PCA also has fairly good facial recognition accuracy. Therefore, it can be said that the ORB-PCA technique can help in increasing the efficiency and accuracy of face recognition[22][25].

Use of LBP (Local Binary Pattern) and ORB features for facial expression recognition. He showed that the combination of LBP and ORB features has good accuracy in recognizing facial expressions. In addition, this method also has a fast execution time and requires little computational resources. Therefore, it can be said that the combination of LBP and ORB features can help in increasing the accuracy and efficiency of facial expression recognition[26][27].

A comparison of the SIFT and ORB methods is needed to provide information on which method can provide a level of matching of feature points, as well as the level of matching speed, accuracy, and robustness that must be considered comprehensively for algorithm selection. SIFT operator and ORB operator have high accuracy, and the results are relatively stable[24][22]. SIFT is more accurate than Surf but runs slower. Brisk operators and Orb operators are relatively fast, but their accuracy is poor. Again, given the characteristics of small cave sculptures, accuracy is the more important factor; Therefore, the SIFT operator was chosen as the feature point matching algorithm in this study.

MATERIALS AND METHODS

Taking images of Buddha statues from public data (pinters205facebuddha), with stacked Buddha images which aim to get the level of compatibility of the images in the identification process of the buddha's face using the Sift and ORB methods, with the following process:

a. The initial stage is the formation of datasets. The dataset comes from public data or private data that form the features of the Buddha statue, by preprocessing the data. Camera-based shooting system (2D) uses local features. For local features, key points are extracted to select the part of the image to be retained for the description part. Local key point detectors are used to detect regions of interest that are invariant to the transformation class (eg scaling, rotation, and translation) for each detected region.

b. Identification Stage. At the stage of dataset formation, there are six processes, namely preprocessing, segmentation of arcuate images, rescaling, feature extraction of points, feature extraction of distances between furcation points, and formation of feature vectors as datasets. In the second stage the identification stage, the image of the statue is processed as in the first stage to obtain the feature vector of the statue pattern. Then carried out the process of identification through the process of training and testing. Performance measurement results

of system identification are done by calculating the value of the confusion matrix.

c. The comparison stage uses two methods, SIFT and ORB.

RESULTS AND DISCUSSION

The research data obtained from the comparison method between the SIFT and ORB methods are as follows:

Image Acquisition

The images used in this study are red, green, and blue (RGB) images taken indoors. Relatively low light intensity. If the light intensity is low, the object will appear non-existent. Figure 1 shows the original image of buddha's face.

Figure 1. Original Image

The image is a representation of the figure 1, and the image is produced from the output of shooting in the form of a photo, the image itself has a lot of information in which there are many sets of pixels, and in image data, there is an influence on reducing image quality for image defects.

a. Elements in a Picture Image: Brightness, Contrast, Outline, and Color.
b. Pixels are the smallest part of an image, each pixel has a different value
c. Resolution is the level of image detail, high resolution is a good determinant of image quality.
d. Convolution Image manipulation process
e. Gaussian: Serves to smooth the image, in the Gaussian smoothing process it uses the normal distribution.

Preprocessing

The result of the pre-processing stage is an image that has a smaller pixel size than the original image and is reduced in size to 1/3 of the actual size. In addition, the processed image has a simple color space obtained from the gray scaling process. Figure 1 shows the preprocessing results of the original image.

Feature Extraction

This step is carried out to obtain the characteristics of each grayscale image method. The features extracted at this stage for both methods, SIFT and ORB, are in the form of numeric form with the term key point. Each key point value represents a characteristic according to the characteristics of the extracted object.

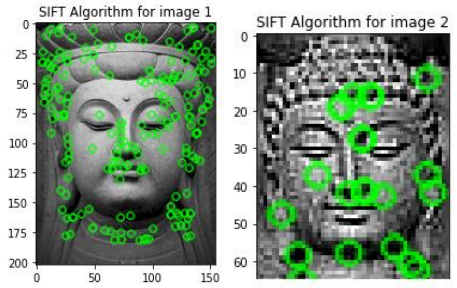

Figure 2. Detector, in this case, using SIFT

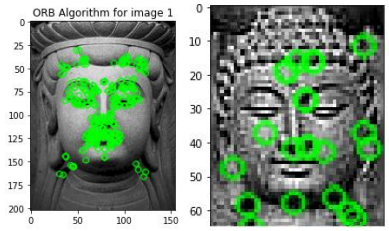

Figure 3. Detector, in this case using ORB

After using Brute Force, the results are shown below. The process of matching two images to mark crucial points uses FLANN Matches as a comparison of the two images

Feature Matching and Testing

This step was carried out to test the sensitivity of the SIFT and ORB methods to distortion effects such as rotation, scaling, and cropping. Tests are carried out by comparing pre-processed images with different images that have experienced various types of distortion

Rotation

The results of tests performed on distorted images with a 90-degree rotation are presented in Figure 3

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and Table 1. Figure 2 shows the results of feature matching using the SIFT method. On the other hand, Figure 3 shows the results of feature matching using the ORB method.

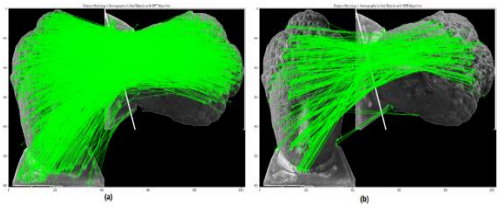

Figure 4 The results of feature matching at 90 degrees rotation

Table 1. Details of the test at an angle of 90 degrees rotation

Method	Key Point 1 (original image)	Key Point 2 (90 degrees)	Matches	Average Match Rate	Time (sec)
SIFT	1738	1735	1616	100%	0.557891
ORB	500	500	422	100%	0.616017

From the test results in Table 1, the results show the number of key points generated by each method. In terms of the number of key points, the ORB method gives less results than the SIFT method and the average SIFT recognition and processing time shows better performance.

Figure 4 The results of feature matching at Flip Horizontal

Table 2. Details of the test at an angle of flip-horizontal

Method	Key Point 1 (original image)	Key Point 2 (90 degrees)	Matches	Average Match Rate	Time (sec)
SIFT	1738	1731	12	2%	0.400285
ORB	500	495	2	1%	0.400961

However, when the horizontal flip is performed, the two compact methods result in fast computation time. Unfortunately, both of them experienced a decrease in keypoint detection, as shown in Figure 4 and Table 2 where the SIFT method only has 7 key points and the ORB method is even smaller, namely 2 key points.

CONCLUSION

ORB differs from SIFT in that it uses a simpler and faster description of BRIEF, thereby making it more efficient in terms of computation time. ORB also has the ability to handle orientation and scale changes in facial images, making it an effective algorithm for face recognition. The results show that the number of key points generated is the number of key points, the ORB method gives fewer results compared to the SIFT method and the average SIFT recognition and processing time shows better performance for an average of 100% at a SIFT matching rate of 2% with time 0.400285 and the ORB method is 1% for the time 0.400961.

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