Chapter 37

IMAGES MATCHING USING THE SURF METHOD ON THE FACE OF BUDDHA STATUE

Linda Marlinda[1,2,*], Supriadi Rustad[2], Ruri Sukobasuki[2], Fikri Budiman[2] and Muhamad Fatchan[2]

[1]Computer Science, University Dian Nuswantoro, Semarang, Central Java, Indonesia
[2]Informatic Engineering, STMIK Nusa Mandiri, Jakarta, Indonesia

ABSTRACT

At present many statues found in Indonesia are damaged and incomplete. Many several Points of Interest to select the amount of data, the Representation of Space Scales to handle differences in object scales, image descriptions, image matching, and face recognition. Data is taken based on images of Buddha's face that match the Buddha statue available in the database using Gaussian extraction on various types of transformations original statues are lost or sold to unauthorized parties and replaced with fake sculptures so that the current face recognition of the statue is very necessary to find out whether it is a Buddha statue. The fast and powerful image matching method is very important in taking pictures, the method discussed now uses the SURF method. Choosing this method requires. The purpose of this research is to apply the original image manually to various types of transformations and calculate matching evaluation parameters such as the number of key points in the image, matching levels, and execution time needed for each algorithm. The result will be seen as a sculptured image that matches the best algorithm for each type of distortion.

Keywords: Images Matching, statue Buddha, SURF (Speed Up Robust Features), face recognition

INTRODUCTION

Indonesia is a unitary country that has a lot of different cultural and ethnic wealth. This wealth can be seen from the historical and archeological heritage which was found as a cultural heritage of the past. Archeology found in the form of statues, ceramics, inscriptions, caves, architecture, gold and other objects that are the result of human activity in the past. The archeology found requires a lot that is damaged or incomplete so that it is necessary to reconstruct past cultures. Documentation is an appropriate effort to preserve archeology so that it is not lost or sold to unauthorized parties and an image matching system is needed [1].

* Corresponding Author's Email: marlinda@mhs.dinus.ac.id.

At present, the number of Buddha statues in Borobudur temple is around 504, with 228 head-shaped Buddha statues and 247 headless Buddha statues [2]. These conditions require conservation efforts, one of which is by matching the image of the head of the statue with the body of the statue that is in the temple. Matching the statue can not be done in a direct way, but by doing more in-depth research on the face of the statue [3]. This is to avoid installation errors that will reduce the importance of the statue so that an image matching method is needed.

Image matching is one part of image processing that is done to look for other images of a similar type of similarity. One parameter that represents the degree of similarity between two images is the euclidean distance. The smaller the euclidean distance between the two images, the more similar the two images will be. Euclidean distances can be calculated based on special characteristics possessed by an image. These characteristics include color characteristics, texture characteristics, shape characteristics, geometry characteristics, and size characteristics. Image matching uses Euclidean distances based on color features. The color feature is calculated on the HSV color space which consists of Hue, Saturation, and Value components [4].

Problems that will arise in matching one image with another picture or comparing two images, then the question will be obtained when the two images being matched are the same or similar, and how this similarity can be measured, defining the first two images and the second picture as identical when all values the same pixel is zero. Although such definitions may be useful in specific applications, such as to detect changes in sequential images in constant lighting and camera conditions, simple pixel differences are usually too inflexible for practical use [5]. Noise, quantization errors, small changes in lighting, and minute shifts or rotations can all make large numerical pixel differences for pairs of images that will still be considered exactly by the human viewer. To solve the current problem using an image matching system with SURF concerning light intensity [6].

Buddhist Statues in Indonesia

The statue is a picture of a worshiped god or saint as outlined in paintings, mosaics, sculptures and so on. Buddha statues can be in the Borobudur Temple has a variety of sizes. In measurement, there are 6 (six) ways to measure the statue, which are (the length of the statue), pramana (width of the statue), unmanaged (thickness of the statue), Parimana (circumference of the statue), Upama (cavity of the statue) and Lambamana (vertical size) [7]. The units of measurement that are often used in making statues are tuning and angular. According to the Samyak sam bhasita script - Pratimanalaksanam, the length of the face of the Buddha statue is 13.5 angles divided into three parts, namely the forehead, lower forehead to the lower nose (nose length), and the lower nose to the chin limit. The size of the forehead and the length of the nose are four angles [8], while from the lower nose to the chin the length is longer. Research on archeology, artifacts, features, and ecofacts has become the main framework for uncovering past cultures. Artifacts are the result of human creations from materials obtained in nature to support and facilitate the activities of life, features are traces of nature and trace due to human activities in the past, ekofak is a relic of the remnants of nature used by humans to support the fulfillment daily necessities and activities [9].

Face Detection on the Statue

Face detection on a statue (face detection) is one of the first steps that are very important before the process of facial recognition (face recognition). The problem of pattern classification on the face detection of the statue is given input in the form of an image with the class label being output [8]. the process of segmenting facial areas on the statue of an image works by examining facial features, then the process of separating the face image from the background offline, after that the process of detecting faces can be done [9]. Data set used alicevision.github.io. In this case there are two class labels, namely the face of the original statue and the face of the dataset statue [10].

There are four different approaches to face detection problems [11]:

a. Knowledge-based method: Rules are based on human knowledge about the defining features of the face of a human being. The majority of these rules discuss the relationship between features.
b. Feature invariant method: the algorithm is designed to look for structural features of faces that are invariant to common problems regarding poses, obstacles, expressions, image conditions, and protections.
c. Template matching method: with a set of samples given, a set of similar standard face patterns can be generated. The definition between sample image and pattern set can be calculated to conclude.
d. Appearance-based method: similar to the template matching method. The aim is to get higher accuracy with greater variation in training data.

Speed-Up Robust Features (SURF) Method

The image feature detection method uses a key point that has a fixed value when it changes rotation, changes in light, scale, blurring, 3-dimensional transformation, and changes shape. Changes in the shape of the image occur because the shape of the image is not complete and perfect. Test images that are not intact are caused by a background object covering, or taking pictures with the camera imperfectly, and the position of the image changes in color or shape. With the initial step of making invariant space scale space is divided into octave numbers [12].

The process presents octave numbers to the filter response, by increasing the size of the filter so that the maximum convolution process is carried out to increase the size limited by the positive or negative lobe length of the second-order Gaussian derivative. 9x9 filter output for lowest level conditions. The filter process uses the Gaussian value $\sigma = 1.2$ [13].

The Method of Calculating the Similarity or Similarity of an Image

Calculation with regression uses the method of calculating the similarity of images based on distance. Before grouping data or objects to be detected, it is first determined the size of the proximity of the data elements. Euclidean distance is a method of comparing the

minimum distance of a testing image with a training image database. The euclidian distance of two vectors x and vector y is calculated by the equation [7].

$$d(x,y) = [\sum(x_i - y_i)2]^{1/2} \quad (1)$$

if the values of d (x, y) are small, then the two vectors can be matched. If the value is large, the value will be different for the two vectors that are matched. Measurements for replacing quadratic differences by adding up the absolute differences of the variables using the manhattan distance. The steps above are called city block distance (equation 2):

$$D(x,y) = L_p = i(x,y) = \sum \left\| x_i - y_i \right\| \quad (2)$$

Processing Matching on Key point

The matching process of the circular area around the pixel is made into a key point. The creation of a rectangular area on the selected cross and extracting the SURF descriptor is the process of matching features between two images [14, 15]. By calculating the keypoint descriptors by calculating the Wavelet Haar response of the first order in the x and y directions. To reduce computation time on feature extraction and feature matching process, which has also been proven to increase robust and process speed using image integrals.

METHODS

The SURF method in processing features has a constant value for changes in scale, rotation, blurring, and lighting. In detecting face statues by looking for an interesting point at a detected face object location is described as follows. The SURF Feature Extraction Testing Process on the test image by displaying an interesting point in the face area of the image of the test image using Gaussian. In the testing process cutting the face area of the statue that was detected using the region of interest (ROI) method, to facilitate the detection of the face area using the SURF method. The results of the SURF feature extraction on the test image by displaying interest points that are in the face area of the test image, there are points of interest in the face area of the test data statue and can be detected after going through the SURF extraction process. The test data entered comes from a face image of the statue [16]. Where each face has undergone a rotation and scale transformation.

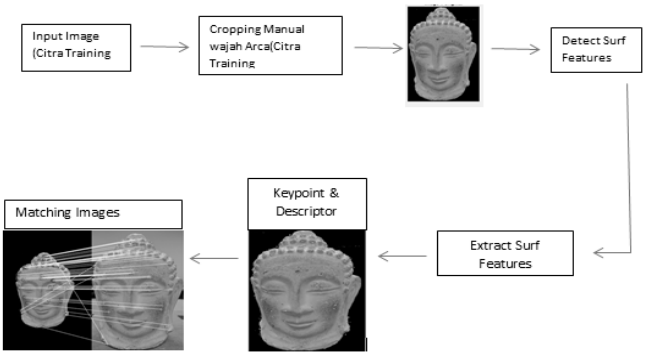

Figure1. Processing with the SURF Method.

The results of the SURF feature extraction in the initial data image by displaying an interesting point in the face area of the initial data image. Points of interest in the face area of the initial data statue can be detected after going through the extraction process. The Matching Testing Process Using FLANN, after the extraction stage, is completed, the next step is to compare the same points of interest using the FLANN method. Referring to the method for matching the SURF feature, which is one of the methods of approximated nearest neighbor (FLANN) fast library. Where this FLANN feature looks for the closest and most suitable interest point value. If the value of the interest points in the test image and the initial data image are considered to be the same and are considered the most suitable, then a line will be drawn from each of the test images and the initial data image. From the picture above you can see the withdrawal of interest points with the same value.

RESULTS AND DISCUSSION

SURF Feature Extraction Testing Process on Test Imagery

The following is the result of the SURF feature extraction on the test image by displaying an interesting point in the face area of the image of the test image using gaussian:

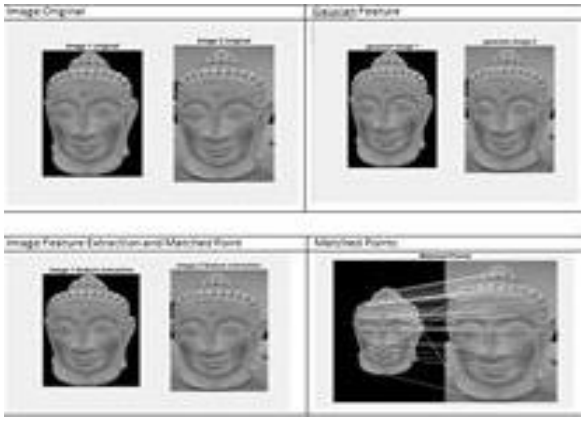

Figure 2. The extraction feature process with the SURF method.

Figure 3. Image rotation of the Buddha statue.

The image is a representation of the image, and the image is produced from the output of taking pictures in the form of photos, the image it self has a lot of information in which a lot of pixel sets, in image data there is an influence on the deterioration in image quality of image defects [17].

1. Elements in the Image image: Brightness, Contrast, Contour and Color.
2. Pixels are the smallest parts of an image, each pixel has a different value - different
3. Resolution is the level of detail of the image, the high resolution as a good determinant of the quality of the image.
4. Convolution The process of image manipulation
5. Gaussian: Serves to smooth the image, in the process of smoothing gaussian using a normal distribution.

In the test image, the image underwent rotation transformation by rotating the image by rotating per-300 to 2400. Then obtained 8 test images with the position of the image of the face of the statue as follows: 300, 600, 900, 1200, 1500, 1800, 2100, 2400.

Rotational Change Testing

Table 1. Picture of Distance Matrix Clustering using Ecludien

	59,91	44,943	43,960	40,289	43,805	41,357	46,422
59,91		64,082	63,677	57,757	61,892	62,088	61,192
44,943	64,082		48,927	47,011	43,548	42,777	47,231
43,96	63,677	48,927		43,312	44,188	38,894	36,818
40,289	57,757	47,011	43,312		43,105	44,151	46,521
43,805	61,892	43,547	44,188	43,105		33,88	43,019
41,357	62,088	42,777	38,894	44,151	33,88		37,838
46,422	61,192	47,231	36,818	46,521	43,019	37,838	

The face detection system test results use the SURF method by calculating the value of the interest points obtained in the test image and the initial data image. Ecluedien Distance Value on the above Buddha dataset with preprocessing images with different positions produces proximity values as in the distance matrix image as in Table 1. The table explains the level of similarity of 100% for shooting face statues based on the SURF method.

From the test results, it can be seen at the testing stage that facial image extraction has been successfully used using SURF. Besides, it can display the number of interest points in each image, be it the initial data image or the test image. By using the FLANN matching technique, we can display the number of interest points with the same value according to FLANN calculations. For analysis of each test result are:

1. Changes in Rotation

The number of test images used amounted to 8 test images that have undergone rotational changes. Assuming that the position of the image used is at a predetermined rotation, namely: 300, 600, 900, 1200, 1500, 1800, 2100, 2400 for each face used. For the results of the interest point value obtained, it can be analyzed that the value of interest points for sample data is of a fixed value for each sample.

2. Change in scale.

For testing the scale change of the one face image test statue. The number of images transformed is scaled down. Interest point values can be extracted well and after being matched with the FLANN method, the points on the face areas that are compared are correctly positioned.

CONCLUSION

Image matching on a Buddha statue using the SURF method in testing face images with rotational changes and scaling strong value points in changes. The use of extraction can increase the value of interest points. If the face image data is not the same, this is due to the small number of samples. Determination of the face area of the statue is used as parameters of the eyes, nose, lips, and eyebrows. Detection of interest point values in certain areas, for example on the eyes, nose or lips. The results of Images Matching on the statue's face statue can be used for the damaged statue's face.

REFERENCES

[1] Gruen A., F. Remondino, and L. Zhang, 2003. "Automated modeling of the great Buddha Statue in Bamiyan, Afghanistan," *Int. Arch.*

[2] Setyawan H. Hendratno A. Sutopo M. Kurniawan J. Santosa P. Setiyawan I, *2017. "Study of Matching Head of Buddha Statues of Borobudur Temple Phase II",* XI, pp. 4-24.

[3] Renoust B., Oliveira Franca M., Chan J., Garcia N., Le V., Uesaka A., Nakashima Y., Nagahara H., Wang J., Fujioka Y., 2019. *"Historical and Modern Features for Buddha*

Statue Classification," SUMAC 2019 - Proc. 1st Work. Struct. Underst. Multimed. Herit. Contents, co-located with MM 2019, pp. 23-30.

[4] Remondino F., Spera G., Nocerino E., Menna F., and Nex F. 2014. "State of the art in high density image matching," *Photogramm. Rec.*, 29 (146), 144-166.

[5] Basuki R. S., Hariadi M., Yuniarno E. M., and Purnomo M. H. 2015. "Spectral-based temporal-constraint estimation for semi-automatic video object segmentation," *Int. Rev. Comput. Softw.*, 10 (9), 959-965.

[6] Karami E., Prasad S., and Shehata M. 2017. *"Image Matching Using SIFT, SURF, BRIEF and ORB: Performance Comparison for Distorted Images."*

[7] Wang H., He Z., Chen Y. He, D., and Huang Y. 2018. "Average-face-based virtual inpainting for severely damaged statues of Dazu Rock Carvings," *J. Cult. Herit.*

[8] Metusala D., Fauziah., Lestari D. A., Damaiyani J., Mas'udah S., and Setyawan H.2020. "The identification of plant reliefs in the lalitavistara story of Borobudur temple, central Java, Indonesia," Biodiversitas, vol. 21, no. 5, pp. 2206–2215.

[9] Renoust B., Oliveira Franca M., Chan J., Garcia N. Le V., Uesaka A., Nakashima Y., Nagahara H., Wang J., Fujioka Y. 2019. "BUDA.ART: A multimodal content-based analysis and retrieval system for Buddha statues," *MM 2019 - Proc. 27th ACM Int. Conf. Multimed.*, pp. 1062-1064.

[10] Rahman A. Y. and S. Sumpeno. 2006. *"Statue Segmentation at Sidoarjo Mpu Tantular Museum Using Learning Vector Quantization*," pp. 16-21.

[11] Tan X., S. Chen, Z. H. Zhou, and F. Zhang. 2006. "Face recognition from a single image per person: A survey," *Pattern Recognit.*, 39 (9), 1725-1745.

[12] Wu Q., G. Xu, Y. Cheng, Z. Wang, W. Dong, and L. Ma. 2019. "Infrared Physics & Technology Robust and e ffi cient multi-source image matching method based on best-buddies similarity measure," *Infrared Phys. Technol.*, 101, 88-95.

[13] Hilman F. P. and U. Telkom. 2015. "*Comparison of surf and sift methods in the system of a comparison of surf and sift methods on signature identification system*," 2 (2), 2467-2481.

[14] Oliva D., *Studies in Computational Intelligence 825 Metaheuristic Algorithms for Image Segmentation: Theory and Applications*.

[15] Belanche L. A.2011. "Review and Evaluation of Feature Selection Algorithms in Synthetic *Problems." arXiv: 1101*. 2320.

[16] Shuo H., W. Na, and S. Huajun. 2012. "Object Tracking Method Based on SURF," *AASRI Procedia*, 3, pp. 351-356.

[17] Yang X. and K. T. T. Cheng. 2014. "Local difference binary for ultrafast and distinctive feature description," *IEEE Trans. Pattern Anal. Mach. Intell.*, 36 (1), 188-194.

INDEX Hal