JESICA: Journal of Enhanced Studies in Informatics and Computer Applications
Journal homepage: jesica.itsk-soepraoen.ac.id
ISSN:
Vol. 1, No. 1, February 2024, Pp. 23-27

Development of Basic Finger Shapes Indonesian Traditional Dance Application Using Color-Based Hand Gesture Recognition

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Keywords:
Hand gesture, recognition, dance application

Abstract
UNESCO stated that Indonesian traditional dance is a world cultural heritage that must be preserved and maintained. Efforts made by the government to preserve traditional dance are still not successful. Research shows that students have difficulty in learning traditional Indonesian dance exercises. Therefore, this study develops a solution that focuses on the difficulty of learning the basic finger postures in traditional Indonesian dances. This is important because fingers are instruments in dancing that have meaningful forms, such as Supit Urang Tertutup, Nyempurit, Ngruji, Supit Urang Terbuka, Kepelan, Baya Mangap, and Ngithing. Learning the practice of basic finger postures aims to provide an independent learning experience through repetitive movements to strengthen or strengthen. This research has succeeded in making a real-time Color-Based Hand Gesture Recognition application for reliable Android devices. This is evidenced by applications that can function well in test scenarios with varying lighting and background conditions. Finally, students can learn the hand gestures of traditional Indonesian dances independently with ease. In addition, the application of the results of this research also contributes to becoming a learning medium in the current era of Blended Learning. Suggestions for future research are to increase the accuracy of Nyempurit and Ngithing attitudes.

1. Introduction

Indonesian traditional dance is a world cultural heritage that must be preserved. Since 2011, the Saman dance has been inscribed as a table of non-object cultural heritage from UNESCO that needs to be guarded. There are 9 Balinese dances that are divided into three traditional dance genres in Bali which are inscribed as the Representative List of the Intangible Cultural Heritage of Humanity in Windhoek, Namibia, 2015 [1]. Until 2017, as many as 47 dances from 594 non -object cultural works have been registered as Indonesian Cultural Heritage (WBTB) which are managed by the Directorate General of Culture, Ministry of Education and Culture and Permanent Delegation of the Republic of Indonesia to UNESCO [2].

Efforts have been made by the government to preserve traditional dance. The Ministry of Education and Culture stipulates Traditional Construction Guidelines and Regulations regarding the implementation of dance clubs as a curriculum for extracurricular programs at all school levels [3][4]. But in fact, students still have difficulty in learning Indonesian traditional dance exercises. From the results of research on the Margapati dance in 2018, it shows that the mastery of students of the Department of Dance Education, Yogyakarta State University class of 2012 in movement techniques is in the difficult category with a percentage of 54.5%. Mastery of movement intensity is included in the difficult category, with a percentage of 66.7%. Mastery of student memorization is included in the difficult category, with a percentage of 50%. Difficulties in learning the practice of Indonesian traditional dance are also experienced by students of SMA Negeri 5 Bukittinggi, Department of Sendaratasik. From the results of research in 2012 it can be seen that the Tanjung Katung dance is classified as difficult with an interpretation index of 71.70%. The difficulty is caused by internal factors such as memory as many as 58.20% of students have difficulty memorizing variety 1 [5].

Based on these difficulties, this research is focused on the difficulty of studying the basic attitude of the finger in traditional Indonesian dance. The basic attitude of the finger is to organize the finger so that it produces meaningful shapes, such as closed, nyingurit, ngruji, open, open, kepelan, middle mangap, and ngithing [5]. Learning Practices of Basic Attitude The finger becomes important because the finger is a musical instrument in dancing.

Practical learning of basic finger postures focuses on experiential learning through repetitive movements with the aim of strengthening or building. Students should learn basic finger postures on their own and more time. There are no experts who correct the truth when students do the exercises themselves at home. Therefore, this research is important in order to produce a system that can record and recognize student finger movements in real time and repeatedly.

Segmentation is an important step in the hand gesture recognition process. The condition of the room is also a

problem, because it affects the retrieval of hand objects in real time [6][7][8][9]. A powerful real-time hand gesture recognition system for Android devices has been successfully developed using color-based hand segmentation [10][11][12]. Color-based hand segmentation is the easiest way to distinguish palms from images, computationally inexpensive, and more informative than luminance images or edge segment images [13][14].

Hand gestures captured by smartphone cameras can be analyzed directly without having to touch the screen. Hand gestures can be interpreted as a variety of gestures or movements produced by a combination of fingers, always able to express the meaning of the signer, so that it means natural communication as Human-Computer Interaction [15]. Thus, students can learn the basic finger postures in traditional Indonesian dance exercises easily.

2. Research Method

The result of this research is an Android mobile application for the client side. This mobile application is designed to visually recognize 7 static gestures from finger gestures, such as the Supit Urang Tertutup, Nyempurit, Ngruji, Supit Urang Terbuka, Kepelan, Baya Mangap, and Ngithing. Application development includes presampling colors, hand segmentation, features extraction, classification, and results. The flow chart of the proposed application is shown in Figure 1.

Figure 1. Proposed application flowchart

2.1 Presampling Colors

The application starts with color sampling by the user. The background color and hand use are collected by 7 boxes displayed on the screen as shown in Table 1. Both are used to obtain a binary image from the RGB data input by calculating the threshold. Please note, the number of boxes is an empirical value which means it can change. After obtaining the 7 hand color data, the hand area of the 7 upper and lower bounds is calculated, which can be reflected as a 6-dimensional vector.

Table 1. Presampling colors

Illustration	Matrix
	Presampling background colors $P_b = \begin{bmatrix} X_1 & Y_1 & Z_1 \\ X_2 & Y_2 & Z_2 \\ \cdots & \cdots & \cdots \\ X_7 & Y_7 & Z_7 \end{bmatrix}$
	Presampling hand colors $P_h = \begin{bmatrix} X_1 & Y_1 & Z_1 \\ X_2 & Y_2 & Z_2 \\ \cdots & \cdots & \cdots \\ X_7 & Y_7 & Z_7 \end{bmatrix}$

2.2 Hand Segmentation

Thresholding is the easiest way to separate the hand from the background. If the image intensity is less than the threshold, then each pixel in the image is replaced by a black pixel. Meanwhile, if the image intensity is greater than the threshold then it is replaced with white pixels. Each data limit of 7 colors is obtained first, then 7 binary images of the

hand is calculated, which is added using "or". There are similarities in the background color, which creates another binary image. Then, "and" carried out in two binary images and the results are obscured, dilated and eroded to clean the noise. The application of the median filter to reduce noise in binary images has been chosen by the researchers. Replacing each entry with the median value of the neighbors is the goal of the median filter. The median filter will consider the environmental value by increasing the value. and taking the median value, in this study the median value is 5. Finally, the output of the filter and the binary images of the detected segmented hands obtained through all these processes are shown in Figure 2. [16][17].

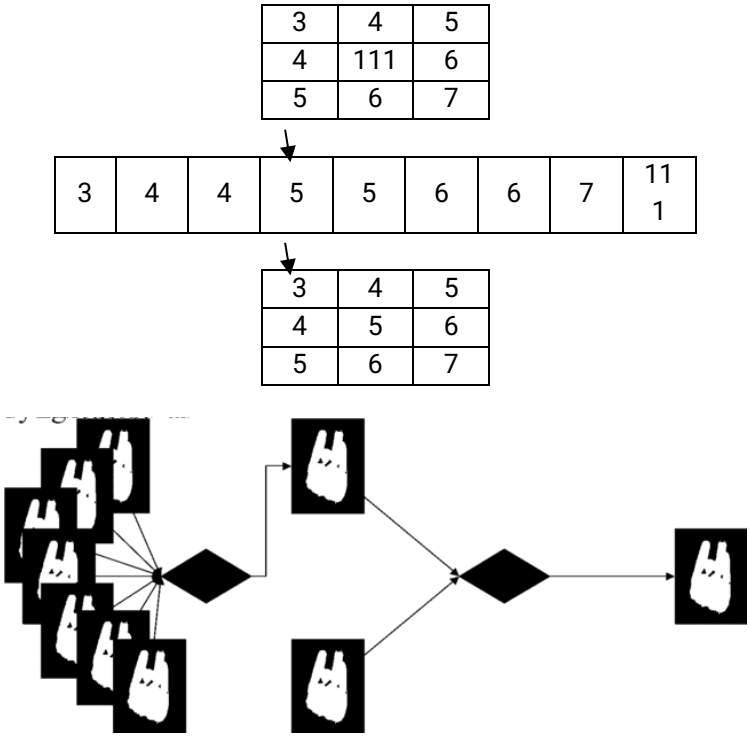


Figure 2. Filter output and binary image step

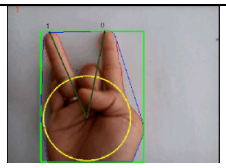
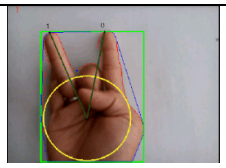
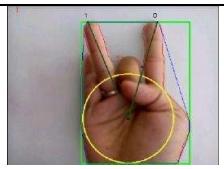
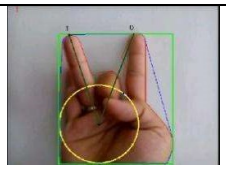
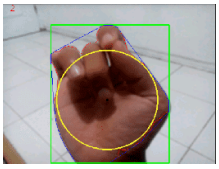
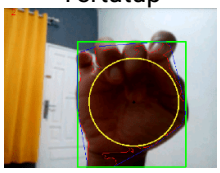
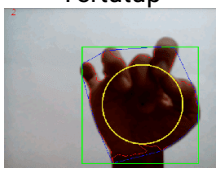
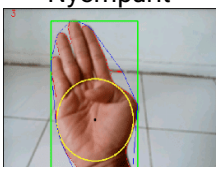
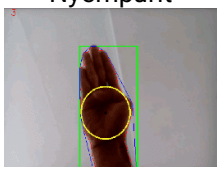
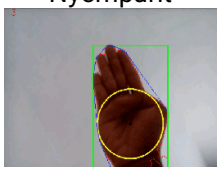
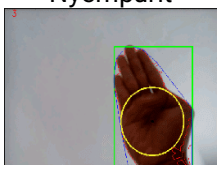
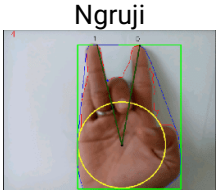
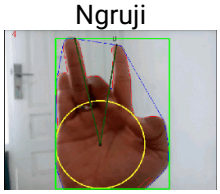
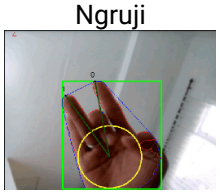
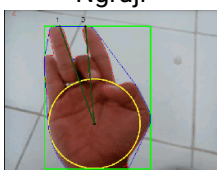
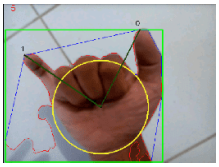
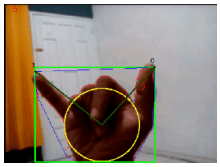
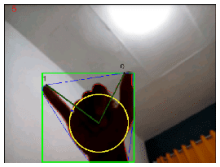
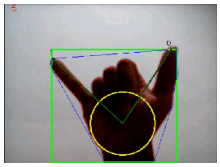
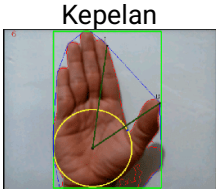
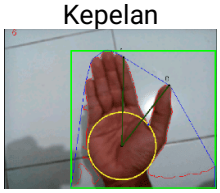
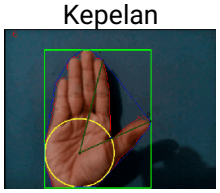
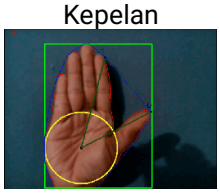
2.3 Classification

Multiclass SVM is useful for the classification of basic finger attitudes in which the number of testings is more than 2 cues. We apply multi-class classifications using the library mentioned in LIBSVM. LIBSVM is used to classify different cues based on vector features. The Multiclass SVM function is to create an exercise model and make predictions of basic finger attitudes.

3. Results and Discussion

In order to show results, certain scenario tests have to be carried out under different lighting conditions and different backgrounds. 3 frames are captured for each move with the predicted label displayed as red numbers in the image. 3 frames for each move with different test scenarios is enough to prove accuracy. The functional test of the objective system is shown in Table 2. However, according to the observations, the final recognition of the results is highly dependent on the detection results. That is, if the hand is detected well, which means the extracted feature vector represents the hand movement correctly, then the hand can be classified into a valid category with high probability. So, hand detection function is more important than recognition. Table 2 shows the functional analysis of the objective system. The hand detection functionality can be seen from the contours and finger vectors of the stamped image. 3 frames are enough to pay attention to whether these elements are all true and stable training and testing frames. The hand gesture recognition function can be seen from the red label in the upper left corner of the captured photo. One of the seven movements failed to be recognized by this system is Ngithing which is recognized as Nyempurit. This happens because the extraction features of both are the same. Therefore, the average recognition rate of the proposed system is 85.71%.

Table 2. Functional test

Training Set Frame	Number of Correct Functional Test Response			Recognition Rate
	Frame 1	Frame 2	Frame 3	
 Supit Urang Tertutup	 Supit Urang Tertutup	 Supit Urang Tertutup	 Supit Urang Tertutup	100%
 Nyempurit	 Nyempurit	 Nyempurit	 Nyempurit	100%
 Ngruji	 Ngruji	 Ngruji	 Ngruji	100%
 Supit Urang Terbuka	 Supit Urang Terbuka	 Supit Urang Terbuka	 Supit Urang Terbuka	100%
 Kepelan	 Kepelan	 Kepelan	 Kepelan	100%
 Baya Mangap	 Baya Mangap	 Baya Mangap	 Baya Mangap	100%
 Ngithing	 Nyempurit	 Nyempurit	 Nyempurit	0%
Standard Deviation				0,37%
Average				85,71%

4. Conclusion

The system has clearly succeeded in using the Android Open CV library for image processing on an Android 4.4.2 smartphone with a Quad-core processor, 1 GB RAM, and a 5 MP camera. This system can be controlled without touching the smartphone screen. Students only need to think about the movement with the rear camera, then do the appropriate

basic finger gestures. Therefore, what is meant by natural communication as Human-Computer Interaction (HCI) and students can learn basic finger attitudes in traditional Indonesian dance practices easily. Researchers have also succeeded in recognizing differences in basic finger attitudes, namely Color Based Hand Segmentation and Support Vector Machine (SVM) as reliable classifiers. However, the accuracy obtained is 85.71%, because this system responds to the same Nyempurit and Ngithing feature extraction.

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