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Facial Expression Detection Using Local Binary Pattern And K-NearestNeighbor Methods

Aries Maesya[1], M. Iqbal Suriansyah[2], Nizar Zulmi Ramadhan[3]
[1,2,3] Pakuan University, Bogor, Indonesia
Corresponding email: a.maesya@unpak.ac.id

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Abstract. Facial Expression Detection is the recognition of a pattern where the input is a digital image and the output is a label of a person's emotions that have been made into a class, which class has been stored in the database as trainingdata to find the closest or similar. Pattern recognition with training data or similar classes is done using artificial intelligence with various methods. This study aims to test the Local Binary Pattern and k-Nearest Neighbors methods to be implemented in facial expression detection and create a system on a computer to be able to know human facial expressions are happy or sad. Local Binary Pattern is defined as the ratio of the binary value of the pixel at the center of the image to the 8 values of the surrounding pixels.K-Nearest Neighbors algorithm with supervised learning which aims to find new patterns in the data by connecting new data patterns with existing data patterns. Based on the results of manual testing on sad expressions, the accuracy is 90% and happy expressions are 80%. Furthermore, the K- Fold Cross Validation test, at 5-Fold Cross Validation at 61.66% and at 10-Fold Cross Validation at 75%.

Keywords: Facial Expression Detection; Local Binary Patterns; K-Nearest Neighbor

INTRODUCTION

Humans communicate in social life is divided into two ways, namely verbal communication and non-verbal communication. All cues that are not words are non-verbal. In non-verbal communication, one of them is by using facial expressions. A study conducted by Albert Mahrabian (1971) concluded that the confidence level of people's speech was only 7% from verbal language, 38% from vocal sounds, and 55% from facial expressions [9]. By understanding facial expressions, when communicating, humans can understand thefeelings of the other person communicating.

In the 1970s, human interaction with computers has grown rapidly. In today's sophisticated era, there is research on computers that seem to know human facial expressions. There are several stages that are passed until the computer is able to detect the expression of a digital image, namely taking the facial area in a digital image, image extraction, data classification for training, and data classification for testing [3].For each stage there are various methods that can be used. For the feature extraction stage there are Gabor Wavelet methods, Gabor Filters, Local Binary Patterns, and others, then at the classification stage there are Support Vector Machines, k- Nearest Neighbors, Backpropagation, and others [2] [3] [4].

Previous research conducted by Claudia (2018), entitled "Face Expression Detection Using the Gabor and Haar WaveletFeatures" in his research, the lowest accuracy was obtained using the Haar feature, which was 70% [3]. In addition, research conducted by Adi Saputra (2015) with the title "Recognition of Facial Expressions Using Local Binary Patterns (LBP)" using a Japanese female model dataset totaling 213 Digital Images, from the experiments carried out the highest accuracy was obtained at 84% for the person

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testing scheme. -dependent with LBP operator configuration (p=8,r=8) and 16 region segmentation. Then the next research conductedby Arif (2017), entitled "Recognition of Human Facial Expressions Using 2-D Gabor Filter and Support Vector Machine (SVM)" based on the results of expression recognition in the JAFFE database which has been widely used, the results of expression recognition in the database Indonesian facial expressions are not as good as the results of the JAFFE database recognition [2].

The rapid development of human interaction with computers and the success of several previous researchers conducting research on the topic of facial expressions, the authors decided to conduct research with the theme of facial expression detection aiming to create a system on a computer that allows computers to know human facial expressions, in this study will combine two methods namely the Local Binary Pattern method at the feature extraction stage with the consideration that the Local Binary Pattern is easy to implement and the computational level is lower so it does not require a long time in feature extraction, at the classification stage the k-Nearest Neighbors method is chosen, while for the dataset that will be the training data used Indonesian faces by multiplying variations of the image as much as 200 photos consisting of 10 models of human faces with 2 expressions in each model. Based on the above background, this research is entitled "Face Expression Detection using the Local Binary Pattern and k-Nearest Neighbors method".

METHOD

The research method used in Facial Expression Detection uses the Local Binary Pattern and K-Nearest Neighbor methodswith the System Development Life Cycle (SDLC) pattern. Thestages that are structured and quite complete make the authors consider choosing the SDLC method in Facial Expression Detection research using the LBP and KNN methods. The stepsof the SDLC method approach are described in a flowchart.

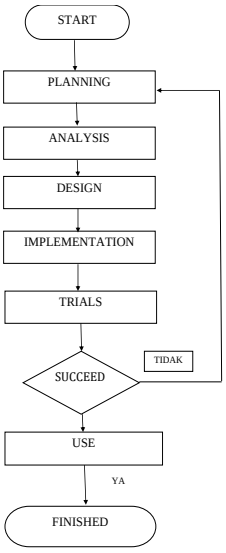

Figure 1: System Development Life Cycle Approach

Stages of system planning related to Facial ExpressionDetection using the Local Binary Pattern and K-Nearest Neighbor methods, namely Literature Study of previous research or references related to this research, determining the number of expressions

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used, Image Acquisition, and Preprocessing to produce more accurate results on human facial expression detection.

The analysis stage is carried out an analysis of the system that will be created and the possibilities that will occur, so thatit can be prepared from the beginning so that a system is created that can make it easier for users to use it and can run asexpected.

The system design stage is a very important process in building a program. In designing this system, several designs were made, namely, system design in general in the form of flowcharts, grouping test data, grouping training data, and designing user interfaces. The system flowchart can be seen inFigure 2.

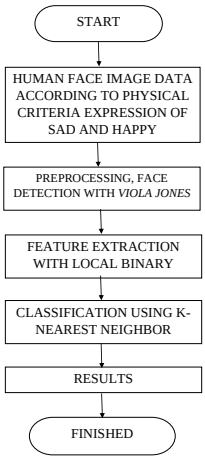

Figure 2: System Flowchart

This testing phase is carried out to ensure whether the results of the system match the actual results. The stages of testing carried out are:

a. Structural Test
   Trial to find out whether the system has been structured properly with an emphasis on application features that meet user needs, whether they are good and correct according to the design that has been made.
b. Functional Test
   Functional testing is carried out to determine the navigationand validation process whether the application made can function properly or not according to its function.
c. Validation Test
   Validation trials are carried out by testing the data and the results, whether the results of the system are in accordance withthe expected results.

The evaluation stage is the result of the system whether each input data is in accordance with the knowledge data or whether there are still many shortcomings so that a re-analysis is carried out for the system.

RESULTS AND DISCUSSION

The facial expression recognition system is a pattern recognition system consisting of 4 modules, namely, image acquisition module, preprocessing module, feature extraction module, matching module [3].

Image acquisition has the objective of determining the required data and selecting a digital image recording method. This stage starts with the object to be photographed. In

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this study, during the process of taking digital images of human faces using a Canon DSLR camera type 1200d, using samples of the human faces of students and extracurricular Paskibra students as many as 9 people plus 1 author's face, a total of 10 people as samples. This study uses 2 facial expressions, namelyhappy and sad.

Preprocessing in this study cuts the facial area using the Viola Jones method with haar features. The stages of the ViolaJones method are depicted in Figure 3 [2] [3]:

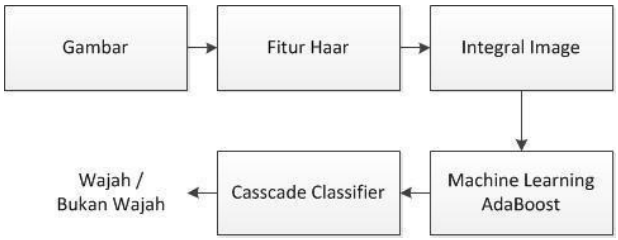

Figure 3: The Stages of the Viola Janes Method

The function is carried out in the preprocessing stage by applying the viola jones method in this study to get the value offeature extraction which is focused on the facial area so that apart from the face area, it does not get a value when extractingfeatures using the Local Binary Pattern method. The results of the Vioal Jones method are also carried out to detect only the face when taking test data via a webcam on a laptop. The results of cutting the facial area using the Viola Jones method can be seen in Figure 4.

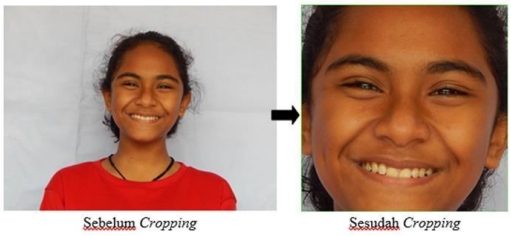

Figure 4: Results of cutting the facial area using the Viola Jones method

Value of the pixel at the center of the image with the 8 values ofthe surrounding pixels. After all the pixel values have been compared and the binary values obtained from the comparison results, then arrange 8 binary values clockwise or vice versa and convert 8 binary bits into decimal values to replace the pixel values in the center. The process of thresholding the 3x3 neighbors of each pixel as the middle value and converting theresult into a binary value, and 256-bin LBP. The results of the image that has been extracted can be seen in Figure 5.

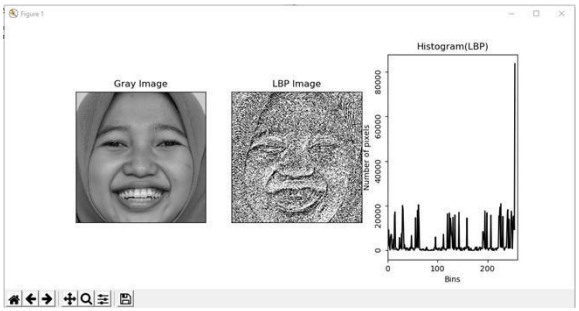

Figure 5: Feature Extraction Results of the LBP Method

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The K-NN algorithm defines the value of K, determines the distance between the input data and all training data, sorts the data based on the results of the distance determination, forms groups based on the value with the closest neighbour, chooses the value with the most frequent occurrences. (Priambodo, Dewi, & Triwiratno, 2015). Measuring distances in the KNN algorithm is done in a way that is often used to measure distances in the KNN method, namely Euclidean Distance(Euclidean Distance) is a method for measuring distances fromtwo or more vectors that are most often used (Hartono & Lusiana, 2017).

Based on the test results on happy and sad human facial expressions, using 200 photos of training data, then testing with40 images of facial expressions to get an overall accuracy calculation of 85%. Tests on sad expressions contained 2 images that were detected incorrectly and 18 images that were detected correctly resulting in an accuracy percentage of 90%, testing on happy expressions contained 4 images that were detected incorrectly and 16 images were detected correctly resulting in an accuracy percentage of 80%. Can be seen in table 1.

Table 1: System Test Results Manually

Data	True	False	Accuracy Results (True/total testdata*100)
Sad	18	2	90%
Happy	16	4	80%
AverageOverall accuracy	34	6	85%

Based on the results of the K-Fold Validation test, it was carried out with two folds, namely 5-fold validation and 10- fold validation to get different accuracy values. The average accuracy for 5-fold validation gets 61.66% can be seen in Table 2.

Table 2: 5-Fold Cross Validation Test Results

K Value	1	2	3	4	5
Accuracy	50%	83.33%	50%	50%	75%
Average = 61.66%					

Meanwhile, for 10-fold validation to get 75% can be seen in table 3.

Table 3: 10-Fold Cross Validation Test Results

K Value	1	2	3	4	5	6	7	8	9	10
Accuracy	0 %	50%	100%	75%	75%	100%	100%	75%	50%	75%
Average= 75%										

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The highest accuracy based on the above test is found in 10-fold validation with a value of 75%. Can be seen in the form of a diagram in Figure 6.

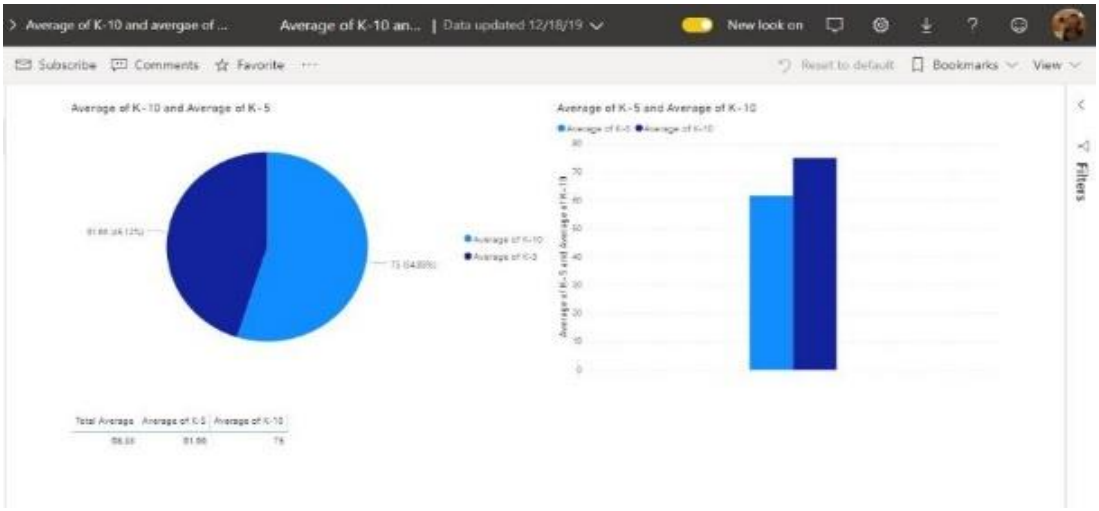

Figure 6: Comparison of 5-fold with 10-fold, Validation Results

In the interface, the first display is the result of the representation of facial expression data that has gone through the preprocessing, feature extraction, and classification stages which are entered into the program for processing and then matched the results with the closest value. The system display can be seen in Figure 7 for the display of happy and sad expressions.

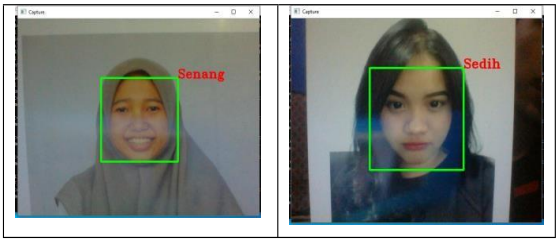

Figure 7: System display on Happy and Sad Expressions

CONCLUSION

Based on the results of the research that has been done on the detection of facial expressions using the Local Binary Pattern (LBP) and K-Nearest Neighbor (KNN) methods by going through several stages ranging from planning, analysis, design, implementation, testing and validation. The research that has been carried out has obtained several conclusions, from trials conducted using 220 data consisting of training dataand test data using k-fold cross validation and producing an average accuracy value of 61.66% for 5-fold and 75% for 10- fold. So that the greatest accuracy is in the 10-fold position.

Then a trial was conducted on the system manually using the entire training data of 200 images of training data for happyand sad expressions with test data of 40 images of happy and sad expressions. The testing process on sad expressions resulted in 2 images that were detected incorrectly and 18 images that were detected correctly with 90% accuracy results,testing on happy expressions contained 4 incorrectly detected images and 16 correct images detected with 80% accuracy results. Overall for testing the correct expression of sad and happy detected as many as 36 and errors as many as 4 images so

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that the average value of accuracy is 85%. The physical criteria detected in facial expressions in this study were found on the face, eyes, cheeks, and mouth. In testing the system, themost influential part is the mouth or lips. When the lips make acurved line up the system detects happy otherwise when the lips make a curved line down the system detects sadness. So, inthe condition of a straight lip line or a neutral state, the system detects a sad expression.

The results of this study produce a significant difference inaverage accuracy, this is because during the training process the training data at each stage of the test has a different amount.When testing manually the amount of data is fully used for each test data so that the program can detect more accurately on each test data being tested. From the results of this study, it is hoped that the Local Binary Pattern and K-Nearest Neighbormethods can be combined for facial expression detection systems or artificial intelligence.

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