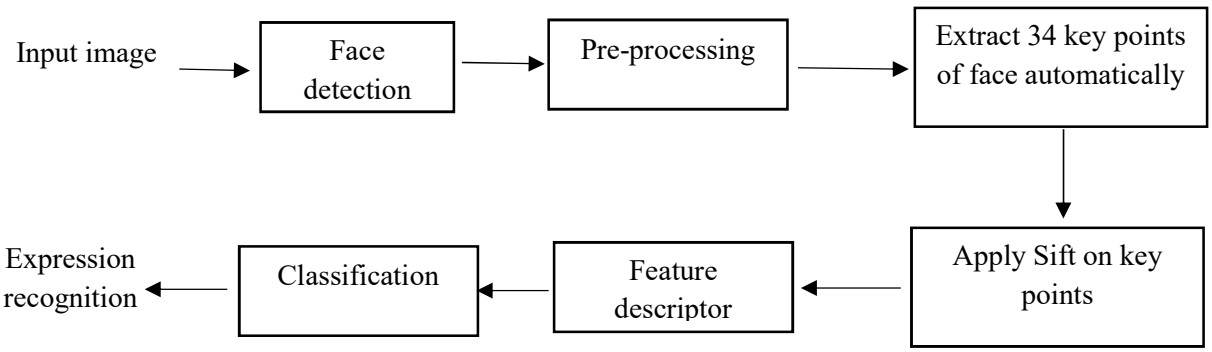
Facial Expression Recognition using Sift Descriptor

Abstract

Facial expressions are one of the most powerful and direct tools for people to connect with the feelings of other people. Facial expression recognition is one of the important issues raised in the fields of artificial intelligence and machine vision; and so far various methods have been introduced concerning facial expression recognition. Some of these methods have shortcomings such as sensitivity to changes in lighting, rotation, enlargement, and noise. The SIFT descriptor is one of the most widely used of these methods, and has great stability in the face of changes such as rotation, noise, and enlargement. Therefore, in this thesis, an attempt has been made to study this descriptor with the purpose of making it stable against some of these problems. One of the shortcomings of the SIFT method is that points on the face are obtained in a spatial scale, and, therefore, these points may not be effective in recognizing the facial expression. Therefore, in this research, the purpose has been to apply the SIFT descriptor on key points of the face which have been obtained in an intelligent manner, and which are effective in recognizing facial expressions.

Implementations carried out in experiments conducted in this research indicate that the proposed algorithms, when tested on the database JAFFE, are superior to the base SIFT algorithm and to other algorithms introduced in this area. Results obtained show that with changes made in the base SIFT descriptor the rate of facial expression recognition improves by two percent, that less time is needed to conduct the test , and that the time required to extract the facial features is less than that needed to apply the SIFT descriptor on the whole face.

1- Proposed Method



1-1- Face detection using Harr-like features

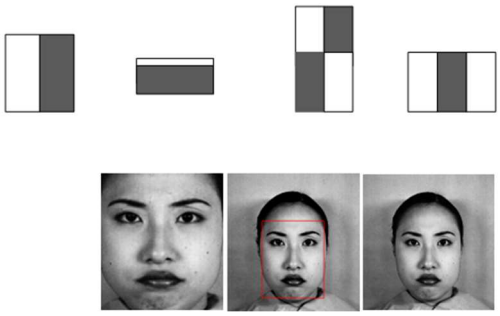


Figure 1. Face detection using Harr-like features

1-2- Pre-processing

- Convert image to grayscale color space
- Resizing images to 128×128
- Smoothing using histogram equalization

1-3- Extract facial key points automatically

1-3-1- Image binarization

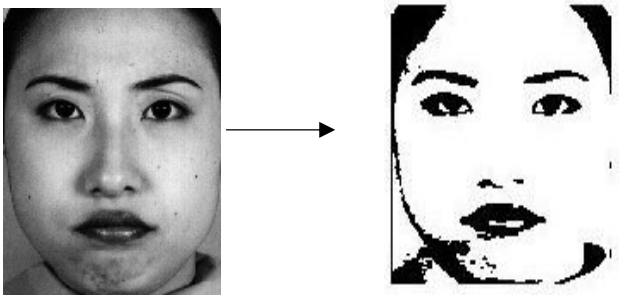


Figure 2. Binary image

1-3-2- Integral image curve

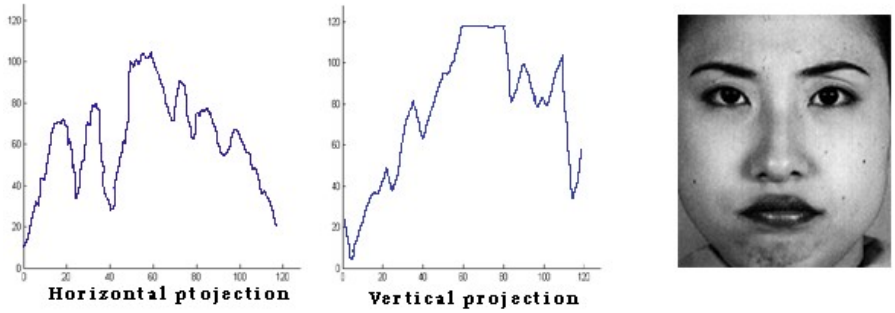


Figure 3. Integral image curves

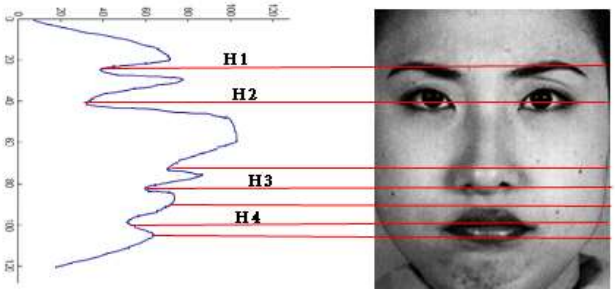


Figure 4. Horizontal integral image diagram

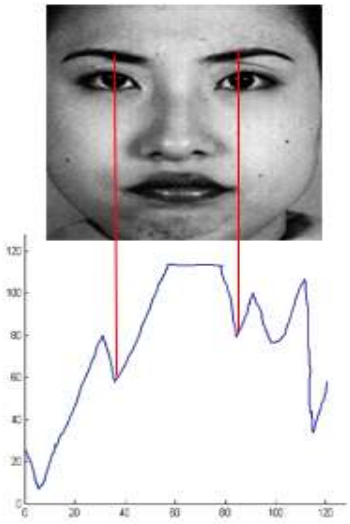


Figure 5. Vertical integral image diagram

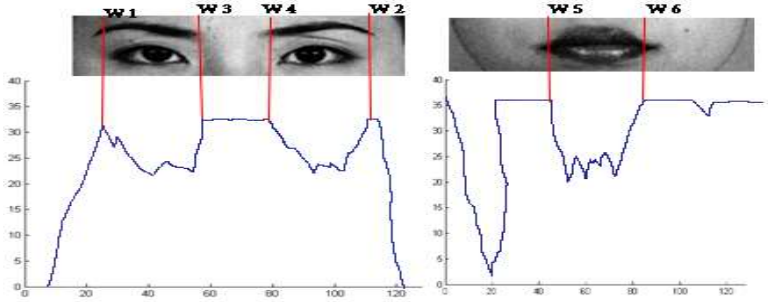


Figure 6. Eye area and mouth area extraction

Table 1. Calculation of key points

Key points	X coordinates of key points	Y coordinates of key points
2	$x_2 = H_2 - (H_2-H_1)/3$	$y_2 = y_0$
4	$x_4 = H_2 + (H_2-H_1)/3$	$y_4 = y_0$

7	$x_7 = H_2 - (H_2-H_1) / 3$	$y_7 = y_5$
9	$x_9 = H_2 + (H_2-H_1) / 3$	$y_7 = y_5$
16	$x_{16} = (0.15*H) / 2$	$y_{16} = y_0$
17	$x_{17} = (0.15*H) / 2$	$y_{17} = W/2$
18	$x_{18} = (0.15*H) / 2$	$y_{18} = y_5$
19	$x_{19} = (0.15*H) / 2$	$y_{19} = W/2$
20	$x_{20} = H / 2$	$y_{20} = y_{10}$
21	$x_{21} = H / 2$	$y_{21} = y_{13}$
29	$x_{29} = x_{25}$	$y_{29} = y_{10}$
30	$x_{30} = x_{25}$	$y_{30} = y_{13}$
31	$x_{31} = (x_{32} – x_{28}) /2$	$y_{31} = y_0$
32	$x_{32} = H$	$y_{32} = W/2$
33	$x_{33} = x_{31}$	$y_{33} = y_5$

1-4- Description of key points based on SIFT

- Assign direction to each key point
- Calculation of descriptor key points
- Feature vector matching

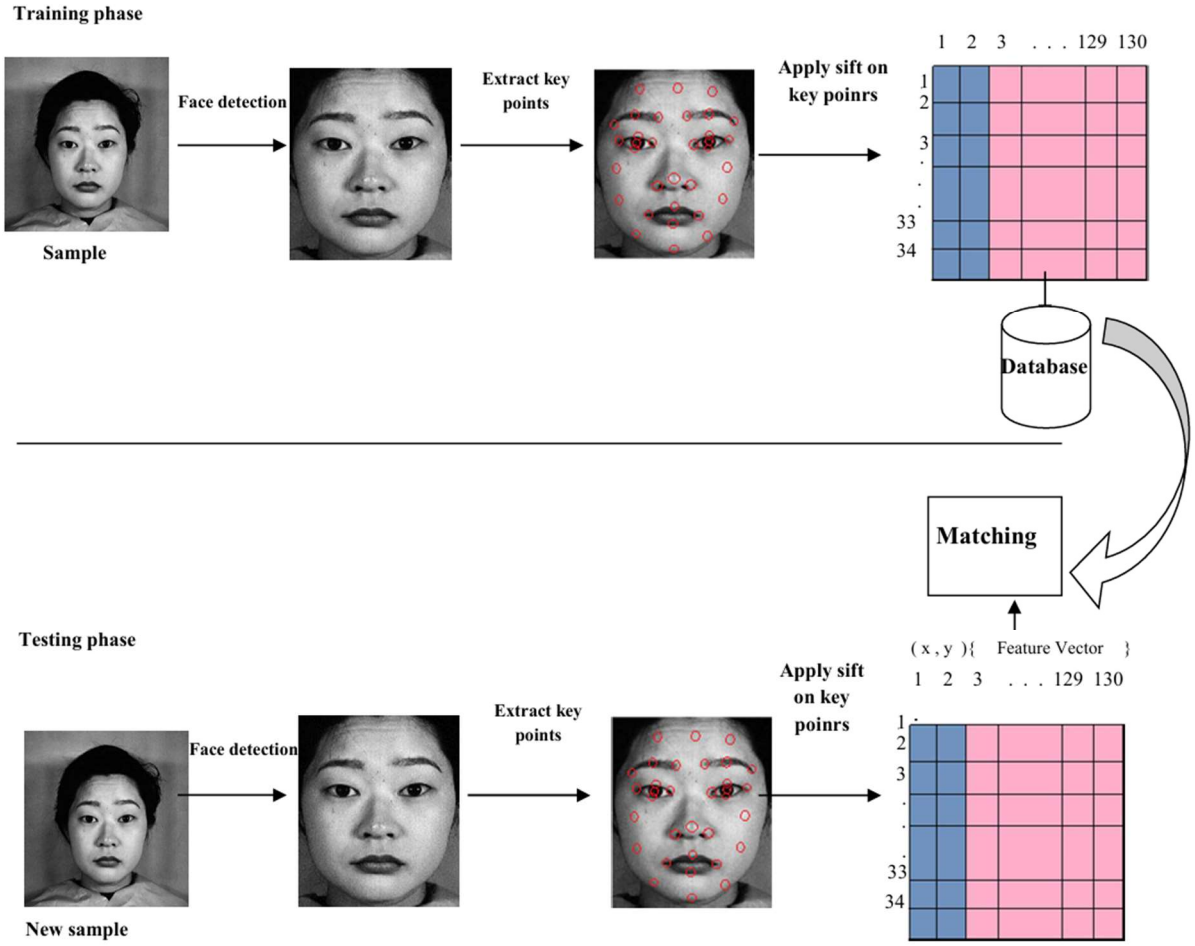


Figure 7. Proposed method

2- Experimental results

2-1- Database

- JAFFE
- Cohn-Kana

Method/ accuracy	SIFT on key points of face	SIFT on the whole face
30% for train-70% for test	85.73%	81.10%
30% for test-70% for train	97.20%	95%

Table 2. Comparison of the proposed method of applying SIFT to the whole face

K-FOLD , K=10	95/71	92.88%

Table 3. Comparing the recognition accuracy of the proposed method with other methods

SIFT on 34 face key points + Euclidean distance (proposed method(	SIFT on whole face + Euclidean distance	Gabor filter+KNN	34automatic key points +Gabor+K-NN	34 key manual points + Gabor + LVQ	
٪97.20	٪95	٪94	٪95.15	٪87.51	70% of data for training and 30% for testing

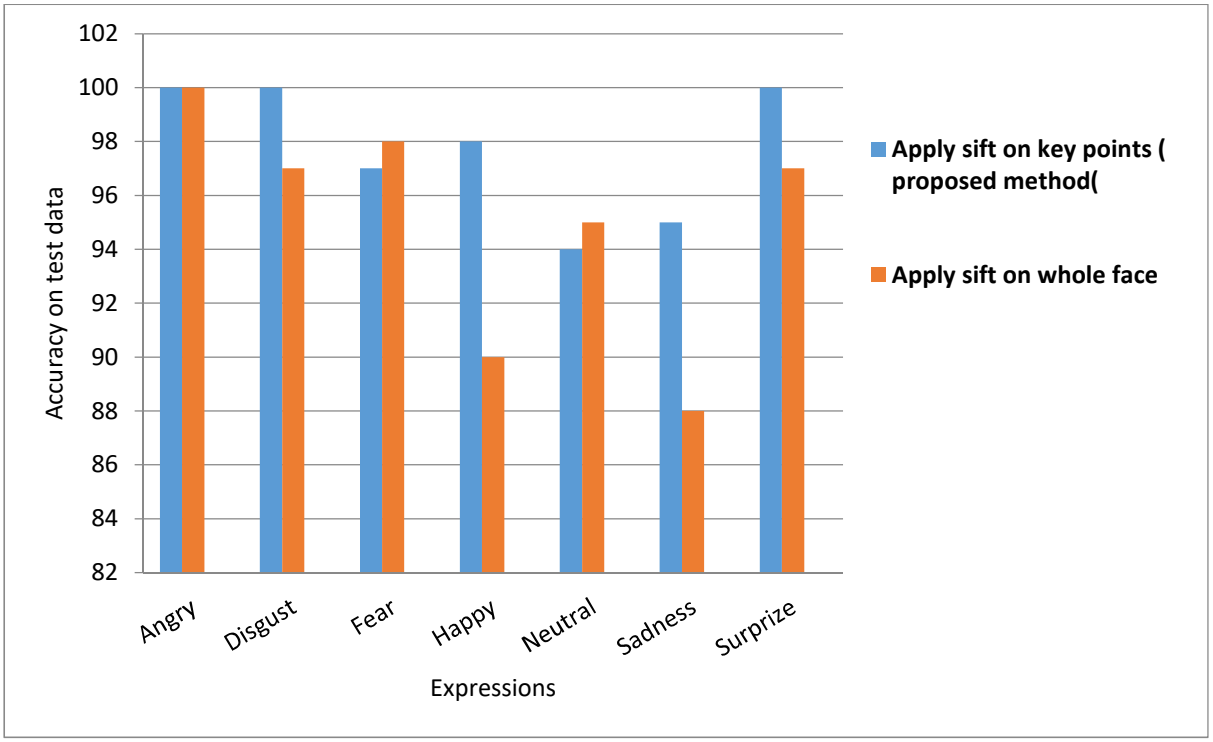


Figure 8. Comparison of recognition accuracy of different facial expressions

Smaller scale image Original image Bigger scale image

Figure9. Image in different scales

Table 4. Comparison of facial expression recognition accuracy in different scales

128×128	90×90	original (256×256) image	Different scale
%91	%86	%97.20	Recognition accuracy of the proposed method
%60	%54	%95	Recognition accuracy of 34 key points + Gabor

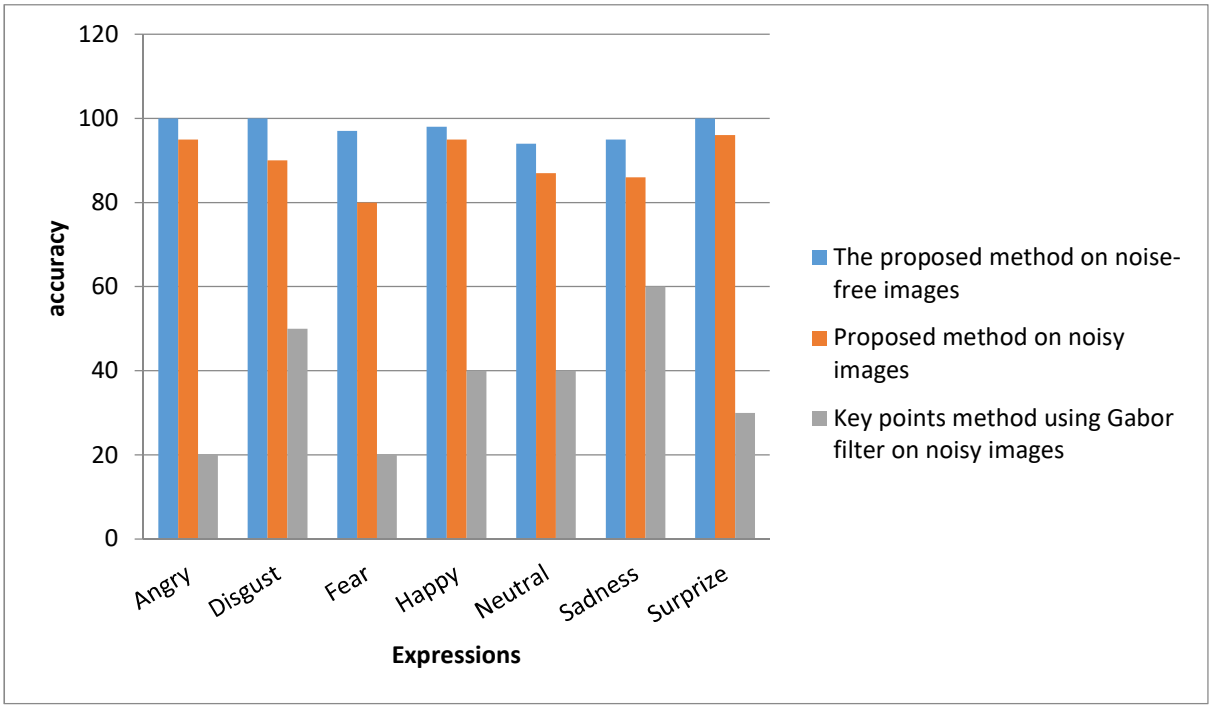


Figure 10. Comparison of recognition accuracy of different facial expressions using noisy images

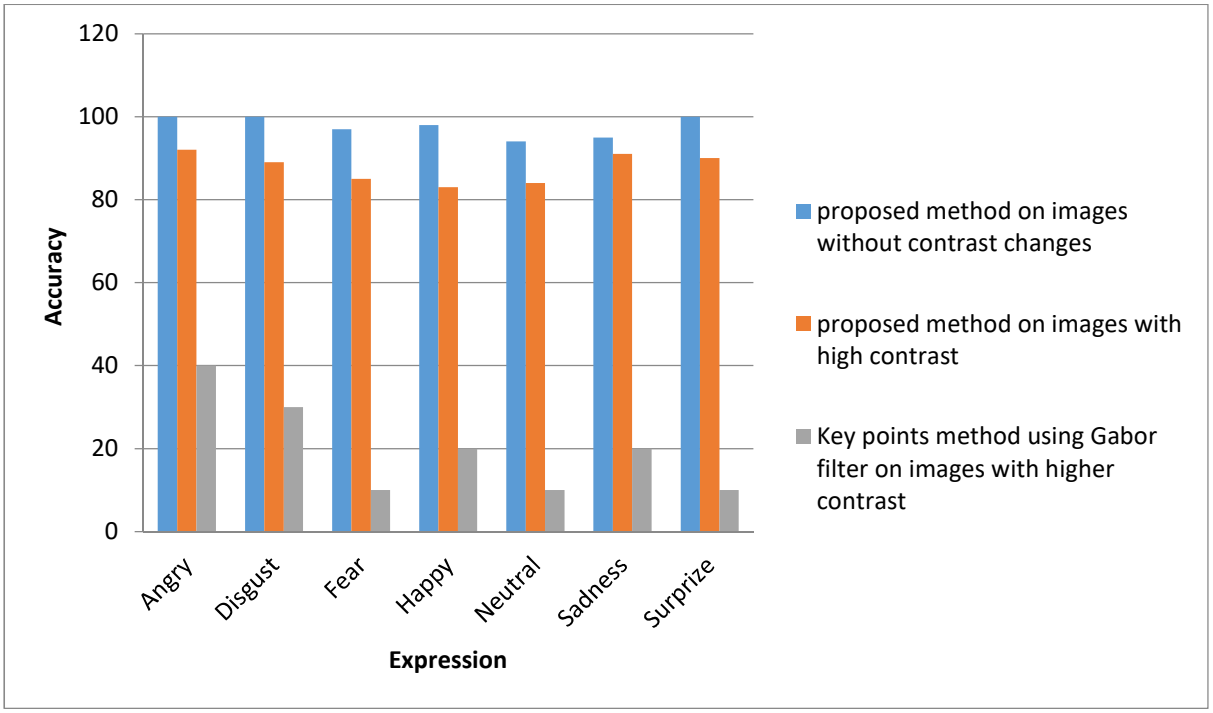


Figure 11. Comparison of recognition accuracy of different facial expressions using test dataset in high contrast

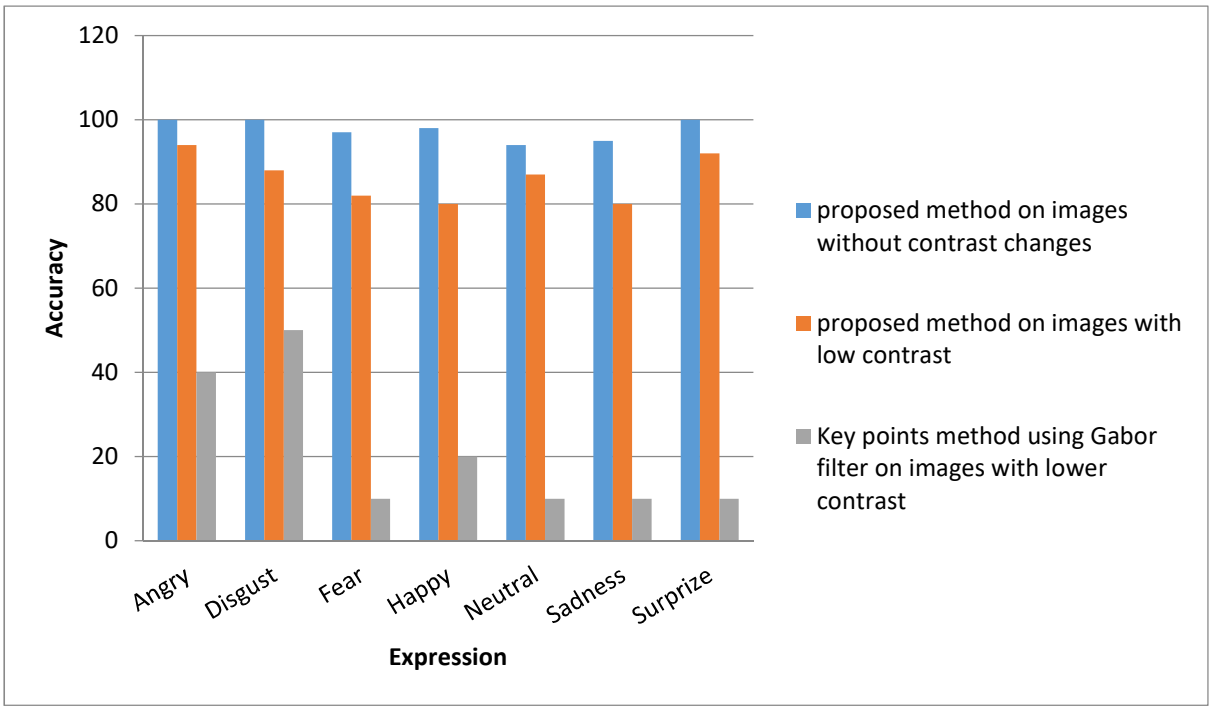


Figure 12. Comparison of recognition accuracy of different facial expressions using test dataset in low contrast