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# Robust Hybrid Face Recognition Technique

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**Abstract:** Face recognition is a very crucial task and regularly utilized for biometric systems.In the event that face picture is distorted with noise then the procedure of face recognition turns out to be more troublesome. This paper presents the hybrid approach for face recognition under different emotions and additionally under noisy conditions. The approach uses hybrid filtering technique based on neighboring pixels for removing noise followed by face recognition algorithm using modified scale invariant transform (MSIFT). For recognition, the images of only neutral face expressions have been stored in the database. the face recognition method significantly deals with face images with different emotions (happy, sad, anger, disgust, surprise) of one person. Hence there is no need to store images under different emotions of the same person. Hence helps to reduce the size of the database which increases the performance. The experiments have been performed on Japanese Female Facial Expression (JAFFE) and Yale databases. To demonstrate the performance of the proposed approach, results are taken on salt and pepper noise corrupted images. The comparison of face recognition with noise and without noise has also been presented. From the results, it was observed that hybrid approach can achieve 97.65% and 92.12% recognition rate even in the presence of 30% noise density on JAFEE and Yale databases respectively.

**Keywords:** Filters, Face Recognition, Noise, Salt and pepper noise.

## 1. Introduction

The face recognition system is used to identify and distinguish the identity of human being. Human faces can be detected, tracked, identified or verified with the help face recognition system[8][9].The face recognition system takes a face image as input and compare it with provided database. But same face may appear differently because of age, expressions, noise and lightening conditions which becomes a challenge for face recognition techniques to recognize it. [2][3][7]. Noise is the one of main problem in the face recognition system. The performance of a face recognition technique strongly varies because of noisy image and noisefree image.

Hence it is very important to enhance the face image to improve the performance of face recognition technique [1]. The noise can be removed in preprocessing step. This will lead to better feature extraction and classification [6].

In the previous paper [5] a modified scale invariant feature transform (MSIFT) had been developed which worked efficiently to recognize a face under different emotions. The experiments were performed on noise free database. After that we designed a Hybrid filtering technique based on neighboring pixels to remove impulse noise from images. The extensive comparisons had been performed with existing techniques to evaluate its performance and it had

been concluded that it is an efficient technique to remove noise from images by preserving its all important information. In this paper, first we are applying Hybrid filtering technique based on neighboring pixels [4] to remove noise from image and then applying MSIFT [5] to recognize a face under different emotions. To check the performance of this combined approach, the noise has been added to the images at different noise densities.

## 2. Proposed Robust Hybrid Face Recognition Technique (RHFRT)

RHFRT has been proposed for the face recognition under different emotions as well as under noisy conditions to enhance recognition rate for the face images which are corrupted with saltand pepper noise. The proposed RHFRT algorithm modifies face recognition technique(FRT) [5] by changing its preprocessing step (i.e. Gaussian filtering) with noise filtering technique (NFT) [4]. Hence it involves three phases:

### 2.1 Noise Filtering of Face Image

In this phase, salt and pepper noise from the face image is eliminated with the help ofNFT [4] and denoised image is passed to feature extraction process.

### 2.2 Feature Extraction of Face Image

In this phase, features of the face image under different emotions have been calculatedusing MSIFT [5] in DWT domain.

### 2.3 Recognition

In this phase, the face images have been recognized based on the matching criteria i.e.CoC.

## 3. Methodology of RHFRT

The basic methodology of this approach has been shown in Figure-6.1 followed by algorithm.

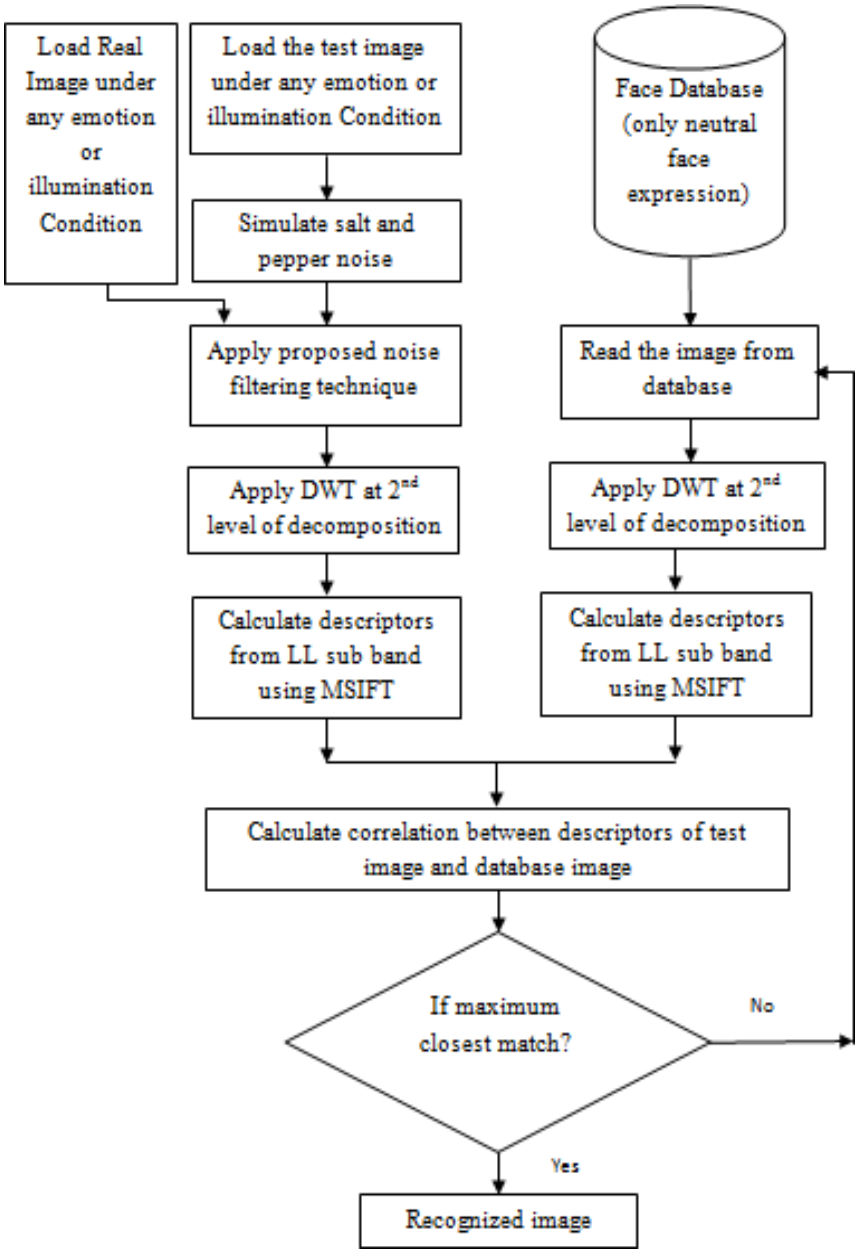


**Figure 6.1: Basic Methodology of RHFRT**

## Algorithm

(a) Load the test image

(b) Check whether the processing pixel, $P_{XY}$ is noisy or not. If it is not noisy then retain its value, otherwise go to step (c).

(c) Check, is there any other noisy pixel in its neighborhood (window). If yes then go to step (e) otherwise go to step (d).

(d) Trim all 0's and 255 values from window and calculate median to replace noisy pixel.

(e) Identify Case in which processing window falls i.e.

Case 1: if selected window contains either all 0's or all 255's.

Or

Case 2: if selected window contains only combination of both 0's and 255's.

Or

Case 3: if selected window contains combination of some noisy pixels and non-noisypixel values.

(f) If selected window falls in Case I, then retain the pixel value. If selected window falls in Case 2, then replace the processing pixel with midpoint of neighboring pixels. If selected window falls in Case 3, then trim all the 0's and 255's from window and calculate the midpoint of remaining pixels and use it to replace processing pixel.
(g) Apply DWT at level-2 to get the LL sub band of the processed image and database images.
(h) Calculate descriptors of from LL sub band ($1/4^{th}$ of original image) of each image obtained from step (g) using MSIFT.
(i) Calculate CoC between the descriptors of preprocessed image and each database image.
(j) Retrieve the image from database which gives maximum CoC value.

## 4. Results and Discussions

To test the robustness of the proposed RHFRT, results are taken on both noise free as well as salt and pepper noise corrupted images. Also, to analyze the performance of proposed hybrid approach results are taken at different noise levels (noise of varying densities is simulated into the image ranging from 10% to 90% density level). The experiments have been performed on JAFFE and Yale databases. From the results, it has been observed that hybrid approach significantly recognized the faces under different emotions, affected with illumination conditions and noise. It is observed that hybrid approach can accomplish 97.65%recognition rate on JAFEE database even in the presence of 30% noise density.

### 4.1 Quantitative Results

Tables-6.1 and 6.2 shows the performances of RHFRT with respect to original SIFT, proposed NFT and proposed FRT at various noise levels on JAFEE and Yale databases respectively. The comparison among the techniques has been shown graphically in Figure-6.3and 6.4 on JAFEE and Yale databases respectively. From the results, it has been observed that performance of SIFT is enhanced by combining NFT with SIFT, but proposed hybrid technique yields better recognition performance.

### 4.2 Qualitative Results

To show the robustness of the method, the visual results on salt and pepper simulated images with different expressions and different illumination conditions are presented in Figures 6.4 to 6.9. The visual results demonstrates recognition of sad face image corrupted with 10% saltand pepper noise density, angry face image corrupted with 30% salt and pepper noise density and surprised

face image at 50% salt and pepper noise density respectively of JAFEE database. Similarly, Figures 6.7 to 6.9 show visual results on face image affected with right side light and also corrupted with 10% salt and pepper noise density, face image with glassescorrupted with 30% salt and pepper noise density and happy face image corrupted with 50% salt and pepper noise density respectively of Yale database. The accurate recognition by proposed method under different conditions demonstrates the robustness of proposed RHFRT.

**Table 6.1: Recognition Rate in the Presence of Different Noise Densities on JAFEE Database**

| Noise Density | Total images | Original SIFT | | NFT+SIFT | | FRT | | Proposed RHFRT | |
|---|---|---|---|---|---|---|---|---|---|
| | | Recognized | RecognitionRate | Recognized | RecognitionRate | Recognized | RecognitionRate | Recognized | RecognitionRate |
| Noise Free | 213 | 191 | 89.67% | 191 | 89.67% | 208 | 97.65% | 208 | **97.65%** |
| 10% | 213 | 84 | 39.43% | 189 | 88.73% | 102 | 47.88% | 208 | **97.65%** |
| 30% | 213 | 0 | 0% | 186 | 87.32% | 0 | 0% | 208 | **97.65%** |
| 50% | 213 | 0 | 0% | 181 | 84.97% | 0 | 0% | 204 | **95.77%** |
| 70% | 213 | 0 | 0% | 154 | 72.30% | 0 | 0% | 181 | **84.97%** |
| 90% | 213 | 0 | 0% | 121 | 56.80% | 0 | 0% | 152 | **71.36%** |

**Table 6.2: Recognition Rate in the Presence of Different Noise Densities on Yale Database**

| Noise Density | Total images | Original SIFT | | NFT+SIFT | | FRT | | Proposed RHFRT | |
|---|---|---|---|---|---|---|---|---|---|
| | | Recognized | RecognitionRate | Recognized | RecognitionRate | Recognized | RecognitionRate | Recognized | RecognitionRate |
| Noise Free | 165 | 133 | 80.60% | 165 | 80.60% | 152 | 92.12% | 152 | **92.12%** |
| 10% | 165 | 61 | 37.57% | 132 | 80.00% | 69 | 41.81% | 152 | **92.12%** |
| 30% | 165 | 0 | 0% | 130 | 78.78% | 0 | 0% | 152 | **92.12%** |
| 50% | 165 | 0 | 0% | 124 | 75.15% | 0 | 0% | 147 | **89.09%** |
| 70% | 165 | 0 | 0% | 109 | 66.06% | 0 | 0% | 134 | **81.21%** |
| 90% | 165 | 0 | 0% | 91 | 55.15% | 0 | 0% | 116 | **70.30%** |

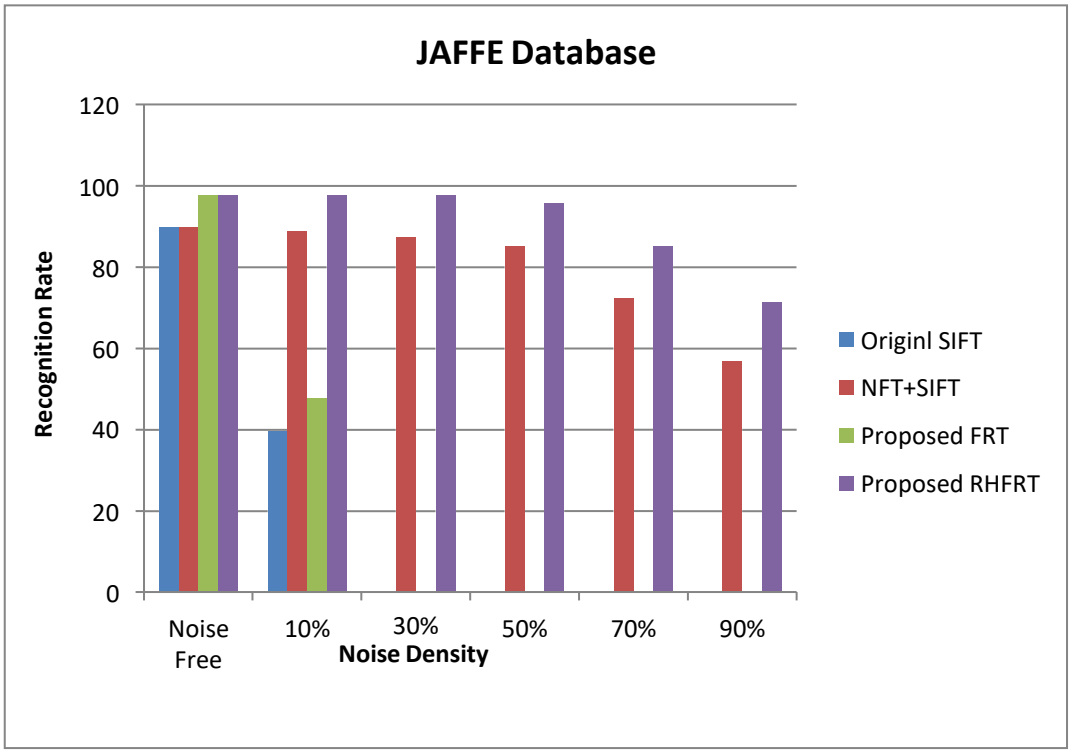

**Figure 6.2: Comparative Analysis of Different Techniques in Terms of Recognition Rate on JAFEEDatabase at different Noise Densities**

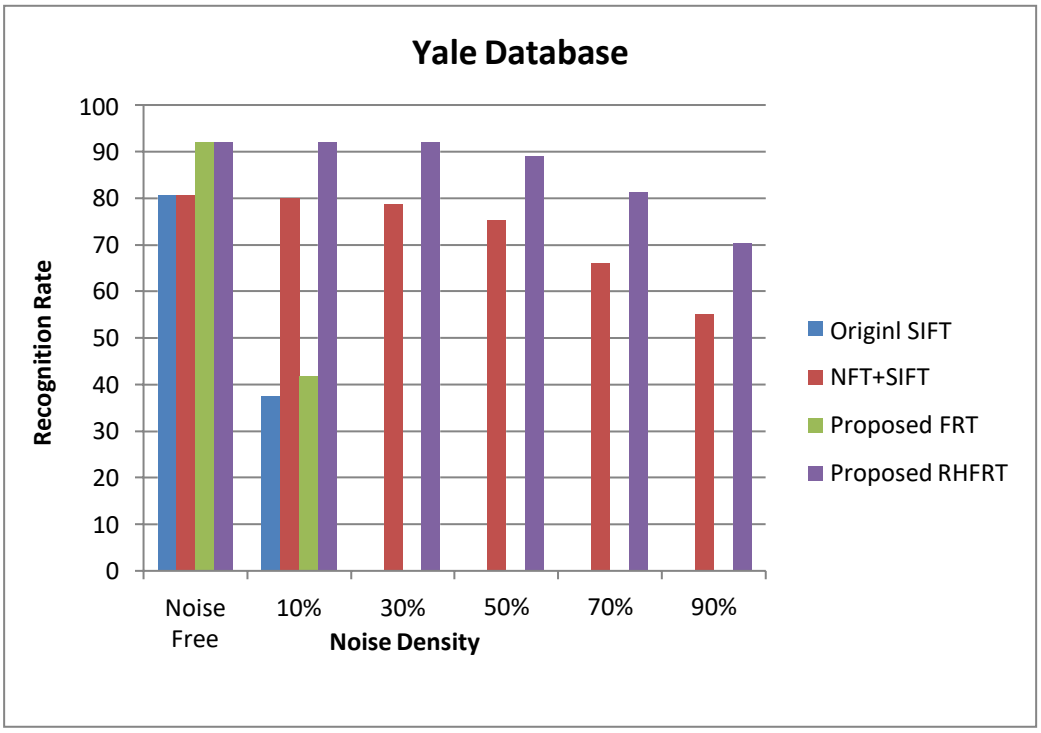


**Figure 6.3: Comparative Analysis of Different Techniques in Terms of Recognition Rate on YaleDatabase at different Noise Densities**

| | | |
|---|---|---|
|  Original Test Image |  Test Image Corrupted with10% Noise Density |  Recognized Image |

**Figure: 6.4 Recognition of Sad Face at 10% Noise Density with RHFRT on JAFEE Database**

| | | |
|---|---|---|
|  Original Test Image |  Test Image Corrupted with 30% Noise Density |  Recognized Image |

**Figure: 6. 5 Recognition of Angry Face at 30% Noise Density with RHFRT on JAFEE Database**

| | | |
|---|---|---|
|  Original Test Image |  Test Image Corrupted with 50% Noise Density |  Recognized Image |

**Figure: 6.6 Recognition of Surprise Face at 50% Noise Density with RHFRT on JAFEE Database**

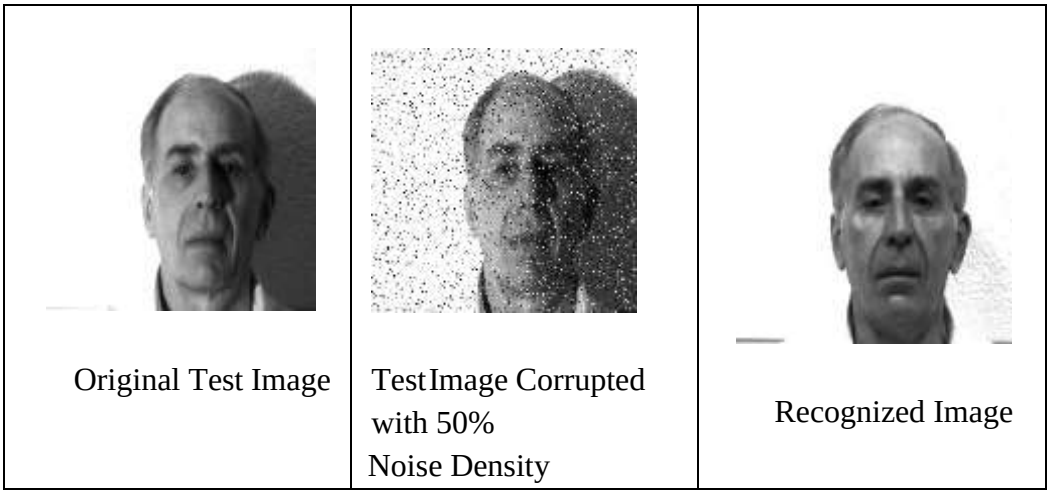


**Figure: 6.7 Recognition under Right Side Light Face at 10% Noise Density with RHFRT on YaleDatabase**

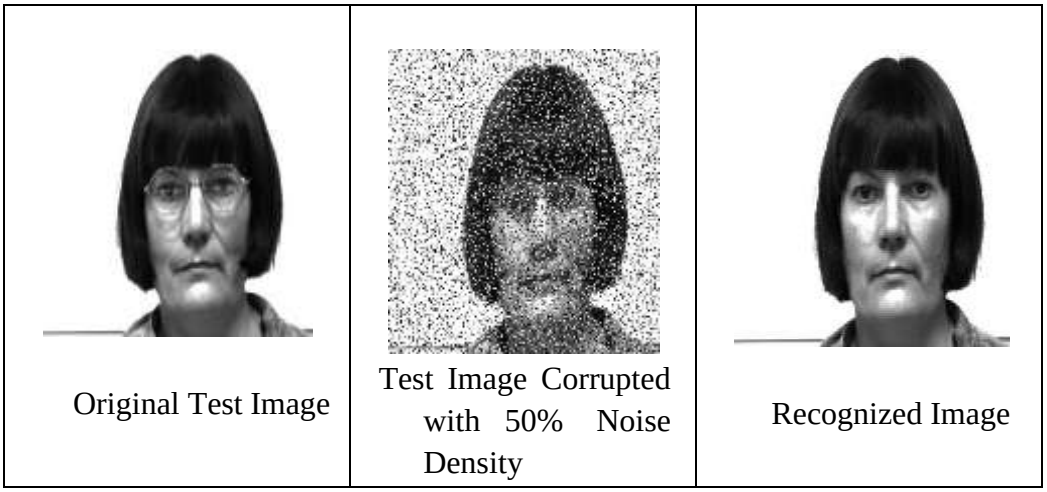


**Figure: 6.8 Recognition of Face with Glasses at 30% Noise Density with RHFRT on Yale Database**

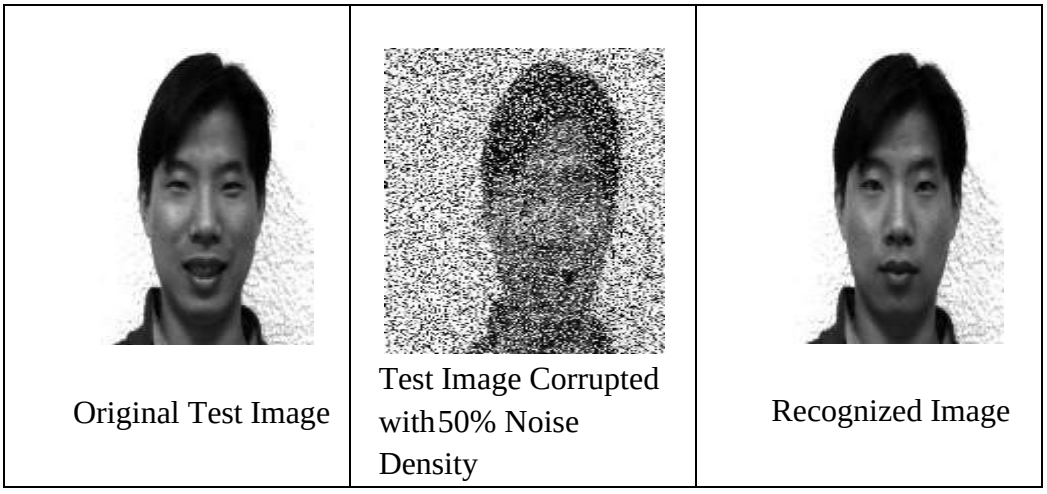

**Figure: 6.9 Recognition of Happy Face at 50% Noise Density with RHFRT on Yale Database**

## 5. Conclusion

The proposed RHFRT technique is robust to recognize a face under different noisy conditions, expressions, illumination conditions as well as wearing of glasses. It has been observed that even face images corrupted with 90% noise density additionally provide great recognition rate. The novelty of face recognition technique is that it stores only neutral expressions of face image and capable to recognize the face with different expressions. Henceit reduces the size of database (as only neutral face expressions are stored in database). The excellent experimental results confirmed the robustness of the method.

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