Advanced Face Detection Mechanism for Images Corrupted by High Noise Elements

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***Abstract*— Removal of noise is an important criterion of image processing to improve the interpretability of the information present in the images for a human viewer. There are many unwanted elements in a picture which are commonly known as noise which must be removed from an image for further processing. Super mean filter is more selective filter for removing impulse noise which helps in preserving edges and other high frequency parts of an image. In this paper study of face detection in noisy environment has been done. The images are highly affected by salt & pepper noise. The methodology used in this paper is performed in two levels. In first level, faces are detected from highly corrupted image with Impulse Noise by using support vector machine (SVM). In the second level after applying Super Mean filter, faces are detected from the filtered image by using support vector machine. Finally, the performance of the filter is judged based on face detection results obtained from two processes mentioned above.**

Keywords— Face Detection, support vector machine (SVM), Gabor Filters, Super Mean Filter.

I. INTRODUCTION

The face detection is one of the most demanding fields of research in image processing. In spite of large research in this field, it is difficult to build a face identification system similar to human being. It has become a frequently need of our life as it finds its uses in areas like surveillance system, digital monitoring, PC, camera, social networking, cell phones etc. But due to contamination of noise in an image it is difficult to detect faces perfectly from the noisy image. Simply say, a face detection method can be defined as follows [1]: An image I is given and find all occurrences of faces. This definition implies that some form of differentiation must be made between faces and all non-faces. Though it seems easy initially but it has its own set of difficulties. Variations in lighting conditions can make face images appear substantially different and mixing of noise further complicates the face detection problem. Presence of additional features such as beards, moustaches, and glasses can augment the global structure of the face such as the jaw line and mask local features such as corners of the mouth. Additionally, the large amount of intra-class variations among all faces makes it difficult for a reliable face detection mechanism.

Over the past few decades, many approaches have been proposed for improving the performance of human face detection, which are categorized and given below:

- *Knowledge-based method:* This method is based on finding invariant features of a face within a complex environment, thereby generalizing the position of the face. Relationships among the features of the face help fully in determining whether a human face appears in an image or not [2].
- *Feature invariant approaches:* Invariant features, unresponsive to different positions, brightness, and viewpoints, are utilized in this approach to detect human faces. A statistical model is usually created for describing the relations among face features and the presence of the detected faces. Such face features are facial features, texture, and skin color [3-5].
- *Template matching method:* A template matching with human face features is used to perform a pattern-matching operation based on the template and an input image. Shape template [6] and active shape model [7] are common examples of this method.
- *Appearance-based method:* A series of face images to train a model for the face detection are employed in this method. Various famous algorithms such as Eigen face [8], Neural Network [9], and Hidden Markov Model are basic classifiers used for classification.

In general, the last three methods are more complex than the first one; yet the more features are used in the first method, the more complicated it is.

In most real-time systems the feature-based approach combined with various kinds of face candidate extraction methods is taken into account. These algorithms can be integrated into two-stage framework. In the first stage, regions that may contain a face are marked. This stage mainly pays attention to face candidates. In the second stage, the possible regions, or face candidates, are sent to a “face verifier”, which will give a result whether the candidates are real faces [11]. Different methods give importance on different stages. Again if the face verifier is powerful enough to distinguish between various face and non-face patterns in almost all cases, the candidates selection step may be omitted [9], [12]. In this case, the algorithm can move through the image from left to right, and from top to bottom, treat each sub-region in the image as a face candidate. On the other hand, if most non-face regions are omitted in the first stage and all faces are selected, the verifier for the face detection can be dramatically simplified or even eliminated.

Noise in an image is certainly playing a vital role in decreasing the details of that image. So noise should be removed to get back the details which must help in further processing of image. There are several types of noise like

Gaussian, Rayleigh, Gamma, Uniform, Exponential, Salt & Pepper, etc. Salt & pepper noisy can be visually identified as it looks like salt and pepper.

In this paper, face detection is based on the combinational feature based approach which uses the structure information about the nose region as a robust cue to identify possible face candidates in an image, after which a SVM classifier is trained to identify the face regions among the candidates to successfully detect them. The noise in the image is filtered by the adaptive median filtering.The framework of the entire proposed technique is shown in Fig.1.

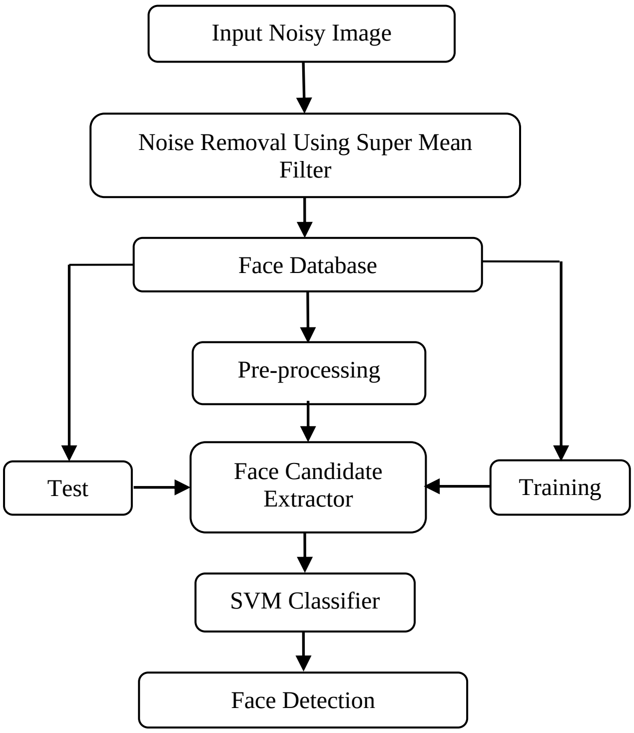

Fig. 1. Block Diagram of the Proposed Method

The rest of this paper is organized as follows. Section II describes the proposed methodology, including the pre-processing stage, the training stage, and the detection stage. Section III shows the experimental results.

II. PROPOSED ALGORITHM

Here the comparison is made between the result of face detection of noisy image and face detection of filtered image. Basically the process focuses on greyscale images; it becomes imperative to include a pre-processing stage for “improving” images. This is achieved using a Super Mean filtering technique for obtaining noise free image [15]. The algorithm of Super Mean Filter is shown blow. Super Mean Filter is a better technique to reduce the high density noise elements i.e. if the density of salt and pepper noise is more than 80-90% then the normal median filter, Adaptive median Filter, Progressive Switching Filter and Decision Based Filter fails to remove the noise present in the image.

Algorithm of Super Mean Filter:

Step (1). Initialize the window size of the filter by 2×2 windows

Step (2). Find out the noise free pixels present in 2×2 windows

Step (3). Find out the mean value of the noise free pixels in selected window

Step (4). Replace the noisy pixel by the calculated mean value in step (3)

Step (5). Repeat steps from 1- 4, to process the entire image for removal of impulse noise

Once the image has been rescued from the noise, the image is sent to the SVM trainer for face detection purpose. For more efficient performance an optimal Gabor filter is used to mark certain regions of the image where a face structure is likely to be present. These regions are called as face candidates. Moreover a generic SVM is trained using the test images. To train the classifier, two set of images are needed. One set contains an image or scene that does not contain the object, in this case a facial feature, which is going to be detected. This set of images is referred to as the negative images. The other set of images, the positive images, contain one or more instances of the object. For training facial features at least 50 negative images with at least a mega-pixel resolution were used for training. These images consists of everyday objects, like paperclips, natural scenery, photographs of forests and mountains. Now this trained SVM is given the face candidate locations to identify the actual face structures among them, and on successful identification it is marked with green boxes. The Algorithm for face detection is as follows.

Finally, a comparison is made between the detected faces from noisy image and the filtered image. This is represented in a block diagram in Fig. 2.

Algorithm for Detection:

Step (1).Remove the salt and pepper noise from the image using Super Mean Filter

Step (2) Identification of possible Face Regions from the filtered image

Step (3). Training of the SVM classifier

Step (4).Identifying the actual faces from the possible face regions

Step (5).Marking the actual faces with green boxes for successful identification

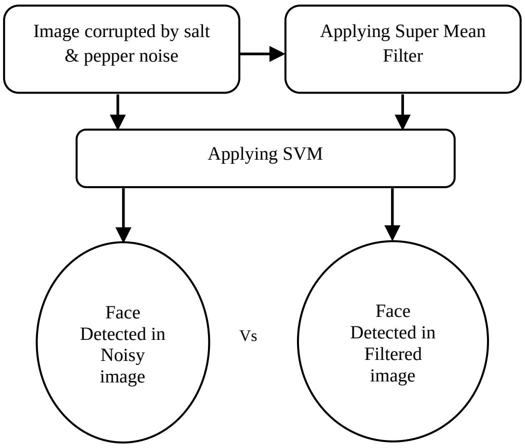

Fig. 2. Face detection with/without filter

III. THE EXPERIMENTAL RESULTS

To check the functionality of the proposed method 130 images collected randomly from our surrounding including 70 face and 60 non face images along with some images from "FERET face database", were used as training images for the SVM classifier. The method was implemented in MATLAB and simulations carried out in simple and complex background to obtain the effectiveness of the program. Fig. 3(a) shows the original image and Fig. 3(b) shows the noisy image, in which 70% noise is present in the image. Fig. 3(c) is the processed image by Super Mean Filter.

Fig. 3(a). Original Image

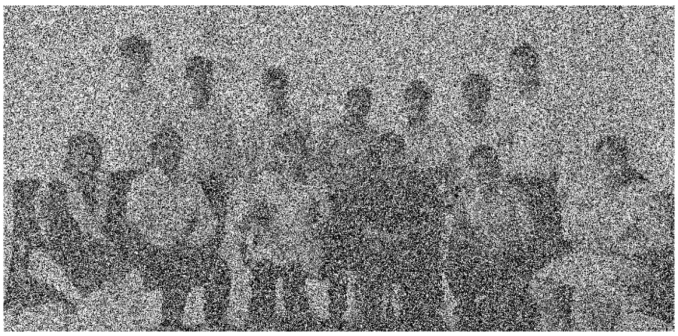

Fig. 3(b). Noisy Image with 70% Salt & Pepper

Fig. 3(c). Processed Image with Super Mean Filter

The test image is sent to the Super Mean Filter for pre-processing. After the filtration, the SVM classifier is trained by face and non-face images. These images are obtained from the FERET database. This trained SVM is now used for detection purposes. The face detection in noisy image is shown in Fig. 4(a) and that in the filtered image is shown in Fig. 4(b).

Fig. 4(a). Face Detection in Noisy Image with 40% Impulse Noise

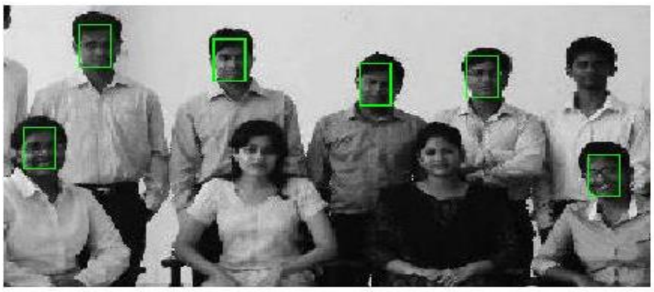

Fig. 4(b). Detection of Face after Filtering

Since the comparison cannot be decided based on only a single test image, two more images were included for obtaining a more comprehensive result under different situations. A particular face image with different intensity levels was used to compare between the results. The results of these are as shown in Fig. 5(a) and 5(b) respectively.

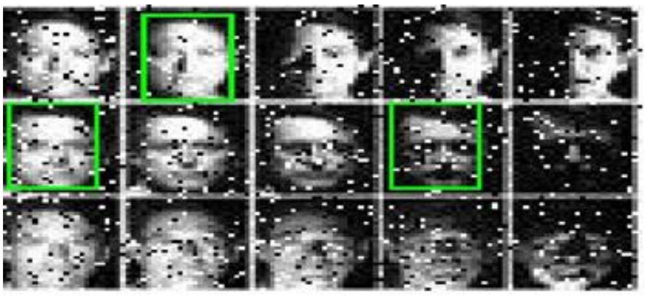

Fig. 5(a). No of Faces in a Single Noisy Image

Fig. 5(b). No of Faces in a Single Filtered Image

Now the number of faces detected in both noisy and filtered images is tabularized in Table-I for a comparative study.

TABLE-I. Face Detection in Noisy and Filtered Images

Fig. No	Image Size	No of Faces	Type of image	Face Detected	False Detection	Hit Ratio
4(a)	353*182	9	Noisy	2	7	22.22%
4(b)			Filtered	6	3	66.67%
5(a)	125*91	15	Noisy	3	12	20.00%
5(b)			Filtered	7	8	46.67%

Depending on the feature used in identification detection rates differ in a significant manner. Result of face detection in noisy environment and after filtrations is shown in TABLE-I. The proposed algorithm provides an increment in face identification rate over the noisy images.

IV CONCLUSION AND FUTURE WORK

Face detection is an important aspect for various fields of study such as face recognition, expression detection, video monitoring, status authentication, and others for which till date it remains an important research field. In this paper it has been shown that the efficiency of using the nose structure as an identifying feature for face detection improves the success rate. Improvement in this algorithm can be made by parallel processing of independent steps as noted earlier. Improvements can also be made in developing methods to identify faces from angles or even when the face remains obscured. Future research will thus focus on looking for more effective approaches for detecting face more accurately.

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