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Face Detection in an Enhanced Image

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***Abstract*— Images captured in a dusty atmosphere typically leads in negative deterioration such poor contrast, lacking colors, or colour cast, it can have a significant impact on the quality of photographs. Dusty conditions frequently cause colour shifts towards opaque yellow, an orange hue, or a brownish tone in photographs. Therefore, to improve the dependability of gathered images for later interpretations, such undesired artefacts must be appropriately handled. As a result, these artefacts could cause problems for a number of image processing and computer vision tools, including security systems, intelligent transportation systems, and tools for motion detection, object recognition, and object tracking. The visual quality of photos can be considerably enhanced by combining the face identification method Viola-Jones with Contrast Limited Adaptive Histogram Equalization (CLAHE). CLAHE is a well-known method for boosting contrast in photos, which is especially helpful for photos with inconsistent lighting. The Viola-Jones algorithm is a popular face detection algorithm in computer vision applications because it is quick and reliable. By combining these two methods, we can accurately and efficiently recognize faces while also improving the contrast of photos.**

Keywords*— *CLAHE (Contrast Limited Adaptive Histogram Equalization),Violaj Jones,Face Detection.

I. INTRODUCTION

There are several uses for the important computer vision tasks of image enhancement and face detection. Image enhancement is the technique of raising an image's contrast, sharpness, and colour saturation in order to enhance its visual quality. The process of locating and detecting human faces in an image or video frame is known as face detection. A well-liked method for boosting contrast in photographs, particularly those with uneven lighting, is Contrast Limited Adaptive Histogram Equalisation (CLAHE). When using CLAHE, an image is divided into small blocks, the histogram of each block is calculated, and the pixel intensities inside each block are then distributed according to the histogram. This technique effectively boosts contrast while preventing over- and underexposure in light and dark areas of an image. Offering a trustworthy processing method is crucial to obtaining outcomes of a satisfactory calibre. This can be done by creating specialised hardware or software, with the latter being preferred in most circumstances. Typically, a variety of image enhancement and restoration techniques are used in these systems. Edge sharpening, picture deblurring, image denoising, lighting improvement, contrast, or color enhancement, and many more processes may be included in these techniques. The pictures shown in figure 1 were captured in dusty weather and the enhancement of the pictures is done using CLAHE for the better visibility of the images.

A cascade of classifiers and Haar like features are used by the Viola-Jones algorithm, a quick and reliable face identification method, to find faces. It operates by separating a picture into a series of tiny rectangular sections and analyszing each one separately using a set of pre-determined Haar like properties. Following that, the features are utilised to train a series of classifiers that gradually exclude non-face regions, producing high accuracy and quick performance. In this situation, we suggest combining the CLAHE and Viola-Jones algorithms to improve image quality while accurately identifying faces. Many other applications, including as surveillance, medical imaging, and digital photography, can use this technology. The proposed method will be thoroughly explained and its efficacy will be shown through experimental data in the parts that follow.

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II. RELATED WORK

A Hybrid Approach to Image Enhancement using Contrast Stretching on Image Sharpening and the analysis of various cases arising using Histogram was proposed by Negi et al. (2014) [1], two frequently used image enhancement methods, contrast stretching and image sharpening, can be combined to provide a hybrid strategy for enhancing an image's visual quality. Contrary to CLAHE, this strategy has some drawbacks. This method's main drawback is that it ignores the regional changes in image content, which might result in the over- or under-enhancement of particular regions. An adaptive gamma correction for image enhancement [2] proposed by Shanto Rahman et al. (2016), which includes applying a non-linear transformation to an image to change its brightness and contrast. Contrary to CLAHE, this strategy has some drawbacks. Adaptive gamma correction's reliance on image content and lighting circumstances is one of its key drawbacks. It is difficult to automate the process and leads to inconsistent picture enhancement across multiple photographs because the gamma correction parameter must be manually adjusted for each image. CLAHE, on the other hand, is a self-adaptive method that adapts to the local image content, avoiding the need for human parameter adjustment and assuring uniform image enhancement across various images. Acoustic image enhancement using Gaussian and laplacian pyramid a multiresolution based technique [3], proposed by Ravisankar et al. (2017). The decomposition of a picture into many scales and the application of image enhancement methods at each scale constitute the multiresolution-based strategy for acoustic image enhancement employing Gaussian and Laplacian pyramid. Contrary to CLAHE, this strategy has some drawbacks. The significant computational complexity of this strategy is one of its key drawbacks. It can be computationally demanding, needing a large amount of processing time and computer resources, to decompose the image into several scales and then enhance the image at each size. Li et al [4] proposed a real-time face detection method that uses a convolutional neural network to detect faces in images and videos. Convolutional neural networks (CNNs) are trained in order to identify faces in an image. Even though this method has produced impressive face detection results, it also has several drawbacks in comparison to the Viola-Jones algorithm. The convolutional cascade neural network's high computational cost is one of its key drawbacks. It takes a lot of data and computer power to train a deep CNN model, which can be time-consuming and expensive.

The Viola-Jones algorithm, on the other hand, is a quick and effective method that only needs a little amount of computing power to detect faces in real-time. Its propensity for overfitting is another drawback of the convolutional cascade neural network. "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks" [5] by Ren et al. (2016), creates potential object regions using a Region Proposal Network (RPN), and then classifies and fine-tunes the discovered items using a Fast R-CNN network. Although this method has demonstrated cutting-edge object detection performance, it also has certain drawbacks in comparison to the Viola-Jones algorithm.Its significant computational complexity is one of Faster R-CNN's primary drawbacks. Multiple deep CNN models must be trained for the RPN and Fast R-CNN network, which uses a lot of data and computer power. “Face movement detection using template matching” [6] proposed by Ahmad Zarkasi et al. (2018), despite being a straightforward and understandable approach, it differs from the Viola-Jones algorithm for face detection in a number of ways. Changes in position, scale, and lighting conditions all affect how a face looks, and template matching is sensitive to these differences. This makes it less reliable than the Viola-Jones algorithm, which is made to account for these variances and can result in false positives and false negatives.“An approach to face detection and alignment using hough transformation with convolution neural network” [7] proposed by Oshin Misra et al. (2016), is a method for finding faces by converting the input image into a parameter space where a face is represented by a circular or elliptical shape. Although this approach can be integrated with convolutional neural networks (CNNs) for increased accuracy, it differs from the Viola-Jones technique for face detection in a number of ways. The following are some drawbacks of utilising CNN and Hough transformation for face alignment and detection.The Hough Transform can be computationally expensive because it uses a lot of processing to look for faces in the parameter space, especially when paired with CNNs. Because of this, it is less suited for real-time applications where efficiency is crucial. “Face detection using skin tone segmentation” [8] proposed by Sayantan Thakur et al. (2011), light levels play a significant role in segmenting skin tones, and even little changes in illumination can result in inaccurate segmentation. For instance, skin tone segmentation may not function properly if the lighting is too bright or too dim, resulting in false positives or false negatives. Given that the algorithm is frequently trained on a small sample of skin tones, skin tone segmentation can be biassed in favour of a certain ethnicity.

III. METHODOLOGY

The proposed methodology can be implemented in three steps as shown in Figure 2. The first step is to take the input image that needs to be processed. The second step is to apply the contrast limited adaptive histogram equalisation (CLAHE) image enhancement algorithm to the input image. This involves in applying filtering, assigning frequency counts and probability function with zero, calculating PDF and CDF for each frequency occurrence and equalization mapping. The output of this step is an enhanced image with improved brightness, contrast, and color fidelity. The third step is to perform face detection on the enhanced image using the Viola-Jones algorithm. This involves applying a set of pre-defined Haar-like features to detect faces in the image frames.In this final step detected faces are highlighted by drawing bounding boxes around the detected faces in the image frame.

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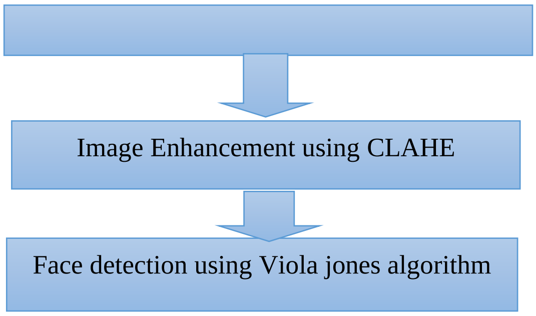

Figure 1: Flow chart Face detection in hazy condition

The Contrast Limited Adaptive Histogram Equalization (CLAHE) algorithm is an image processing technique that enhances the contrast of an image. It is a modified version of the standard histogram equalization method that amplifies the contrast in certain regions of the image, which can cause over-amplification. Here's a detailed description of the CL-AHE algorithm and the various steps involved.

At first applying filtering to the input image to reduce noise and enhance the quality of the image.The image is then divided into small, non-overlapping regions or blocks of equal size, usually around 64x64 pixels. This is necessary to process each region separately. For each block, a frequency count of pixel intensity values is assigned and initialized to zero. Using these frequency counts, the probability density function (PDF) and cumulative distribution function (CDF) of pixel intensities in each block are calculated. The PDF represents the probability distribution of pixel intensities in each block, while the CDF represents the probability that a pixel in the block has an intensity value less than or equal to a given intensity value.Next, the pixel values of each block are mapped to a new range using the CDF. Each pixel in the block is mapped to a new intensity value based on the CDF of its original intensity value, which is done using histogram equalization to improve contrast. The contrast of each block is then limited by clipping the new range of pixel values at a predefined threshold called the contrast limit. This step is crucial to prevent over-enhancement of contrast in regions with large intensity variations. The processed blocks are then reassembled into the final output enhanced image.

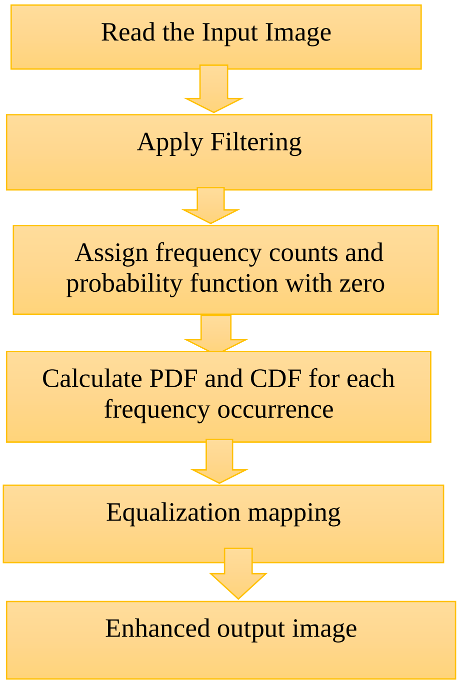

Figure 2: Flow chart of CLAHE

I. *Algorithm for CLAHE*

Step 1: Read the input image.

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Step 2: Apply mean and medianfilter.

$$f(a,b) = (1/mn)\sum_{(s,t)\in Sab} g(s,t)$$

$$f(a,b) = median_{(s,t)\in Sab}\{g(s,t)\}$$

Step 3:Find the frequency counts for each pixel value.
Step 4:Determine the probability of each occurrence using probability function.
Step 5:Calculate cumulative distribution probability for each pixel value.
Step 6: Perform equalization mapping for all pixels.
pval = img(i,j)+1
ieqv(i,j) = ieqvhist(pval)-1
Step 7: Display the enhanced image

II. Viola Jones For Face Detection

The oldest object detection framework is the Viola-Jones framework.A human can easily recognise any face in a photograph or image, but a computer or robot will always require input and pressure. Faces cannot move sideways, thus for this purpose, Viola-Jones requires a strong front view against the camera.

Haar features are straightforward rectangular features that are the sum of pixels from different places inside the rectangle. This rectangle has the ability to scale the image and may be placed anywhere in the frame. 2-rectangle feature is the name of this modified feature set. Each feature type can reveal the presence or absence of specific details in the frame, like edges or texture changes.

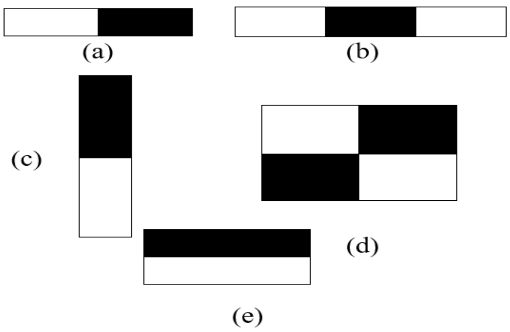

Figure 3:Haar Features

To determine the face features, these haar features are used. For instance, in Figure 4(b), the black coloured portion indicates the presence of a nose, which is situated in the middle of the face. This part is utilised to detect this characteristic.When the white part is designated as -1 and the black part as +1. By deducting the total of pixels under the white rectangle from the total of pixels under the black rectangle, the outcome is determined. For specific features, a threshold is initially set.

Calculated is the average total of each black and white. Next, a threshold check is done on the difference. The value is detected as a relevant feature if it exceeds or equals the threshold

To To add all the pixels in a specific box to its left and upper ones, utilise the integral image component. It is necessary to determine the area's four corner values. This prevents the region's pixels from being added together. The sole purpose of this integral image conversion procedure is to accelerate the calculation of pixels.

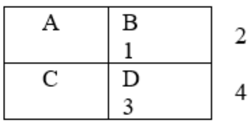

Figure 4: Integral image caluculation

The formula for calculating the total number of pixels in component D of the above Figure is (1+4)-(2+3), or [A+(A+B+C+D)] - [(A+B+A+C)], which results in D.

It is a method for identifying important and unimportant traits. To create a strong classifier, it combines the weights from the weak classifiers. In terms of weighted error, it determines the single rectangular feature and threshold that works the best to distinguish between faces and non-faces in training samples. Each facial image is provided to the system with the same start weights as the others, with yn=1 for facial and yn=0 for non-facial photos. The classifier's weights in the photos have

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now been adjusted. All of the photos are used to train a classifier using a single feature, and the error is calculated. If a face feature is found, the mistake is 0, otherwise it is 1. The weights are updated and the lesser mistakes are picked. In the strong feature, a feature with little inaccuracy is therefore given more weight. Last but not least, a strong classifier exists when some of the weighted features are greater than 50% of the total weights.Non-faces are eliminated in order to shorten the computation time.

This phase is added to the procedure to expedite it and produce accurate results. This process is broken down into multiple steps, each of which contains a powerful classifier. Each feature is divided into several levels. By moving a window over a frame, it can identify faces in the picture. After performing the Adaboost training , the fast way to check if the window contains a facial feature is to cascade the classifiers. The first classifier is the highest weight found than compared to the earlier ones. If the first feature is approved then it moves on for the second classifier until all of the features are approved, then a face is detected.

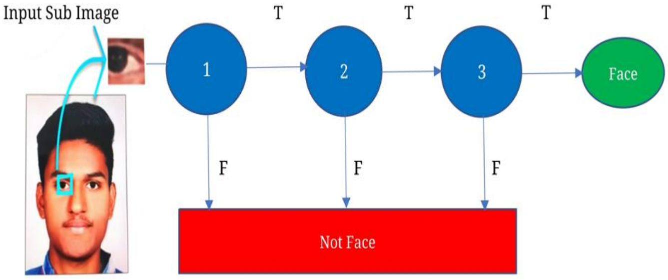

Figure 5: Cascading Process

IV. RESULT AND DISCUSSIONS

The figure below displays a image that was enhanced by cl-ahe and detected using the Viola Jones algorithm

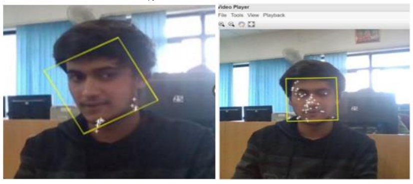

Figure 6: Frame showing single face detection

The improved image, followed by face detection, is displayed below, along with the associated CL-AHE graphs.

Figure 7: Input image

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Figure 8: Processed image

After the image is enhanced it is improved in terms of its colour contrast , quality and brightness and the image is termed as Processed image.

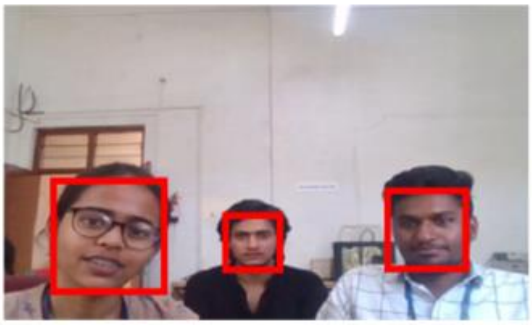

Figure 9: Output image with multiple faces detected

After the completion of above two steps that is , taking the original image and its enhancement and after that the face detection of the living beings present in the image is done using the violas jones algorithm.

Figure 10: image and Processed image

The above figure shows two pictures , one is the original image which is taken in unfavourable weather conditions and the other one is the image which is enhanced using the CL-AHE technique and it is termed as Processed image.

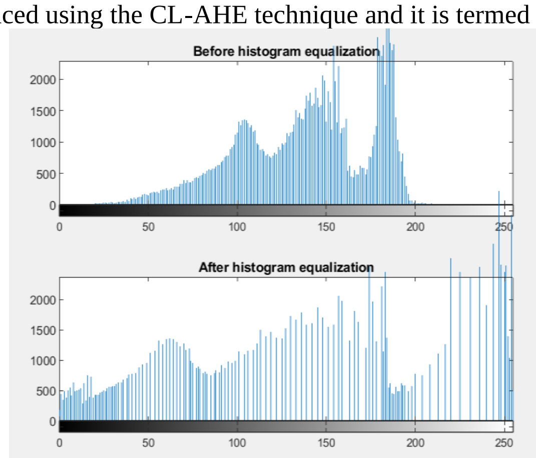

Figure 11: Before and After histogram graphs of an image

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The above figure shows the histogram representation of the original image and as well as the processed image, as the original image is not so clear it is not distributed equally, whereas after the image is processed it has been distributed equally and we obtained a flat profile of the image indicating the quality of the image has been improved.

V.CONCLUSIONS AND FUTURE SCOPE

The objective of this project is to identify and pinpoint human faces in low-contrast images by boosting the contrast, and by doing so, to identify and pinpoint the faces in the image using the viola jones method. Even though it is now simply used to locate human faces in images, this research has the potential to be further developed into a facial recognition system, which has enormous potential in India.

This system can be utilised efficiently in government and private organisations, ATMs, identifying duplicate voters, passport and visa verification, driving licence verification, defence tests, competitive exams, and other situations.

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