Human Frontal Face Construction Using Geometrical Shape Analysis

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Abstract: Intelligence systems are becoming increasingly interested in recent years. For the purpose of defense systems, numerous intelligence systems have been implemented. Biometric and video monitoring systems are two of the best intelligence systems used for security purposes. When a crime scene happens, these intelligence systems are present to detect suspicious persons. Since this study is about human faces, biometric devices can be used to identify them. Different features such as eyes, noses, and lips can be compared to the original images, and suspicious individuals can be easily identified. The second is a video surveillance device, in which multiple photographs are captured at the time of a crime, but there are two big concerns that arise when the images are taken. One is image quality, which is due to brightness, and the other is the absence of a full frontal human face. This thesis focuses on improving the human frontal face and creating a complete human face from the half of the face that is accessible using geometrical measurements. Geometrical measurements of various extracted facial features are taken using various methods. Face is effectively generated using those measurements. Finally, the original image and the created image are distinguished.

Keywords: *Image Enhancement, Landmarking, Intelligence System, Feature Extraction, Geometrical Measurement*

1. Introduction

The field of image processing has expanded at an unprecedented pace over the last decade. To process terabytes of data, newer computers are smarter and faster. Object detection has received a lot of press in this area because of its utility in industries like manufacturing and packaging. Barcodes are widely used to classify items in supermarkets, for example. Tools used in the manufacturing unit must be able to locate the position of items. A bottle filler robot arm, for example, necessitates computer vision, which is used to detect an object's structural properties. Computer vision helps computers to detect objects and process information at a breakneck speed. The camera is the source of machines, just like the eyes are the source of humans [1].

Object detection contains a part of face detection. The main parts of the detections are: Pattern recognition, Image processing, and Computer Vision. These are currently a wide range of research areas. The main purpose of detection is to build an intelligent system that can identify human faces from observable properties such as fingerprints, faces, and irises [3].

Of all these, the face is the strongest look for human users. Various methods have been proposed to detect faces. Recently, some tests have shown that most systems use a frontal facial image as the input pattern. For this front face image, the front face image may not be available. Instead, you have an image of a half face or an image of one side. If you can create a front face from these side view images, you can easily generate it. It is also useful for footage captured from CCTV. You can also create the front of an evil person from CCTV footage [17].

The research is done due to increase in criminal and terrorist activities; Security is a major issue in Pakistan these days. Providing security to citizens, private and public places have become more important. Therefore, for this purpose video surveillance system does this job as accurately as possible by using CCTV's cameras. Images are taken for this purpose of identification from CCTV's cameras. But generally, there are two main problems related to the surveillance video recordings, which are firstly is the low picture quality and other is sometimes unavailability of complete frontal view of a face due to which it becomes very difficult to identify the suspected person from it. Due to these reasons suspected persons cannot be identified. Most of the systems use frontal face for their inputs. However, there are many intelligent based systems described but for the complete face construction from other half part of the face is quite difficult due to different features of the face. Biometric system is also done on the extracted features like fingerprints, eye detection, and frontal face extra.

Lot of research is done on this field of identification but there is very little amount of work done on the side of construction of the face from the other half part of the face. A lot of times good picture quality is not available for construction purpose. So for These problems this Research is done on mainly the enhancement of the images with bad lighting conditions and face construction from half facial views taken from the 2D images. This research is mainly dependent on measurement of frontal features of the half available human face. Construction is done on the basis of

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measurements of the feature. We are not flipping the half face as done in the previous work. This research is for construction from the other half part of the face and getting better results as compared to the previous work.

2. Related Work

Many contributions to the field of face detection and recognition have been made over the years. A multi-resolution rules method is included with G.Yung. This is a knowledge-based approach that uses the structural properties of the face to detect faces. The feature-based approach increases accuracy and detection speed by integrating facial features, skin tone, and multiple facial features, Accuracy is given up. It was agreed to use the template matching process. For this, a stable, uniformly scaled image is used. Predefined face templates and deformable templates were added. Without the use of learning, this was a fully predefined framework. Appearance-based approaches offer quicker and more precise results in all situations, enabling you to differentiate between faces and non-faces. To achieve the desired effects, the neutral network model is widely used.

Many methods have been studied for many years, and much progress has been made in the literature. There have been several methodologies suggested. In this section, we describe the most important work in this field. Many algorithms and techniques have been developed and applied in this field of study.

In 2021 Wang, Y., Dong,X., Li, G., Dong, J., & Yu, H, To create a clean face, it suggests a face texture reconstruction and uses active appearance model instantiation to warp the input face to the projected frontal form. The authors rained this generative model with a manually selected clean face set to eliminate the occlusion. Regardless of whether the input surface involves occlusion, the output would be a clean face [3].

In 2021 Mousavi, S., Charmi, M., & Hassanpoor, H the authors suggested two approaches for identifying a specific spots. 1) Automated processing: On the facial images of identical twins, a tweaked SIFT (M-SIFT) algorithm was used. The eyes, eyebrows, nose, mouth, and facial curves are all divided into five areas in each picture. The most distinguishing facial characteristics of identical twins are the position and number of mismatched main points. 2) Crowdsourcing: Understanding the variations between identical twins' faces in terms of human expectations using cloud intelligence [2].

In 2019Elmahmudi, A., & Ugail, H. the authors looked at how well different parts of the face, such as the eyes, mouth, nose, and cheeks, were remembered. Looking into the results of facial recognition when the face is rotated and when the face picture is zoomed out. The tests included extracting machine learning features using a state-of-the-art convolutional neural network-based architecture and a pre-trained VGG-Face models [1].

In 2018 Jiang, L., Zhang, J., Deng, B., Li, H., & Liu, By Using a coarse-to-fine optimization technique, he created a new method for reconstructing 3D faces from unconstrained 2D images. By aligning the projection of the 3D face landmark with the 2D landmark detected from the input image, the smooth, coarse 3D face was created from an example-based bilinear face model. The rough 3D surface was then refined using photometric integrity constraints and a local modified deformation field to give it a medium surface shape. Finally, restore the fine geometric details by applying the shading method to the intermediate plane [4].

In 2018 Kamenetsky, D., Yiu, S. Y., & Hole, M improved low-resolution RGB footage of the face taken over long distances or in low light conditions using the Atmospheric Eddy Mitigation Algorithm (MPE). MPE is tuned to function properly in - area due to its interactive nature. The authors also suggested three image enhancement techniques to help MPE generate even better images. MPEf and fMPE are for low-light images, and the other is for long-distance images (MPEh) [17].

In 2013 Çeliktutan, O., Ulukaya, S., & Sankur, B. proposed that his research include an overview of marking algorithms, their development over the last decade, classification, and comparison of cutting-edge performance statistics. Owing to the inherent volatility of the face and various conflicting variables such as poses, facial expressions, lighting, and obstruction, computer vision issues have proven to be extremely difficult [16].

2.1 Face recognition based on facial features

This approach uses the image of the face you want to remember to measure a set of geometric features like nose width and length, mouth position, and chin shape. This set of characteristics is then compared to known personal characteristics. To find the closest match, use the required metric, such as Euclidean distance (find the closest vector). Geometric features were used in most of the early work on face recognition (Kanade, 1973), but Craw et al. (1987) did a more recent study in this field.

2.2 Segmentation of an image

Heuristic segmentation or compartmentalization of the face that includes the target region of interest is a common trend. A grid structure, for example, divides a face into two or more horizontal and vertical stripes. This assists in identifying the search field. For example, in the north-east and north-west corners, eyes are searched, while in the southern field, mouths are searched.

A projection histogram is a common method for segmenting a face. Since the eye and mouth areas are relatively dark, the histogram, and the corresponding bands are used to start the eye and mouth quest. The bulk of recent studies. The training picture, on the other hand, is used to learn the target landmark's previous location within the detected face bounding box.

2.3 Viola-jones algorithm:

In the pre-Viola Jones era, color information was primarily used for face and mouth detection. He proposed a facial

segmentation approach based on skin labelling and a nonlinear YCbCr color model's linked component analysis. Non-skin colored masses are considered candidates for the eyes or mouth in the face region.

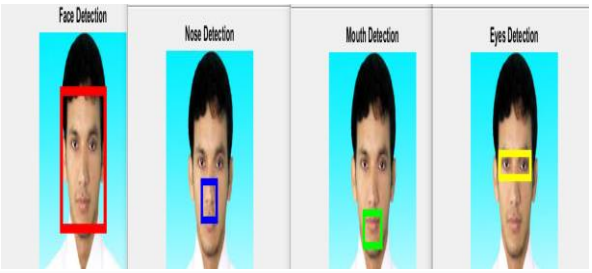

Figure.1. (a) Complete face detection (b) Nose detection (c) Mouth detection (d) Eyes detection

2.4 Land marking

Accurate facial landmark and feature detection has an effect on face-focused tasks like coding, face recognition, facial expression and gesture comprehension, face detection, animation, and face tracking. This is a vital strategy. A popular characteristic that can be used to differentiate between individuals or as an anchor point for a face graph is known as a facial landmark. Frequently used landmarks include the corners of the eyes, the tips of the nostrils, the corners of the nostrils, the corners of the mouth, the end of the eyebrow arc, the earlobe, and the jaw. The word "facial aspect" should be used to refer to the face's entire semantic field. The nose, jaw, chin, cheeks, and brows, as well as the entire area of one or more eyes. Since landmarks such as the corners of the eyes and the tips of the nose are largely unaffected by facial expressions, they are highly precise and are known as reference points.

3. Methodology

Proposed methodology of this research paper is:

1. Collection of the datasets of half-face images.
2. Loading the images in MATLAB TOOL. Resize the images because we maintain the size of all images.
3. Applying Median Filter to remove the noise from them because it is a nonlinear filter smoothing technique.
4. Applying land marking method.
5. Taking measurement of complete eye.
6. Measuring angular distance from eye to nose.
7. Taking measurements of lips.
8. Distance between nose and lips.
9. Finally, create a full human face through geometrical measures.
10. Comparison between original image and constructed image.

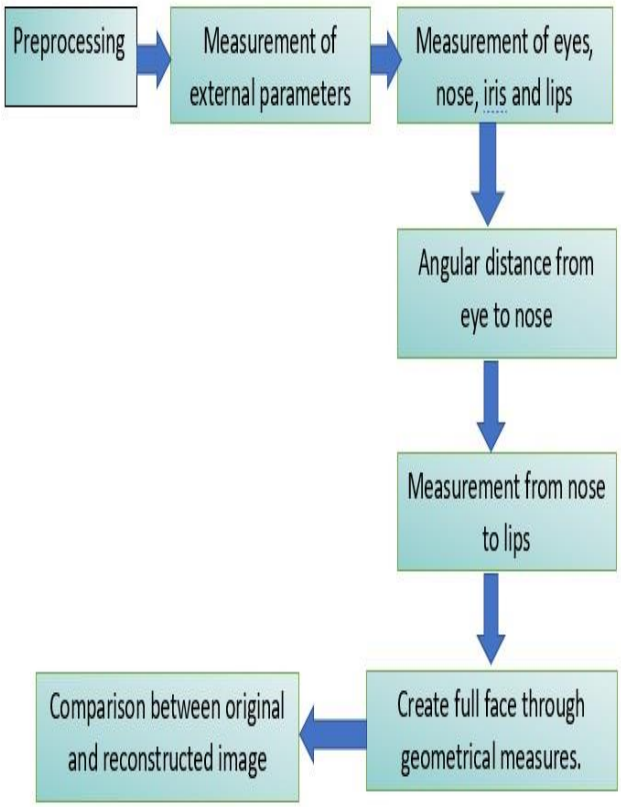

Figure.2. Flow chart of proposed methodology

3.1 Image Processing

Image processing is a process in which we change the image into digital form so we can enhance the image to extract the features of the face to construct the full face image from the half frontal face part of the image.

3.2 Preprocessing

Preprocessing contains different steps to preprocess the image. First of all, we took a data set of full-frontal face images. Then we apply some algorithm to split the image into two parts. Through pre-processing images are set into standard size.

Figure.3. (a) original Image (b) available right side of face

3.3 Image Enhancement

A technique for enhancing the efficiency of a weak or unusable image is image enhancement. The enhanced picture could be used by humans or computers for further processing. Picture enhancement enhances the dominance feature of an image.

It is also used to dispel any remaining concerns about different aspects of digital image processing. Image enhancement techniques are categorized into two types: spatial domain and frequency domain. The spatial domain method is used to directly manipulate an image. The Fourier transform is used in the frequency domain method for image enhancement.

To enhance the image, the image is enhanced using the MATLAB GUI. To determine the bad lighting, various operations such as image cropping, image resize, image sharpening, image brightness, image contrast, image darkening, image flipping, image rotation, and image histogram are performed on the image.

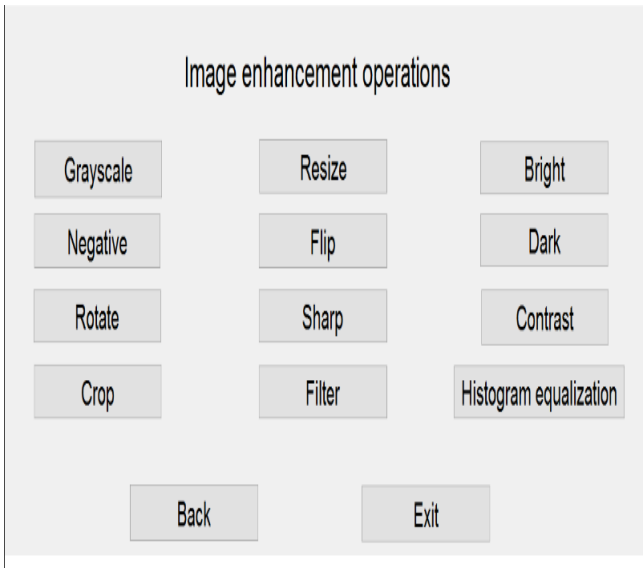

Figure.5. Image enhancement operations

3.4 Convert gray scale into RGB images

All images are converted to grey scale in the pre-processing step. The grey scale images are then converted to binary images in this stage. Also, these images should be free of noise.

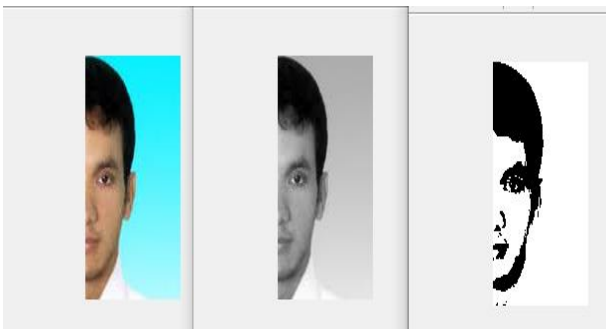

Figure.4 (a) original image (b) RGB to grayscale image (c) grayscale image to binary image

4. Results and Discussion

The Matlab tool was used to successfully conduct the analysis. Google images were used to construct the data collection. The aim of this study is to create a complete human face from half of the available face. As predicted, the results are very reliable. First and foremost, image enhancement is achieved by image preprocessing. The features of a half-human face are identified using land markings. Then geometrical measurements of facial features such as the eye, nose, and lips, as well as angular measurements from the eye to the nose and from the nose to the lips, are taken, and a half-human face is created using these measurements. Following the creation of the half image, the full face is generated using the half constructed image. The original and constructed images are compared too.

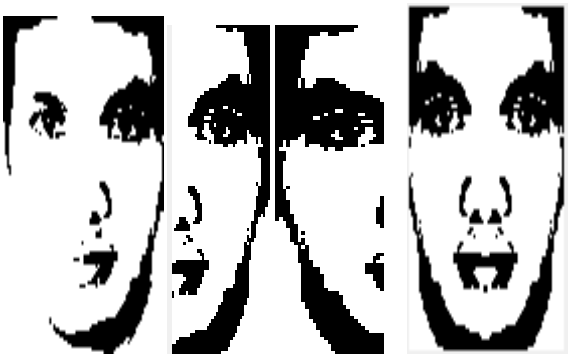

Figure.5 (a,,b) original image (c) constructed half face image (d) constructed full face image

Figure.6.(a) Original Image (b Constructed Image

According to the above findings, there is a very small difference between the initial and built images.

5. Conclusion

Image processing, pattern recognition, and computer vision are all wide topics in science right now. These are the most critical aspects of detection. The main aim of identification is to construct intelligent systems that can instantly recognize a human face based on measurable characteristics such as fingerprints, face, iris, and so on.

Faces are the most powerful look for a human consumer out of all of these. Using the Matlab software tool, we propose a method to detect and create a full face from a half face picture in this review. For image enhancement, we use an image processing median filter on dataset images that aren't readily accessible. And we use the accessible half of the human face to produce a complete human face with the highest degree of resemblance.

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