Review of Face Detection Techniques

Tarun Rajpurohit[1], Aarya Raj[2], Balraj Singh[3]

1, 2, 3 School of Computer Science and Engineering, Lovely Professional University, Phagwara, Punjab, India

---***---

Abstract -*Face Detection, which is an effortless task for humans, is complex to perform in machines. In recent times, the speed of which we are having the resources of computational is in the way of the advancement of face detection technology. There are many fully developed algorithms made to detect the faces. There is a immense increase in the video and image database by which there is an incredible need of automatic understanding and examination of information by the smart systems. Face plays a major role in social intercourse for conveying identity and feelings of a person. The techniques of face detection system play a major role in face recognition, facial expression recognition, human-computer interaction, head-pose estimation etc. Face detection is a computer technology which determines the size of a human face and the location of a human Face in a digital image. There are many topics in the computer vision literature but Face detection has been standout amongst all the topics.[1] This paper is a review of various techniques explored for the Face detection in digital images. Different challenges and the applications of the face detection are also mentioned and presented in this paper. At the end, there are many different standard databases for face detection which are also mentioned with their respective features and conclude this pape*r with several promising directions for future research.

Key Words: **Face detection , Feature Analysis, Eigen Faces, SVM, PCA.**

1.INTRODUCTION

Face detection is an issue of computer vision which involves finding the faces in images. It is also the main and the starting step for many face-related technologies. For instance, there are many technologies like face verification , face modeling, gender and age recognition, head pose tracking, facial expression recognition and many more. [1]

Face detection is a trifling task for humans, which can perform naturally with almost no hard work or effort. However, the task is not simple and its very complex and complicated to perform via machines and requires many computationally complex steps to be undertaken. In recent times, the development in computational technology has ameliorated the research in the area of the Face detection. As of now , there are many algorithms and methods for detecting faces have been proposed . Even so, there is a little attention given in making of a robust and the updated survey of these face detection methods.[1] There are many research projects and commercial products have demonstrated the capability of a computer which can interact with the humans in a very simple and natural way by looking cameras, listening to people through the microphones, understanding these inputs and then reacting to the users or the people in a very friendly manner. There are many techniques but one of the fundamental techniques which enables such natural Human-Computer Interaction (HCI) is Face Detection. Face detection is the first step and initial step also called as the stepping stone to all facial analysis algorithms, including the face alignment, face relighting, face modelling, face recognition, face verification/authentication, head pose tracking, facial expression tracking/recognition, gender/age recognition and many more.[2]
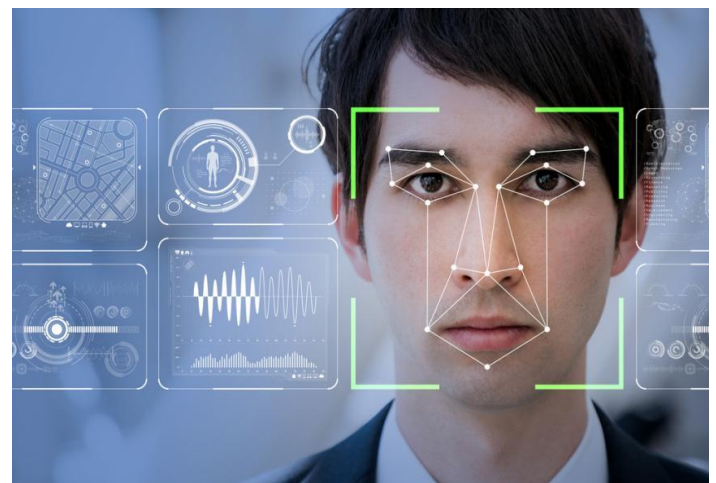

Fig -1: Face Detection

2. THE CHALLENGES IN THE FACE DETECTION TECHNIQUES

There are many challenges in face detection, the reasons behind it is the requirement for accuracy, and the detection rate of the face detection. The challenges are not simple. Some of them are too many faces in images, odd expression, less resolution, face occlusion, illumination, skin color , distance and orientation etc.[2]

- Face occlusion :- Face occlusion is hiding face by any object by which face recognition is not done. It may be any thing like scarf, hairs, hand, glasses etc. It also reduces the face detection rate.

- Illumination :- When there is a lightining effect in the face by which the face cannot be detected properly.

- Odd expressions :- Human face with some odd expressions unlike natural or simple, which have become a challenge for face detection.

- Too many faces in the image :- This means that the image or face which contains too many human faces, which is challenge for the face detection.

- Complex Background :- this mean that a image having many objects in their background that will reduces the accuracy and the rate of face detection.

- Less resolution :- The Resolution of image may be very low or poor means the quality is not good, which is also challenging for face detection.

- Skin color :- The Skin-color differs as the geographical location differs. Skin color of an Indian is different from the an African and the skin color of an African is different from the an American and so on. So , the changing in the skin-color is also challenging for face detection.

- Orientation :- when the face or an image pose is not orientated properly then It reduces the accuracy and detection rate of face detection.

- Distance :- If their is too much distance between the camera and the face which leads to reduce accuracy and the detection in rate of the face detection.

Fig -2: Challenges of Face Detection Techniques

3. NEED OF FACE DETECTION TECHNIQUES

- Human Computer Interaction System :- It is a property , design and the use of the computer technology , which focusing particularly on the interfaces between users and computers.

- Biometric Attendance :- This is the system of taking the attendance of people by their Face or Finger prints etc.

- Gender classification :- The information of the gender can be found from the human being image.

- Document control and access control :- Control can be imposed to document access with face identification system.

- Face Recognition :- A facial recognition system is a procedure by which we can identify or verify a person from a digital image or a video frame.[3] There are many ways to do it one of the ways to do this is by comparing selected facial features from the image and a facial database. It is mainly used for security systems.

- Photography :- There are now some digital cameras which use face detection for autofocus. Face detection is also useful for selecting regions of internet in photo slideshows.[4]

4. FACE DETECTION TECHNIQUES

Face detection is a computer technology which determines the location and the size of a human face in the digital image. In this technology , the facial features are detected and any other objects like trees, buildings and other bodies are not considered from the digital image.[5] It can be also known as a specific case of object-class detection, in which the task is to find the loaction and sizes of all objects in an image that belongs to a given class. Therefore, there are two types of approaches to detect the facial part in the given digital image [6]

A. Feature Based Approach

- Skin color base :- Is a feature which is use for tracking a face having several advantages. Color is an important feature of human faces. The processing of color is much faster than other facial features. Under certain lighting conditions, color is orientation invariant.[7] Tracking the human face while using a color as a main feature has several problems like the color representation of a face obtained by a camera is influenced by many factors like, the ambient light, object movement , etc.

- RGB Color Model :- RGB colors are the terms knownand given for the three primary colors which are Red (R), Green (G), and Blue (B).[1] In RGB color space, there is a normalized color histogram is used to detect the pixels of skin color of an image and can be further normalized for changes in intensity on dividing by luminance. [8]This model localizes and detect the face. So, it is a basically the basic color model and all other model are derived from it. The RGB color model is also light sensitive. There are many other models such as Y CbCr or HSI models by which RGB model have major drawback that it cannot separate clearly the mere color (Chroma) and the intensity of a pixel, that's the reason

sometimes it is difficult to distinguish skin colored regions. Due to this factors it is less favorable and it is widely used for color space for processing and storing digital images and not used widely in skin detection algorithms.
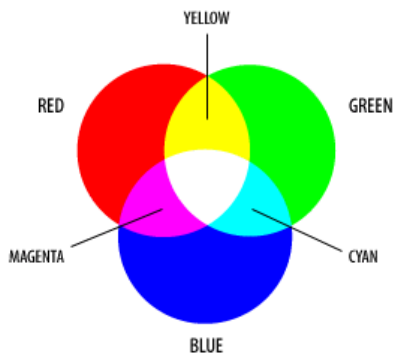

Fig -3: RGB Color Model

- HSV color model :- In this model the color are specified in terms of Hue (H), Saturation (S) and Intensity value (V) which are the three attributes. In this, Hue refers to the color of red, green, blue and yellow having the range of 0 -360. Saturation means the purity of the color and takes the value of 0 - 100% whereas Value refers to the brightness of color and provides the achromatic idea of the color.[9] The Skin color pixel should satisfy the following conditions:

$$0 < H < 0.25$$

$$0.15 < S < 0.9$$

- YCbCr color model :- In this model the terms are specified in terms of Luminance (Y channel) and Chrominance (Cb and Cr channels). It segments the image into a luminous component and chrominance.[10] In YCbCr color model , the distribution of the skin areas is consistent across different races in the Cb and Cr color spaces. Range of Y lies in between 16 and 235 and range of Cb and Cr lies in between 16 and 240.

- Feature Analysis :- These algorithms aim to find structural features that exit even when the pose, viewpoint, or lighting conditions varies, and then use these to locate faces. These methods are mainly designed for face localization.

- Feature Searching :- This is an approach proposed by the Viola and Jones for object detection minimizes computation time while the approach is going to achieve its high detection accuracy .[11] This method proposed by the Viola and Jones is fast and robust for the face detection which is almost 15 times quicker than existing techniques at the time of release with holding the 95% accuracy. To support this approach

Viola and Jones have stated their three key supports. There are three key supports are as follows :-

1. The first one is that the there is introduction of a new image illustration called the integral image which allows the different features used by our detector to be composed very quickly.[11]

2. The second ia an easy and efficient classifier which is uded in a algorithm to select a small number of critical visual features from a very large set of potential features.

3. The third contribution is a process for combining classifiers in the terms of a cascade which allows background regions of the image to be quickly discarded.
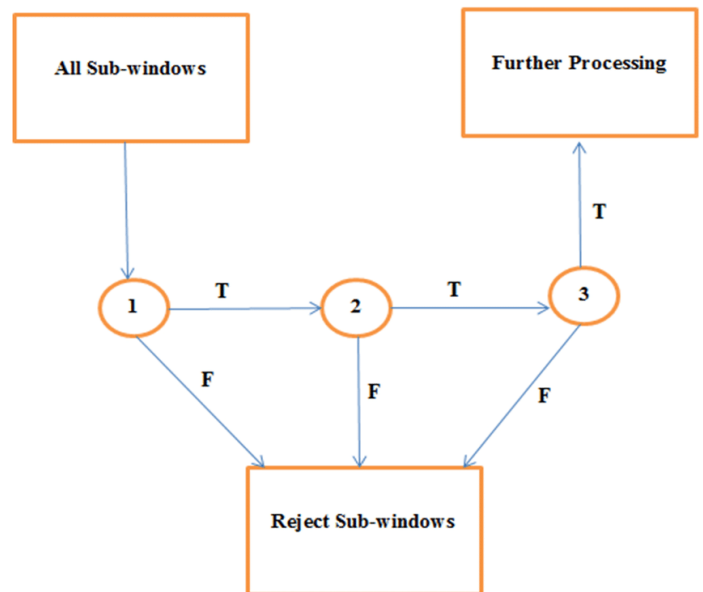

Fig -4: Working of Viola-Jones methodology

Advantages of Feature Searching :-

- Feature Searching is the most admired algorithm for face detection in real time.

- The main advantage of Viola and Jones approach is its uncompetitive detection speed while relatively high detection accuracy, comparable to much slower algorithms.

- Viola and Jones technique for Face detection is successful method as it has a very low false positive rate.

Limitations of Feature Searching :-

- Limited head poses.
- Do not detect black faces.
- Extremely long training time.

B. Image Based Approach

- Neural Network :- This is a network which rationally attached neural network that examines small windows of an image, and chooses whether each window contains a Face.[12]The system arbitrates between several networks to enhance performance over a single network. By which doing this it elimnates the most complex and hard task of manually selecting non-face training examples, which must be selected to cover the entire space of non-face images. In early days this network was the most hierarchical neural network was proposed. An earliest neural network for face detection is developed, which consist of four layers with 1024 inputs units, 256 units in the first hidden layer, eight units in the second hidden layer, and two output units. There are several neural networks present out of which some of the most widely used and known are :[13]

Probabilistic Decision-Based Neural Network (PDBNN)

- Aritical Neural Network (ANN)

- Regions with convolutional neural network (R-CNN)

- Eigen Faces Method :- Eigenvectors has been used in face recognition, in which a simple neural network is demonstrated to perform face recognition for aligned and normalized face images.[14] Images of faces can be linearly encoded in this method with the help of a modest number of basis images. The set of the optimal basis vectors is called as Eigen pictures since these are simply the eigenvectors of the covariance matrix which is computed from the vectorized face images in the training set.[15]

- Support Vector Machine (SVM) :- SVMs are also been used for face detection. SVMs works like a new paradigm to train polynomial function, neural networks, or also the radical basis function (RBF) classifiers.[16] SVMs work on the Induction principle, called structural risk minimization, which have an target to minimize an upper bond on the error. It runs approximately 30 times faster than the system. SVMs are also been used to detect faces.

- Principal Component Analysis (PCA) :- PCA is a technique which is based on the concept of Eigen Faces. PCA on a training set of Face images is performed to generate the Eigen Faces in face space.[17] To detect the presence of a face in scene, the distance between an image region and the face space is computed for all locations in the image. The final result of calculating the distance from face space is a called as the face map.

5. CONCLUSION

In the recent time, face detection has achieved considerable attention from every parts in the society like from researchers in bio-metrics, pattern recognition, and the computer vision groups. In this area, there are countless security, and forensic applications requiring the use of face recognition technologies. Now-a-days, as you can see that the face detection system is very important in our day to day life. There are many technologies and among the entire sorts of biometric, face detection and recognition system is the most accurate in terms of the accuarcy. In this paper, we have presented a review of face detection techniques. It is very much interesting and exciting to see face detection techniques be increasingly used in real-world applications and products. Application of the face detection and the challenges of face detection which are faced are also been discussed which motivated us to do the research in face detection. In future, it is most straightforward direction is to further improvement in face detection in presence of some problems like face occlusion and non-uniform illumination. It has a very bright and great future ahead in upcoming times. Currently, many companies providing facial biometric in smart phones or mobile phones for purpose of access. In future it will be used for payments, security , healthcare , advertising , criminal identifications etc

6. REFERENCES

[1] Kumar, Ashu, Amandeep Kaur, and Munish Kumar. "Face detection techniques: a review." Artificial Intelligence Review 52.2 (2019): 927-948.

[2] Hasan, Md Khaled, et al. "Human face detection techniques: A comprehensive review and future research directions." Electronics 10.19 (2021): 2354.

[3] Ismail, Nurulhuda, and Mas Idayu Md Sabri. "Review of existing algorithms for face detection and recognition." 8th WSEAS International Conference on Computational Intelligence, Man-Machine Systems and Cybernetics. 2009. footnotes in the abstract or reference list. Use letters for table footnotes.

[4] R. Sharma, V. K. Sharma and A. Singh, "A Review Paper on Facial Recognition Techniques," 2021 Fifth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2021, pp. 617-621, doi: 10.1109/I-SMAC52330.2021.9640896.

[5] Zhang, Cha, and Zhengyou Zhang. "A survey of recent advances in face detection." (2010).

[6] Zhenguo Yuan, "Face Detection and Recognition Based on Visual Attention Mechanism Guidance Model in Unrestricted Posture", Scientific Programming, vol. 2020, Article ID 8861987, 10 pages, 2020.

[7]   Crowley JL, Coutaz J (1997) Vision forman machine interaction. Robot Auton Syst 19(3):347-358

[8]   Subban R, Mishra R (2012) Rule-based face detection in color images using normalized rgh color space-a comparative study. In:Proceeding of international conference on computational intelligence and computing research, pp 1-5

[9]   Hashem HF (2009) Adaptive technique for human face detection using HSV color space and neural networks.In: Proceedings of 26th national radio science conference, pp 1-7

[10] Zhu X, Ren D, Jing Z, Yan L, Lei S (2012a) Comparative research of the common face detection methods. In:Proceeding of 2nd international conference on computer science and network technology, pp 1528-1533

[11] Zhang H, Xie Y, Xu C (2011) A classifier training method for face detection based on AdaBoost. In: Proceeding of international conference on transportation, mechanical, and electrical engineering, pp 731-734

[12] Agui T, Kokubo Y, Nagashashi H, Nagao T (1992) Extraction of face recognition from monochromatic pho tographs using neural networks. In: Proceeding of 2nd international conference on automation, robotics, and computer vision, vol 1, pp 1881-1885

[13] Propp M, Samal A (1992) Artificial neural network architectures for human face detection. In: Proceeding of artificial neural networks in engineering, vol 2, pp 535-540

[14] Kirby M, Sirovich L (1990) Application of the Karhunen-Loeve procedure for the characterization of human faces. IEEE Trans Pattern Anal Mach Intell 12(1):103-108

[15] Hotelling H (1933) Analysis of a complex of statistical variables into principal components. J Educ Psychol 24(6):417-441

[16] Mingxing J, Junqiang D, Tao C, Ning Y, Yi J, Zhen Z (2013) An improved detection algorithm of face with combining AdaBoost and SVM. In: Proceeding of 25th Chinese control and decision conference, pp2459-24633

[17] Turk M, Pentland A (1991) Eigen faces for recognition. J Cogn Neurosci 3(1):71-86