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REAL-TIME FACE RECOGNITION BASED ON OPTICAL FLOW AND HISTOGRAM EQUALIZATION

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Abstract
Face recognition is one of the intensive areas of research in computer vision and pattern recognition but many of which are focused on recognition of faces under varying facial expressions and pose variation. A constrained optical flow algorithm discussed in this paper, recognizes facial images involving various expressions based on motion vector computation.

In this paper, an optical flow computation algorithm which computes the frames of varying facial gestures, and integrating with synthesized image in a probabilistic environment has been proposed. Also Histogram Equalization technique has been used to overcome the effect of illuminations while capturing the input data using camera devices. It also enhances the contrast of the image for better processing. The experimental results confirm that the proposed face recognition system is more robust and recognizes the facial images under varying expressions and pose variations more accurately.

Keywords:
Optical Flow Algorithm, Skin Color Segmentation, Histogram Equalization, Feature Extraction, Pattern Matching

1. INTRODUCTION

Face Recognition has been an active area of research in computer vision. Face recognition research is experiencing a major development due to its potential to integrate in multiple applications, such as security and military systems. Face recognition applications are used for access control to high level security. Although it has been in research for several years, face recognition becomes very difficult under varying facial expression and poses variations. Many researchers have been working on these areas to improve the accuracy of the face recognition system. Currently there are many algorithms are available for extracting the facial features, which gives only an average performance under the varying facial expressions and poses variations.

Also the environmental lighting conditions also affect the recognition process. To enhance the accuracy rate, more algorithms have been proposed. Each has its own advantages compared to others. The algorithm here used is an optical flow algorithm which is based on the concept of motion vectors. It can perform well under the varying facial expression conditions providing better results and Histogram equalization has been used to normalize the image for better contrast images, in order to process it for feature extraction.

Pattern matching is the foremost important step in face recognition, as it involves the identification of human faces under varying circumstances. In this process, the extracted feature set has been compared with the database to find a matching set. In order to guarantee optimum performance of the developed algorithm the majority of images used for training, evaluation and testing are taken from some of the standard databases.

2. OPTICAL FLOW ALGORITHM

The concept of optical flow was introduced by the American psychologist James J. Gibson in the early 1940s. It is based on the concept of motion vectors, where the input image is subject to forward or backward prediction in order to estimate its motion in real time. Many algorithms have been proposed based on optical flow, and the most popular among them are Horn–Schunck method, Proesmans method etc. In optical flow algorithm, the features are extracted by using the concept of motion vectors and velocity of the frames. The basic concept of motion estimation is that in most cases, successive video frames will be identical, except for changes induced by objects moving within the frames. Based on the input provided, the optical flow algorithm calculates the frames that are to be associated with the varying facial expression.

In this proposed system, the algorithm proposed by Proesmans, have been used to calculate the optical flow of the given input image. Although horn and Schunck method gave the best performance in terms speed, it fails when comes to accuracy. Proesmans algorithm is much better as it provides much better accuracy rate than other algorithms. It is based on the frame analysis of the motions that has been evaluated by the optical flow by means of motion vectors to identify the varying expressions in the face of the object. It can overcome the effects of varying facial expressions more precisely. And moreover use of optical flow concept will enhance the recognition process more feasible.

3. DESIGN IMPLEMENTATION

Basically there are three steps in face recognition method which constitute of the entire methodology. They are Face Detection, Feature Extraction and Pattern matching.

Fig.1. Face Recognition System

3.1 FACE DETECTION

Face detection is a computer technology that determines the locations and sizes of human faces in digital images. It detects only facial features and ignores the other things, such as buildings, trees and other obstacles. In the Early stage, face-detection algorithms focused on the detection of front view of human faces, whereas latest algorithms attempt to overcome the

more general and difficult problem of multiple-view face detection. It refers to the detection of faces that are either rotated along the axis from the face to the observer, or rotated along the vertical direction, or left-right axis, or both the cases. The latest algorithms consider the variations in the image or video by factors such as pose variation, lighting conditions, and appearance of face.

First step in detecting a facial region is skin color segmentation. Based on the skin color, the image is segregated into two parts. The regions with skin are marked in white, and all other regions are marked with black color. Then based on certain facial parameters, the face has been detected from the separated skin colored region. Once the facial region has been detected, the next step is the extract the feature from the detected region.

3.2 FEATURE EXTRACTION

Feature extraction is the process of extracting the important features from a selected region. When the input data given to an algorithm is too large to be processed and it is detected to be highly redundant, then the input data will be transformed into a reduced set of features representation (also named features vector). Thus converting the input data into a set of features is called feature extraction. The features to be extracted are carefully chosen, so that the feature set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of using the entire input region. Feature extraction involves reducing the amount of resources required to describe a large set of input data. While doing the analysis of complex data one of the major problems arises from the number of variables involved in it.

Performing with large number of variables generally requires a large amount of memory and computation power or a classification algorithm which over fits the training sample and generalizes poorly to new samples.

Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. It makes a template based on the extracted features from the facial region. It is then stored in a database of memory for further process. Best results are achieved when an expert constructs a set of application-oriented features. However, if no such expert knowledge is available general dimensionality reduction techniques may help.

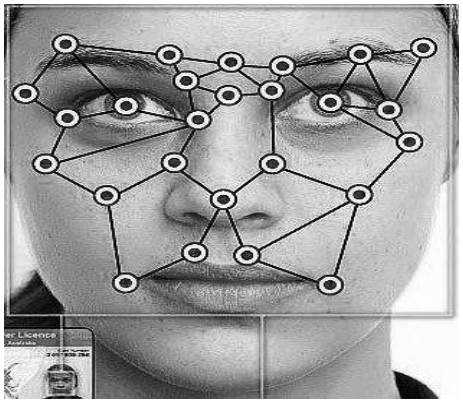

Fig.2. Feature Extraction Method

3.3 PATTERN MATCHING

Pattern Matching otherwise called as Template matching is a technique in digital image processing for finding small parts of an image which match with a template image. It can be used in various quality control applications, or as a way to detect edges in any given images. Template matching can be subdivided between two approaches: feature-based and template-based. In feature-based approach the features of the input image along its edges or corners, are considered as the primary match-measuring metrics to find the best matching location of the template in the trained set of image. Whereas the template-based(also called global approach) method uses the entire feature set from the template, with generally a sum-comparing metric (using SAD, SSD, cross-correlation, etc.) that determines the best location by testing all or a sample of the viable test locations within the search image that the template image may match up to.

In some cases the template may not provide a direct match with the trained image. In such cases, it may be useful to implement the use of Eigen spaces that provides detail of the matching object under a number of different constraints, such as varying facial expressions, color contrasts, illuminations or similar matching objects. In cases where the object is flexible or possible, motion of the object becomes a major problem, and images involving both motion and occlusion problem will become more complex. In these cases, one possible solution is to divide the template image into multiple sub-images and perform matching on each subdivision. In the past, this type of spatial filtering was normally used only in dedicated hardware solutions because of the computational complexity of the operation; however the complexity can be reduced by filtering the image in the frequency domain, which is termed as frequency domain filtering, which is done by using the concept of convolution theorem.

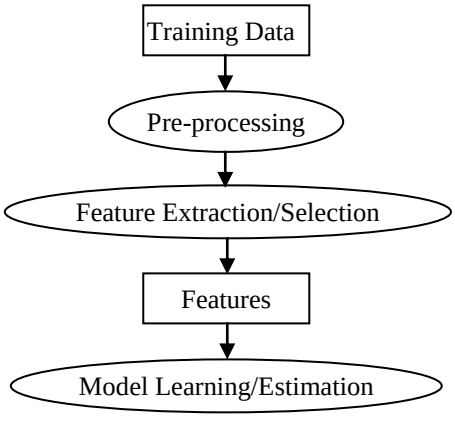

Fig.3. Flow Chart of Pattern matching scheme

The database consists of trained set of data which has pre defined set of features. Once the pre-processing of the input object is done, the extracted feature set is being compared with the templates in the database to find a match. If any found, it displays the result as the face region is recognized.

The overall process includes the extraction and comparison of the facial features in order to recognize any given image to the face recognition system.

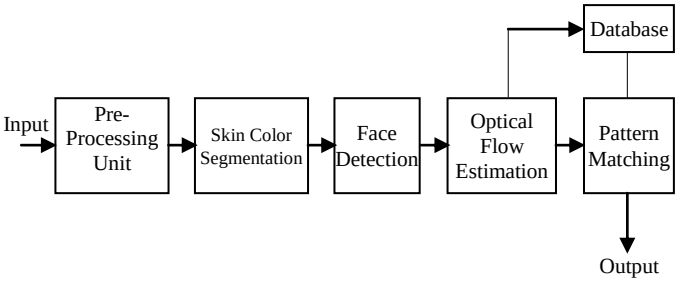

Fig.4. Proposed System Design

3.4 HISTOGRAM EQUALIZATION

Histogram equalization is one of the methods in image processing for adjusting the contrast of the given images. The method is useful in images with backgrounds and foregrounds that are both bright or both dark. It is a simple technique that can be used in any image processing applications. Here it is used for enhancing the contrast of the input images, which is being captured in real time scenarios. It is one of useful technique in normalization of the image.

4. SIMULATION RESULTS

For simulation purpose, MATLAB has been used as simulation tool. The images used here are taken from Aberdeen database which consists of about 686 frontal face images with different facial expressions. All the images are in equal dimensions in order to process them for better performance. The input image is given as color image (RGB image). It has to be converted to grayscale for easier implementation of skin color segmentation and processing of the input image. Then the background portion in the converted grayscale image has been reduced as much as possible using the image segmentation code in Matlab for simplification of the process. Once the background has been reduced from the original image, the image has processed for detecting the face object from the given image.

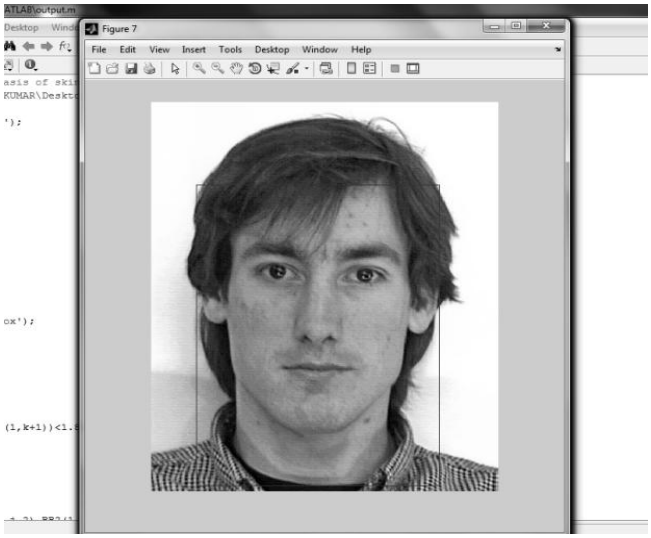

Fig.5. Face Detected output

The region marked in rectangular area indicates the face region of the input image. Once the facial area has been detected, the next step is to extract the features from the faces, by means of optical flow algorithm. It extracts the features from the facial region, under varying facial expressions.

Based on the extracted feature set the template is being created from the feature set, which is then compared with the stored database in the computer. The sample image above represents one of the inputs taken from the Aberdeen database. Moreover about 100 images have been used for the recognition process.

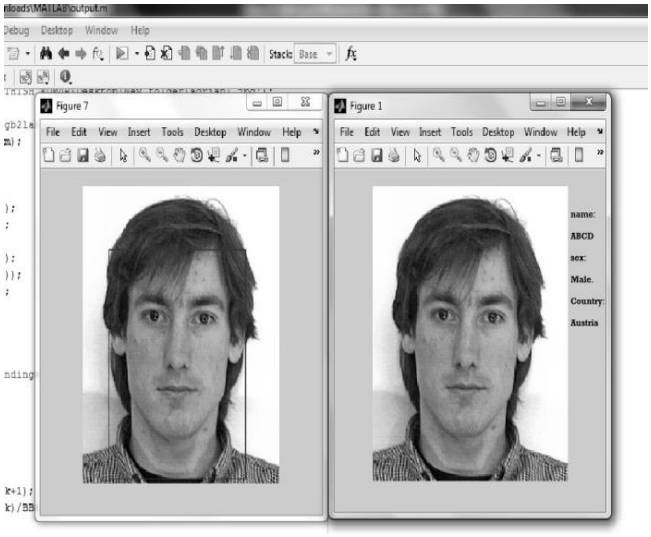

Fig.6. Face Recognition output

Thus the above figure represents the recognized face region, which is based on the trained database, used for this purpose. It also shows that the face region is reported as recognized once it passes all the stages in face recognition system. If it fails to pass any of the stage, it does not process further, and hence the face will not be recognized. Although the speed of processing is quiet slower than the other algorithms, the accuracy rate is much improved, under the circumstances of varying facial expressions. An accuracy rate of about 93% has been observed from the featured images taken from the Aberdeen database.

5. CONCLUSION AND FUTURE SCOPE

In this paper, the simulation model of a face recognition system has been proposed, which used an optical flow algorithm for extracting the feature set and then histogram equalization technique has been used for contrast enhancement of the images. Face recognition systems used today work very well under the constrained conditions, wherein most of the systems work much better with frontal view images and constant lighting conditions. Nowadays, most of the face recognition algorithms fail under the vastly varying conditions under which humans need to be able to identify person's individual traits. The next generation recognition systems will need to recognize people in real-time and in much less constrained situations.

It is known that identification systems that are robust in natural conditions, in the presence of noise, cannot depend on single possibility. Hence combining with other possibilities is

essential. Wearable systems which work in smart environment require their sensing technology to be low powered, smaller size and easily integrable with its user application. Based on all those requirements, systems that utilize face recognition and speaker identification seem to us to have the most potential for wide-spread application. Cameras and microphones today are very cheap and light-weight and also successfully integrate with the wearable systems. Both the video and audio based recognition systems have the critical advantage that they use the modalities, humans use for recognition.

Although many algorithms have been proposed, so far the accuracy of the facial recognition system was not up to the expectations. In the near future, the facial recognition system may be the key factor in security and safety applications. Hence it is essential to do more research work in this area, as it may provide a scope in the field of computer vision. The algorithm here used is suitable for varying facial expressions and illumination conditions. Pose variation and feature occlusion are also becoming a major factor in facial recognition. So, working on these areas will provide a better way for the future of facial recognition system.

REFERENCES

[1] Paul Viola and Michael J. Jones, "Robust real-time face detection", *International Journal of Computer Vision*, Vol. 57, No. 2, pp. 137-154, 2004.

[2] K Padmaja and T. N. Prabakar , "FPGA based real time face detection using Adaboost and histogram equalization", *International Conference on Advances in Engineering, Science and Management* , pp. 111 – 115, 2012.

[3] R. Ahmad, Naghsh-Nilchi and Mohammad Roshanzamir, "An Efficient Algorithm for Motion Detection Based Facial Expression Recognition using Optical Flow", *International Journal of Engineering and Applied Sciences*, Vol. 2, No. 3, pp. 141 – 146, 2006.

[4] M. M. Abutaleb, A. Hamdy, M. E. Abuelwafa and E. M. Saad, "A Reliable FPGA-based Real-time Optical-flow Estimation", *International Journal of Electrical and Electronics Engineering*, Vol. 4, No. 4, pp. 291, 2010.

[5] Al-Hamadi, A. Farag, B. Michaelis, H. Neumann and R. Niese1 "Facial expression recognition based on geometric and optical flow features in color image sequences", *IET Computer Vision* , Vol. 6, No. 2, pp. 79 – 89, 2012.

[6] Junguk Cho, Shahnam Mirzaei, Jason Oberg and Ryan Kastner, "FPGA-Based Face Detection System Using Haar Classifiers", *FPGA*, Monterey, 2009.

[7] Klaus Kollreider, Hartwig Fronthaler, Maycel Isaac Faraj and Josef Bigun, "Real-Time Face Detection and Motion Analysis with Application in 'Liveness' Assessment", *IEEE Transactions on Information Forensics and Se*curity, Vol. 2, No. 3, pp. 548 – 558, 2007.

[8] P. Premakanthan and W. B. Mikhael, "Speaker verification/recognition and the importance of selective feature extraction: review", *Proceedings of the 44th IEEE 2001 Midwest Symposium on Circuits and Systems*, Vol. 1, pp. 57 – 61, 2001.

[9] Aberdeen database. Available: http://pics.psych.stir.ac.uk/ 2D_face_sets.htm.