ARCHITECTURE FOR PRECISE FACE RECOGNITION SYSTEM DEPLOYING QUANTIZATION WITH MULTiresOLUTION CURVELET AND TRAINING WITH SUPPORT VECTOR MACHINE

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Abstract: The proposed research approach addresses various issues in face recognition as well as in computer vision which were signified and researched by multiresolution concepts like wavelet transforms. But survey also shows that only wavelets are not the factors for ideal description of an image as they have very rough directional representations and are absolutely not anisotropic. With the recent developments in Curvelet Transform, which has the potential to overcome these flaws of wavelets, this proposed idea highlights an advance technique of face recognition which is based on multiresolution curvelet. The application will quantize 8 bit image to 4 bit and 2 bit representation in initial phase. In the next phase, the curvelet transform will be applied to all 3 different resolved versions of the image. In the final phase, all the 15 sets of co-efficients were used to train different support vector machines. Finally, the accuracy of the application will be evaluated by identification from different sets of facial image for the proposed robust face recognition system.


I. INTRODUCTION

The problems encountered in face recognition system are considered as one of the most important research areas in human visual system and image statistics. Majority of the face recognition algorithms has witnessed a performance drop whenever face appearances are subjected to variations by factors such as occlusion, illumination, expression, pose, accessories and aging. In fact, often these factors lead to intra-individual variability of face images, to the extent that they can be larger than the inter-individual variability. Multiresolution techniques [1] have already been researched in order to mitigate the loss of classification performance due to changes in facial appearance. The most popular multiresolution analysis technique is found to be wavelet transform. Wavelet decomposition is the most widely used multiresolution technique in image processing. Images have typically locally varying statistics that result from different combinations of abrupt features like edges, of textured regions and of relatively low-contrast homogeneous regions. While such variability and spatial nonstationarity defies any single statistical characterization, the multiresolution components are more easily handled. Not only this, it is also found that the Fourier transform [2] of an image is not very informative from the perspective of object recognition. Other transforms like wavelets, curvelets etc. provide alternative image representations. These transforms represent images in such a way that recognition is facilitated. There are five criteria for multiresolution image transform e.g. (1) Multiresolution. The transform should allow images to be successively approximated, from course to fine resolutions. (2) Localization. The basis elements of the transforms should be localized in both the spatial and the frequency domains. (3) Critical sampling. For some applications (e.g., compression), the transforms should form a basis, or a frame with small redundancy. (4) Directionality. The transform should contain basis elements oriented at a variety of directions, compared with the few directions offered by separable wavelets. (5) Anisotropy. When a physical property changes with direction, that property is said to be anisotropic, e.g. in certain crystals the conductivity of heat is more in horizontal direction than in vertical direction; for such a case, the conductivity is said to be anisotropic.
The proposed work will introduce a novel face recognition technique based on multiresolution curvelet transform where the application deploys the Fast Discrete Curvelet Transform architecture via unequally-spaced fast Fourier transforms and Wrapping since Curvelets have ability to represent edges and other singularities along curves to meet 100% accuracy level in recognizing facial image.

The rest of this paper is organized as follows. We discuss related work in Section II. The problem statement is discussed in Section-III. Assumptions and dependency considered for the research work is elaborated in Section IV. Proposed System is described in Section-V. Implementation Scenario is discussed in Section-VI and finally conclusion and future work is described in Section-VII.

II. RELATED WORK

Tanaya Mandal et al. [3] have introduced a new feature extraction technique from still images using PCA on curvelet domain which has been evaluated on two well-known databases. This technique has been found to be robust against extreme expression variation as it works efficiently on Essex database. The subjects in this dataset make grimaces, which form edges in the facial images and curvelet transform captures this crucial edge information. The proposed method also seems to work well for ORL database, which shows significant variation in illumination and facial details. There has also been an extensive research to describe an image transform [4] that may proof beneficial in image and vision research.

Eero P. Simoncelli et al. [5] presented jointly shiftable transforms that are simultaneously shiftable more than one domain. Two examples of jointly shiftable transforms are designed and implemented: a one-dimensional transform that is jointly shiftable in position and scale, and a two-dimensional transform that is jointly shiftable in position and orientation. It was demonstrated the usefulness of these image representations for scale-space analysis, stereo disparity measurement, and image enhancement.

Minh N. Do [6] constructed a discrete transform that provides a sparse expansion for typical images having smooth contours. Szabolcs Sergyán [7] has presented a face detection algorithm which was used in color images, and some classification methods and this usage for the classification of image database were reviewed.

Emmanuel Candès [8] has described two digital implementations of a new mathematical transform, namely, the second generation curvelet transform in two and three dimensions. The first digital transformation is based on unequally-spaced fast Fourier transforms while the second is based on the wrapping of specially selected Fourier samples. Dengsheng Zhang et al. [9] has presented a new texture feature based on curvelet transform.

III. PROBLEM STATEMENT

The challenging problem consists of a data set of facial images and a defined set of experiments. One of the impediments to developing improved face recognition is the lack of data.

The problem which exists in face recognition actually boils down to identification of an individual depending on array of pixel intensities. Deploying this input values and extracted information from the other images of known person, it has been seen that there are several issues which seeks to assign a name to an unidentified set of intensities of pixels. Another prominent issue is notifying the dependencies laid between values of pixel which actually becomes a statistical signal processing problem.

Certain more problems exist in this area if the application is subjected to a huge database of image or a photograph. There was an issue to pick from the database a smaller set of records so that one of the input image records becomes equivalent to the photograph. This problem in recognition system is rendered difficult by great variability in tilt or rotation of head, lighting intensity, facial expression, etc. Previous research has not witness any progress in this issue but yet this method of correlation of unprocessed data is frequently used by many researchers and has highest probability to fail in situation where the correlation is very minimum between two images of same test-person with different posture.

IV. ASSUMPTIONS AND DEPENDENCIES

The project work assumed an image database of the same person taken from webcam under congenial illumination and lightening and converted to appropriate image file format for exact input. The input image is assumed to have minimal noise, in case if it is there. The prime focus of the project is basically the face recognition, so particular database is selected for that purpose only. The term wavelet
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is usually assumed to refer to an orthonormal basis set. The main dependency of the project work is mainly the Matlab IDE without which the project execution fails at this stage.

V. PROPOSED SYSTEM

Our face recognition system is divided into two stages: training stage and classification stage. In training stage, the images are decomposed into its approximate and detailed components using curvelet transform. These sub-images thus obtained are called curvefaces. These curvefaces greatly reduces the dimensionality of the original image. Then the methodology is applied on selected subbands, which further reduces the dimension of image data. Thereafter only the approximate components are selected to perform further computations, as they account for maximum variance. Thus, a representative and efficient feature set is produced. In classification stage, test images are subjected to the same operations and are transformed to the same representational basis.

In the initial process, recognition is done by varying bit of quantization where digital images in black and white are represented in 8 bits or 16 bits which result in 256 or 65536 gray levels. If we assume that the images are represented by 256 gray levels, in such an image two very near regions can have different pixels values. There are lots of “edges” in a gray scale image and consequently the edge information will be captured by the curvelet transform. In case if there is quantization of the gray levels, nearby regions which has a very little differences in pixels values and formed edges in the original 256 bit image will be merged and as a result only more bold edges in face image will be represented. At this moment, in case the gray-level quantized images are subjected to Curvelet transform, the transformed domain coefficient will contain information of these bolder curves. Images of the same person from the face database, quantized to 4 bits and 2 bits from the original 8 bit representation.

In the subsequent process, recognition is done by multiresolution curvelet transform which permits the user to view an image at multiple scales. In highest magnification, majority of the finest details of the picture is visible, but when magnification is reduced, a rough view of the image is obtained gradually. Taking Curvelet transform at different resolution will allow the capture of the edge information in facial images at varying granularities. The final processing of our recognition system will be done by combination of the above two stages together to get the final output. The multiresolution analysis allows for the coarse to fine approximation of the images. So by combining the aforesaid steps we will have different versions of images, which will be used to train different multi-class SVM. The final recognition decision will be obtained by majority voting of the classifier output as shown in data flow diagram in Fig 1.

![Data Flow Diagram](image)

**Figure 1: Data Flow Diagram**

VI. IMPLEMENTATION SCENARIO

The framework is designed on Matlab IDE. To start working on this application, a database of image is created by taking snaps of 10 different persons in 10 different facial postures or angle. The application is then fed with all the possible inputs from database and is signified by a logical name. The input image is then subjected to bit quantization and then multiresolution curvelet is applied. The screenshots are as follows.

The application accepts the input of image from the database which is subjected to bit quantization as shown in Fig. 2 where the first image is original image, second image is 4 bit quantized image, and third one is 2 bit quantized image. Immediately after this, the next step is multiresolution curvelet transform as depicted in Fig. 3. After performing this stage, the profile can be saved by a name which can be used for understanding the proper identification of test image in this application. The next step of processing then assists in generation of
data which might be used to train support vector machine. The process is repeated for all the 10 sets of database of the training images.

Once the training is completed, the application will prompt the user to feed the test image for verification purpose which is represented by fig 4. The processing is done taking one set of input database image for training and another set for testing the application for identification. For each of the two pairs of training and testing set thus obtained, two sets of experiments were performed. The application is tested with all the 10 sets of test images for analyzing the performance with regards to 8 bit, 4 bits, and 2 bits. The performance of the application is also scrutinized by considering multiple image resolution parameters (high, average, low, lowest), accuracy classifier, final accuracy, rejection rate, as well as incorrect classification.

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<tr>
<th>Bits</th>
<th>Final accuracy</th>
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<tbody>
<tr>
<td>8</td>
<td>98.2</td>
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The above table shows the parameters which are used for analyzing the accuracy of the application developed. Each experiment is checked for 8 bits, 4 bits as well as 2 bits and found to provide accuracy level of 98.2%, 99.2%, and 99.2% respectively. Although with a minimal rejection rate of 0.8 in 8 bit quantization, the experiment shows absolutely zero rejection rate in both 4 bits and 2 bits of quantization respectively. The evaluation of this performance is shown in Fig. 5 in graph.

<table>
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The next set of performance evaluation is conducted considering distinct parameters like average accuracy classifier and final accuracy as shown in Table 2.

Once the training is completed, the application will prompt the user to feed the test image for verification purpose which is represented by fig 4. The processing is done taking one set of input database image for training and another set for testing the application for identification. For each of the two pairs of training and testing set thus obtained, two sets of experiments were performed. The application is tested with all the 10 sets of test images for analyzing the performance with regards to 8 bit, 4 bits, and 2 bits. The performance of the application is also scrutinized by considering multiple image resolution parameters (high, average, low, lowest), accuracy classifier, final accuracy, rejection rate, as well as incorrect classification.

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This set of evaluation is performed with almost all possible set of image resolution ranging from highest to lowest. The evaluation shows the results of average accuracy classifier as 94.82, 93.15, and 91.85 for 8 bit, 4 bit, and 2 bit respectively with all final accuracy of 100%. The graphical representation is shown in Fig. 6.

We can enhance the same to recognize the facial expression of a human.

REFERENCE


VII. CONCLUSION

The project work highlights one of the possible utilization of multiresolution curvelet transform for better accuracy in face recognition system. The main aim of the project work is to design an architectural framework to propose a multiresolution Curvelet based method for face recognition. The research work also aims to highlight a new texture feature based on curvelet transform. The technique makes use of curvelet transform which represents the latest research result on multiresolution analysis where the 8 bit image is quantized to 4 bit and 2 bit representation. Multiresolution methods provide powerful signal analysis tools, which are widely used in feature extraction, image compression and denoising applications. Database of large classes should be experimented in future work. If small database is used, it classifies as false positive results. This project can be enhanced to capture live things by integration fast motion cameras to the server.

Figure 6: Graph for Table 2