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Very Low Resolution Face Recognition in Parallel Environment

Debabrata Chowdhuri[#1], Sendhil Kumar K.S.[#2], M Rajasekhara Babu[#3], Ch. Pradeep Reddy*

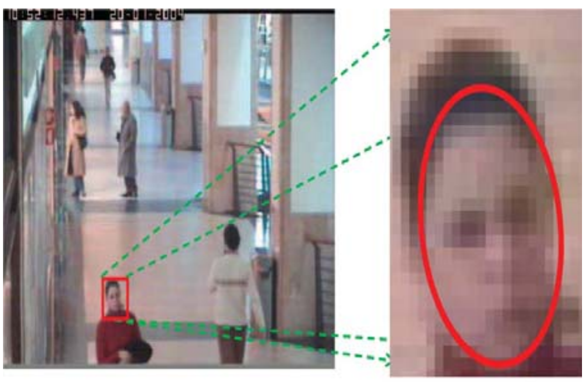
[#]*School of Computing Science and Engineering*
**School of Information Technology and Engineering*
VIT University, Vellore-14, T.N., India

***Abstract*— This project tries to solve very low resolution (VLR) problem in face recognition where the resolution of the image to be recognized is lower than 16 × 16 pixels. With the increasing demand of surveillance camera-based applications, the VLR problem happens in many face application systems. Existing face recognition systems are not able to give satisfactory performance on the VLR face image. Based on this new approach, two constraints, namely, new data and discriminative constraints, are designed for good visual and face recognition applications under the VLR problem, respectively. Experimental results show that the proposed Feature extraction technique based on relationship learning and Euclidian distance outperforms the existing algorithms in face recognition from public face databases.**

***Keywords*— Face recognition, Feature Extraction, very low resolution (VLR)**

I. Introduction

Increasing surveillance camera demands for more accurate face detection technology for surveillance applications ranging from small-scale stand alone camera applications in bank or supermarket. When the person is not close to the camera, the face region will be smaller than 16 × 16 pixels. Working on such a very low resolution (VLR) face image is called a VLR face problem.



(a) (b)

Fig. 1. Typical frame from a surveillance video (CAVIAR database). (a) Surveillance video. (b) Face region.

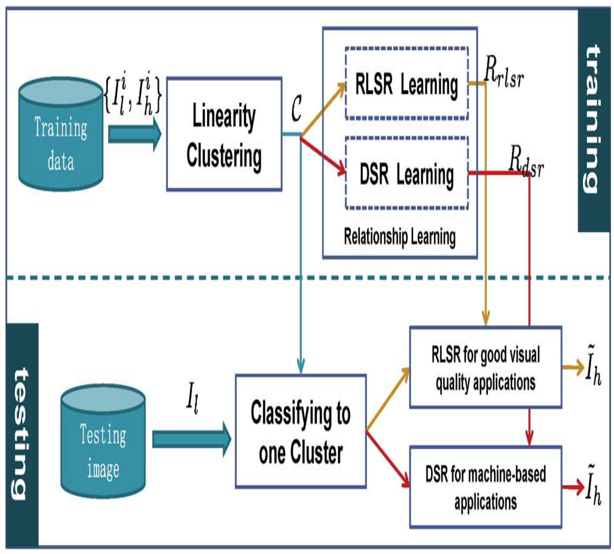
Empirical studies[2] showed that minimum face image resolution between 32 X 32 and 64 X 64 are required for existing algorithms. Recognition performance will be dramatically degraded under the VLR problem[3]. This is because the VLR face image contains very limited information and much of the image details have been lost, as shown in Fig. 1(b).

A potential method to solve the VLR problem is to recover the missed details of the face image. Therefore, Feature extraction technique is employed. Because of the self-similarity of the face images and Euclidian distance, learning-based Feature extraction technique is used to enhance the resolution of the face images. Existing algorithms can be categorized into two approaches namely, maximum a posteriori (MAP) and example-based approaches. Both approaches employ the same criterion to perform error evaluation for the reconstructed HR images, which is called a data constraint. The data constraint is used to compare the images by calculating the distance in the low-resolution (LR) image space for SR processing. This method works well if the distance metric in the VLR image space reflects the actual face similarity in the HR image space. However, experimental studies show that the face similarity measure in the VLR image space cannot reflect the actual face similarity of HR face images. As such, the existing SR algorithms may not be employed under the VLR problem.

Identification technique is closer to the way human beings recognize each other.

II. Related work

1. <u>Existing SR Algorithms</u>



Block diagram of the proposed SR algorithm

2. Two SR Approaches: MAP and Example Based

MAP-Based Approach:

In this approach, the HR image is constructed via finding the HR image by maximizing conditional probability $P(I_h|I_l)$ i.e. ,

$$I_h^* = \arg\max P(I_h|I_l)$$
$$= \arg\max \frac{P(I_l|I_h)P(I_h)}{P(I_l)} I_h$$

Generally, $P(I_l|I_h)$ is modeled by the Gaussian distribution,so the maximizing $P(I_h|I_l)$ is equivalent to minimize the data constraint as follow

$$\| DI_h - I_l \|^2$$

where D is the downsampling operator

Example Based approach: The example-based approach constructs the HR image by a linear combination of the HR training images (so-called examples). Mathematically, it can be written as

$I_h^* = \sum \omega_i I_h^i$ where $\{I_h^i\}$ are the training HR i images, and $\{\omega_i\}$ are the Weight.

To determine the weights, they minimize the error created by the linear approximation for the input LR image as follows:

$$\{\omega_i\} = \arg\min \| I_l - \sum_{i=1} \omega_i I_h^i \|^2$$

Since the LR-HR image pair satisfies

$I_l = DI_h$ where D is the downsampling operator

we substitute I_h^i by DI_h^i and we get

$$\{\omega_i\} = \arg\min \| I_l - \sum_{i=1} \omega_i D I_h^i \|^2$$
$$= \arg\min \| I_l - D \sum_{i=1} \omega_i I_h^i \|^2$$

Since $\sum \omega_i I_h^i$ is the reconstructed HR image, let $I_h = \sum_i \omega_i I_h^i$ then the equation becomes

$$\{\omega_i\} = \arg\min_{i=1} \| DI_h - I_l \|^2$$

Therefore the approach reconstructed HR image that is similar to the input of LR image space.

III. Proposed Method

Block Diagram of "Very Low Resolution Face Recognition In Parallel Environment " is as follows. Face Recognition System consist of four modules. These are as follows:

Image Reader: This module is responsible for read an image for recognition

Feature Extraction: This module is used to extracting the feature of an image

Find Euclidean Distance: This module is used to extracting calculation the Euclidean distance between test image and image exist in the database.

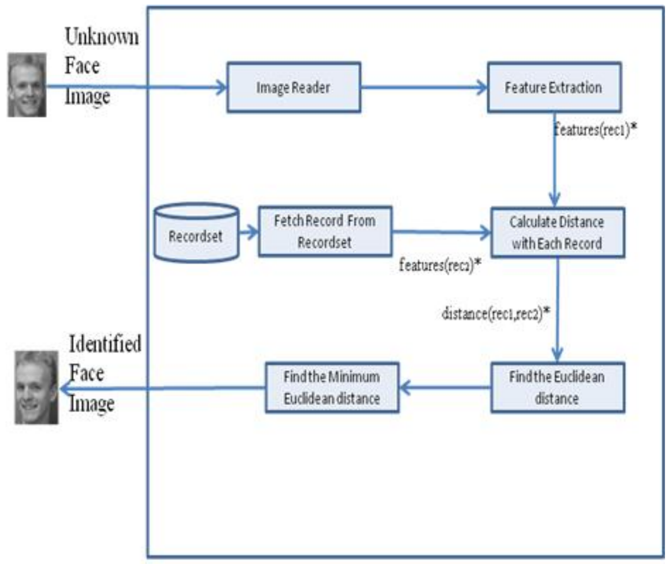
Find Minimum Euclidean Distance: This module is responsible for find the minimum Euclidean distance to recognize an image.

Euclidean Distance

$$(d)=\sqrt{(a_1-a_2)^2+(b_1-b_2)^2+(c_1-c_2)^2+(d_1-d_2)^2}$$

Where: a_1, b_1, c_1, d_1 *are the extracted features of input image*

a_2, b_2, c_2, d_2 *are the extracted features of existing image*



*recs= energy, corelatation, contrast and homogeneity

Block Diagram of Proposed Method

IV. Face Recognition Process

There are four steps in face recognition process:

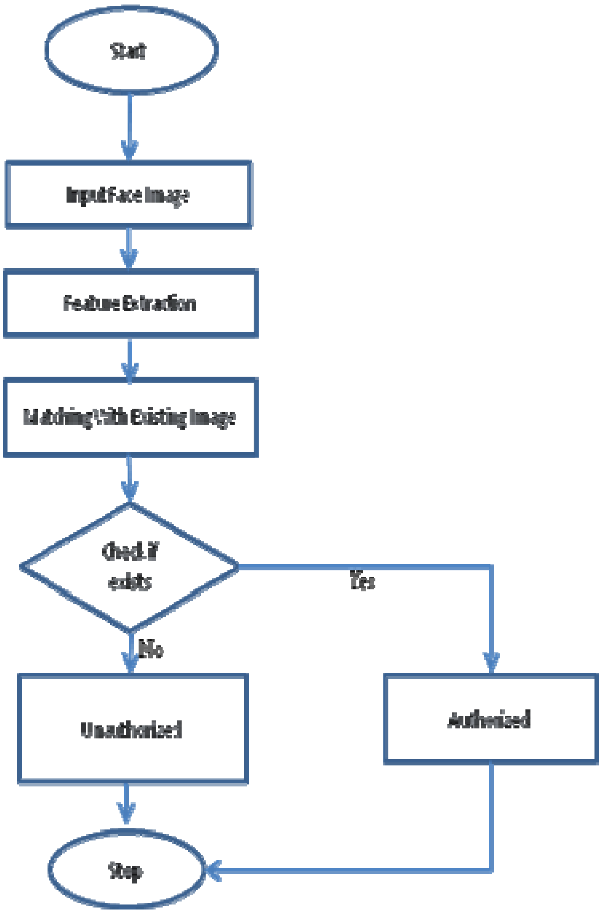
Acquiring a sample: In a complete, full implemented biometric system, a sensor takes an observation. The sensor might be a camera and the observation is a snapshot picture. In our system, a sensor will be ignored, and a 2D face picture "observation" will supplied manually.

Extracting Features: For this step, the relevant data is extracted from the predefined captured sample. This is can be done by the use of software where many algorithms are available. The outcome of this step is a biometric template which is a reduced set of data that represents the unique features of the enrolled user's face.

Comparison Templates: This depends on the application at hand. For identification purposes, this step will be a comparison between a given picture for the subject and all the biometric templates stored on a database. For verification, the biometric template of the claimed identity will be retrieved (either from a database or a storage medium presented by the subject) and this will be compared to a given picture.

Declaring a Match: The face recognition system will return a candidate match list of potential matches. In this case, the intervention of a human operator will be required in order to select the best fit from the candidate list. An illustrative analogy is that of a walk-through metal detector, where if a person causes the detector to beep, a human operator steps in and checks the person manually or with a hand-held detector

V. Flow Diagram for Proposed System



Flow Chart

VI. Experiment

Two experiments are designed to evaluate the Performance, namely, Sequential and Parallel. execution method. Using Matlab Parallel Toolbox we parallelized the code to enhance the performance of the system. For comparison. Experimental results show that the proposed method is faster than the existing one.

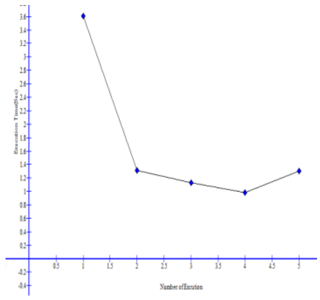
VII. Database and Settings:

Public face databases are selected for the experiments. Which consists of 400 frontal view face images(10 per individual) is used. All images are manually aligned by the position of the eyes and normalized to the resolutions of 16 X 12 (VLR). The images are well aligned. Since there is no general method for aligning images with different poses, only frontal view images are used in our experiments. In database, images are divided into different class label. In the database, images from 40 persons (ten per person) are randomly selected as the training data.

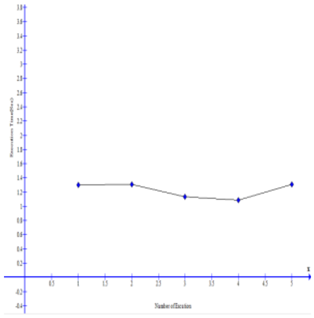
Low Resolution Image Database

VIII. Result Analysis

To evaluate the performance of the proposed method on a face recognition system, we carry out the experiments in both sequential and parallel environment. We compare the performance in both the environment. In sequential environment the performance of system gets reduce but in parallel environment we get a stable performance of the system.



Sequential Execution



Parallel Execution

IX. Conclusion

The VLR face recognition problem has been defined and discussed in this paper. To solve the problem, feature extraction method is used and to enhance the performance parallel environment is used. For machine-based face recognition applications, a discriminative constraint was designed and parallel environment is integrated with the new data constraint. Experimental results show that the proposed method is effective in comparison to existing method performance.

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