Facial Recognition using Bunch Graph Method

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Outline

- **Introduction.**
- **Block Diagram**
- **Existing Methods**
- **Real World Applications**
- **Graph Mapping Algorithm.**
- **Understanding Bunch Graph Mapping**
- 1. Pre-processing
- 1.1 Jets
- 1.2 Comparing Jets
- 2. Face Bunch Graphs
- 3. Generating Face Representations by Graph Matching
- 3.1 Matching Procedure.
- 4. Recognition
- **References.**

Reporting Since 01/Jan/2020 till 1st presentation

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Introduction

- The face is one of the easiest ways to distinguish the individual identity of each other.
- Face recognition is a personal identification system that uses personal characteristics of a person to identify the person's identity.
- Human face recognition procedure basically consists of two phases:
- **FACE DETECTION**, where this process takes place very rapidly in humans, except under conditions where the object is located at a long distance away,
- next is the **RECOGNITION**, which recognize a face as individuals.
- Recognition stage is then replicated and developed as a model for facial image recognition.

Block Diagram

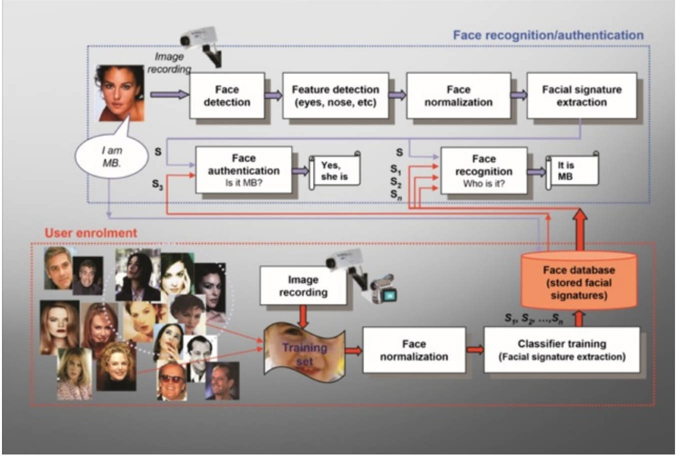


Figure 1: Complete Procedure

Existing Methods

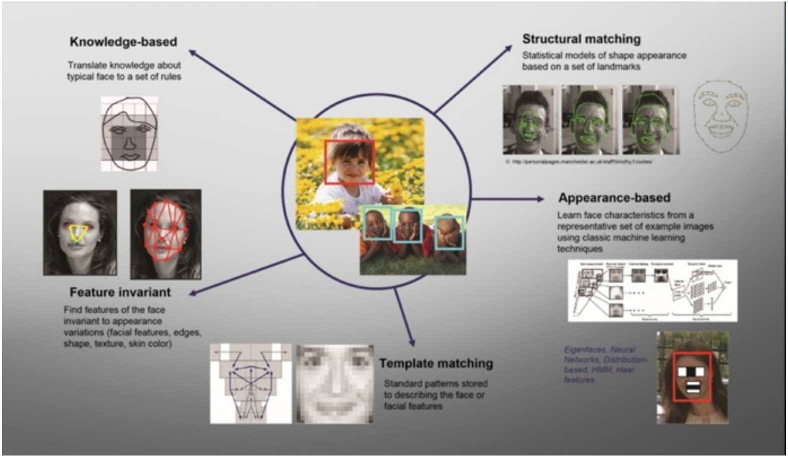


Figure 2: Existing Methods

Real World Applications

- Identification Solutions : Passports, Driving Licenses etc
- Homeland Defence : Identification of Known terrorists, etc
- Airport Security : Enhanced Security with no or less error.
- Surveillance Solutions. : Combined usage of CCTV cameras with facial recognition can really help in surveillance.

Graph Mapping Algorithm

- All human faces share a similar topological structure. Faces are represented as graphs, with nodes positioned at **fiducial points**. (Eyes, Nose...) and
- The Edges labelled with 2-D distance vectors. Each node contains a set of 40 complex wavelet coefficients at different scales and orientations (phase, amplitude). They are called jets.
- Recognition is based on labelled graphs.
- **A labelled graph** is a set of nodes connected by edges, nodes are labelled with jets, and edges are labelled with distances.
- Three major extensions to this system in order to handle larger galleries and larger variations in pose, and to increase the matching accuracy, which provides the potential for further techniques to improve recognition rate.

Graph Mapping Algorithm

- Firstly, the phase of the complex wavelet coefficients to achieve a more accurate location of the nodes and to disambiguate patterns which would be similar in their coefficient magnitudes.
- Secondly, employ object adapted graphs, so that nodes refer to specific facial landmarks, called **fiducial points**.
- The correct correspondences between two faces can then be found across large viewpoint changes. Thirdly, introduced a new data structure, called the **bunch graph**,
- which serves as a generalized representation of faces by combining jets of a small set of individual faces. This allows the system to find the fiducial points in one matching process, which eliminates the need for matching each model graph individually. This reduces computational effort significantly.

Graph Mapping Algorithm

- **The Graph Mapping Algorithm** treats one vector per feature of the face. Feature for the face are the eyes, nose, mouth etc. This has the advantage that changes in one feature (eyes open, closed) does not necessarily mean that the person is not recognized any more.
- **Drawbacks of this algorithm** are that it is very sensitive to lightening conditions and that a lot of graphs have to be placed manually on the face but with the make of features, being the output of band pass filters, and these are closely related to derivatives and are therefore less sensitive to lightning changes.

ALGORITHM : UNDERSTANDING Bunch Graph Mapping

1. Pre-processing

The representation of local features is based on the wavelet transform. Wavelets are biologically motivated convolution kernels in the shape of plane waves restricted by a Gaussian envelope function. The set of convolution coefficients for kernels of different orientations and frequencies at one image pixel is called a jet.

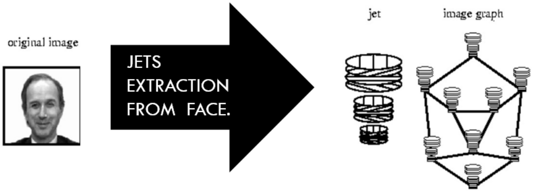


Figure 3: Graph Extraction from raw image

1.1 Jets:-

A jet describes a small patch of grey values in an image I(x) around a given pixel x= (x,y).

A jet J is defined as the setJjof 40 complex coefficients obtained for one image point

1.2 Comparing Jets

Due to phase rotation, jets taken from image points only a few pixels apart from each other have very different coefficients, although representing almost the same local feature. This can cause severe problems for matching. We therefore either ignore the phase or compensate for its variation explicitly. The similarity function

$$\mathcal{S}_a(\mathcal{J}, \mathcal{J}') = \frac{\sum_j a_j a'_j}{\sqrt{\sum_j a_j^2 \sum_j a_j'^2}},$$

Figure 4: Similarity Function

2. Face Bunch Graphs

To find fiducial points in new faces, one needs a general representation rather than models of individual faces. This representation should cover a wide range of possible variations in the appearance of faces, such as differently shaped eyes, mouths, or noses, different types of beards, variations due to sex, age, race, etc. Itis obvious that it would be too expensive to cover each feature combination by a separate graph. We instead combine a representative set of individual model graphs into a stack-like structure, called a face bunch graph(FBG)

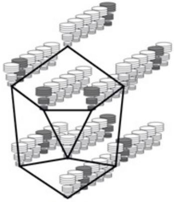


Figure 5: Bunch Graph formation

3. Generating Face Representations by Graph Matching

So far we have only described how individual faces and general knowledge about faces are represented by labelled graphs and the FBG, respectively. We are now going to explain how these graphs are generated. The simplest method is to do so manually. We have used this method to generate initial graphs for the system, one graph for each pose, together with pointers to indicate which pairs of nodes in graphs for different poses correspond to each other. Once the system has an FBG (possibly consisting of only one manually defined model), graphs for new images can be generated automatically by Bunch Graph Matching. Initially, when the FBG contains only a few faces, it is necessary to review and correct the resulting matches, but once the FBG is rich enough (approximately 20 graphs) one can rely on the matching and generate large galleries of model graphs automatically.

3.1 Matching Procedure

The goal of Bunch Graph Matching on a probe image is to find the fiducial points and thus to extract from the image a graph which maximizes the similarity with the FBG.

- Step 1: Find approximate face position
- Step 2: Refine position and size.
- Step 3: Refine size and find aspect ratio.
- Step 4: Local distortion.

The resulting graph is called the image graph and is stored as a representation of the individual face of the image.

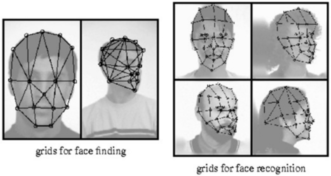


Figure 6: Bunch Graph formation

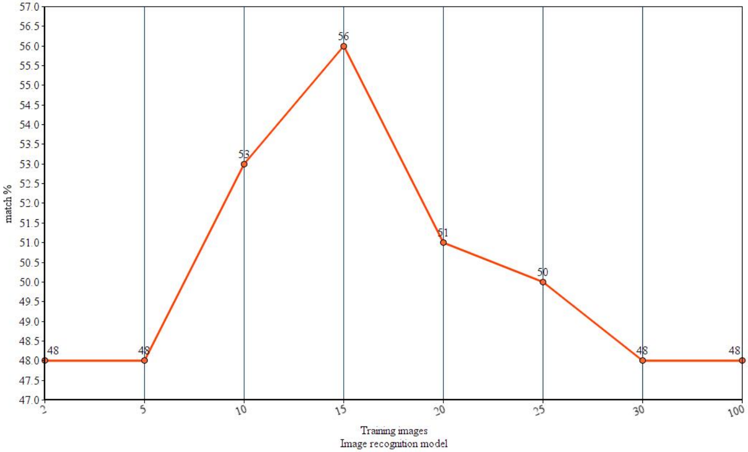
4. Recognition :-

After having extracted model graphs from the gallery images and image graphs from the probe images, recognition is possible with relatively little computational effort by comparing an image graph to all model graphs and picking the one with the highest similarity value. A comparison against a gallery of 250 individuals took slightly less than a second. The similarity function we use here for comparing graphs is an average over the similarities between pairs of corresponding jets. For image and model graphs referring to different pose, we compare jets according to the manually provided correspondences. If GI is the image graph, GM is the model graph, and node n n′ in the model graph corresponds to node n′ in the image graph, we define graph similarity as:

$$\mathcal{S}_{\mathcal{G}}(\mathcal{G}^{\mathcal{I}}, \mathcal{G}^{\mathcal{M}}) = \frac{1}{N'} \sum_{n'} \mathcal{S}_a(\mathcal{J}^{\mathcal{I}}_{n'}, \mathcal{J}^{\mathcal{M}}_{n_{n'}}),$$

Figure 7: Bunch Graph formation

Matching % with Sample size



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