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Analysis of the Human Face Detection Mechanism Process and Recognition Problem

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ABSTRACT

Face recognition problem is result well-organized with good efficiency and discriminative facial looking descriptors so as to can offset with biggest variations in clarification, pose, facial appearance, olding, incomplete occlusions and other changes in face looking problem. The problem of face recognition is all regarding to face detection. This is a main fact that seem fairly out of the ordinary to new researchers in this field. Real-time face detection involves detection of a face from a series of frames from a video capturing device.

Key Word: Face, Detection, Recognition, Process, Frame, Image, Matching.

1. INTRODUCTION:

Face Recognition technology developed in the 80's and it has speedily developed, particularly in the 90's.Automatic face recognition is a broadly used biological recognition technology system. One of the key challenges of face recognition problem is result well-organized with good efficiency and discriminative facial looking descriptors so as to can offset with biggest variations in clarification, pose, facial appearance, olding, incomplete occlusions and other changes in face looking problem. In comparison with other recognition methods, face recognition has more suitable and convenient features. Human being can visually identify people by human face. People can be fairly identified even in the extremely serious illustration stimulated condition.

1. A human face detection process:

The problem of face recognition is all regarding to face detection. This is a main fact that seem fairly out of the ordinary to new researchers in this field. However, previous to face recognition is potential problem, one be obliged to be able with reliably finding a face and its landmarks symbols. This is fundamentally a segmentation problem as well as in practical systems, most of the attempt goes into solving this task. In fact, the authentic recognition depended on features extracted as of these facial landmarks is single a small last step.

There are two types of face detection problems:

1) Face detection problem with images

2) Real-time face detection problem

2.1 Face detection problem with image:

Most face detection systems attempt to extract a fraction of the whole face, thereby eliminating most of the background and other areas of an individual's head such as hair that are not necessary for the face recognition task. With static images, this is often done by running a ***"window"*** across the image. The face detection system then judges if a face is present inside the window [1]. Unfortunately, with static images there is a very large search space of possible locations of a face in an image. Faces may be large or small and be positioned anywhere from the upper left to the lower right of the image.

Figure 1: Successful face detection in an image with a human face

Most face detection systems use an example based learning approach to decide whether or not a face is present in the *window* at that given instant [2] [3]. A neural network or some other classifier is trained using supervised learning with "face" and "non face" examples,

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thereby enabling it to classify an image such as *window* in face detection system as a 'face' or 'non-face'.. Unfortunately, while it is relatively easy to find face examples, how would one find a representative sample of images which represent non faces. Therefore, face detection systems using example based learning need thousands of “face” and “non-face” images for effective training [4]. Used 1025 face images and 8000 non-face images generated from 146, 212, 178 sub-images for their training set. There is another technique for determining whether there is a face inside the face detection system's *window* using Template Matching. The difference between a fixed target pattern of face and the *window* is computed and threshold. If the window contains a pattern which is close to the target pattern of face then the window is judged as containing a face. An implementation of template matching called Correlation Templates uses a whole bank of fixed sized templates to detect facial features in an image [5] [6]. By using several templates of different fixed sizes, faces of different sizes of scales are detected. The other implementation of template matching is using a deformable template [7]. Instead of using several fixed size templates, we use a deformable template, which is non rigid and thereby change the size of the template hoping to detect a face in an image. A face detection scheme that is related to template matching is image invariants. Here the fact that the local ordinal structure of brightness distribution of a face remains largely unchanged under different illumination conditions [8], is used to construct a spatial template of the face which closely corresponds to facial features. In other words, the average grey-scale intensities in human faces are used as a basis for face detection.

For example: Almost always an individual’s eye region is darker than his forehead or nose.

Therefore an image will match the template if it satisfies the 'darker than' and 'brighter than' relationships [2].

2.2 Real-time face detection problem:

Real-time face detection involves detection of a face from a series of frames from a video capturing device. While the hardware requirements for such a system are far more stringent, from a computer vision stand point, real-time face detection is actually a far simpler process than detecting a face in a static image. This is because unlike most of our surrounding environment, people are continually moving. We walk around, blink, fidget, wave our hands about, etc.

Figure 2: Frame 1 Eroded image

Figure 3: Frame 2 Dialed image

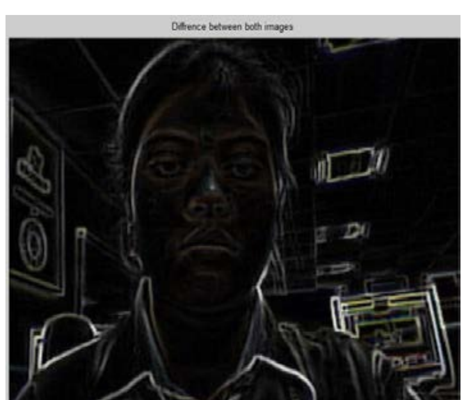


Figure 4: Temporally filtered image

Since in real-time face detection, the system is presented with a series of frames in which to detect a face, by using spatiotemporal filtering such as finding the difference between subsequent frames, the area of the frame that has changed can be identified and the individual detected [9] [10]. Furthermore as seen in **Figure 4**: exact face locations can be easily identified by using a few simple rules, such as:

A. The head is the small blob above a larger blob the body

B. Head motion must be reasonably slow and contiguous -heads won't jump around erratically [11] [12].

Real-time face detection has therefore become a relatively simple problem and is possible even in unstructured and uncontrolled environments using this very simple image processing techniques and reasoning rules.

2. Face Detection Schemas:

Image-based representation of faces, for example in 2D intensity arrays, is directly classified into a face group using training algorithms without feature derivation and analysis. Unlike the feature-based approach, these relatively new techniques incorporate face knowledge implicitly [8] into the system through mapping and training schemes.

A. Local feature

B. Global feature

C. CU-VIREO374

D. Training from Web images

E. Special features from face and audio.

Among the five components, local feature contributed most, and each of the other components incrementally improved the detection performance. For the first four components, we use SVM to train models separately, while the last component, face and audio, is used as a filtering step to rerank SVM classification results for only two concepts *singing* and *two-people*. Outputs of different SVMs are combined using average fusion. We briefly describe each of the components below.

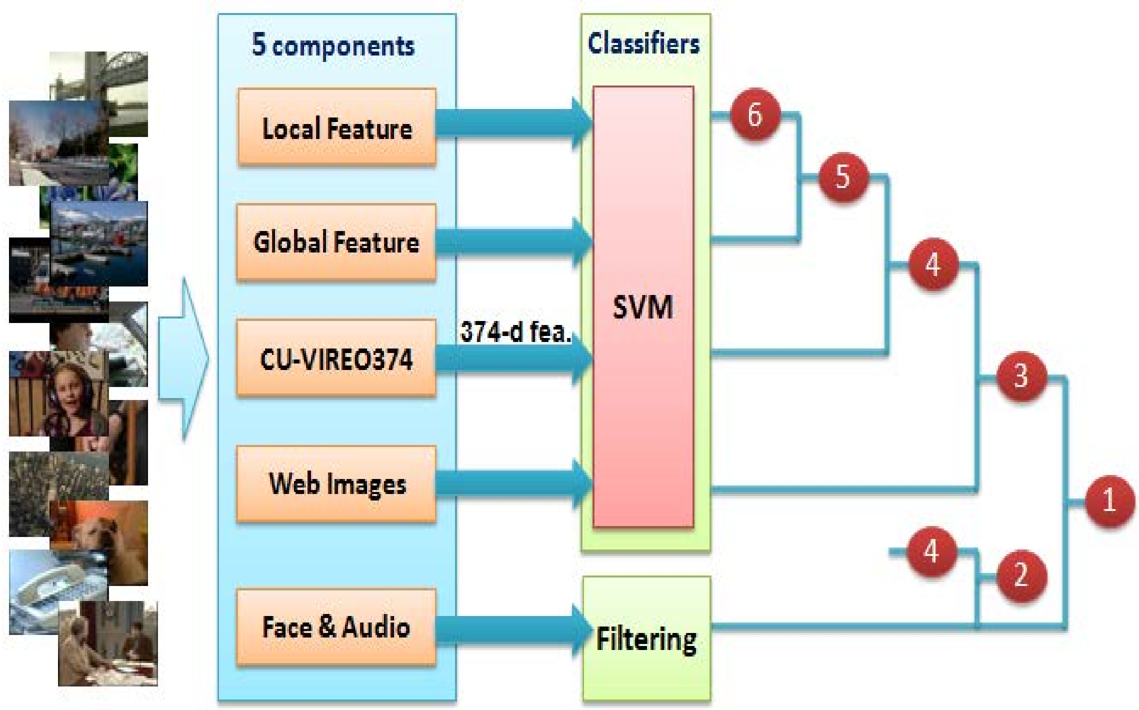
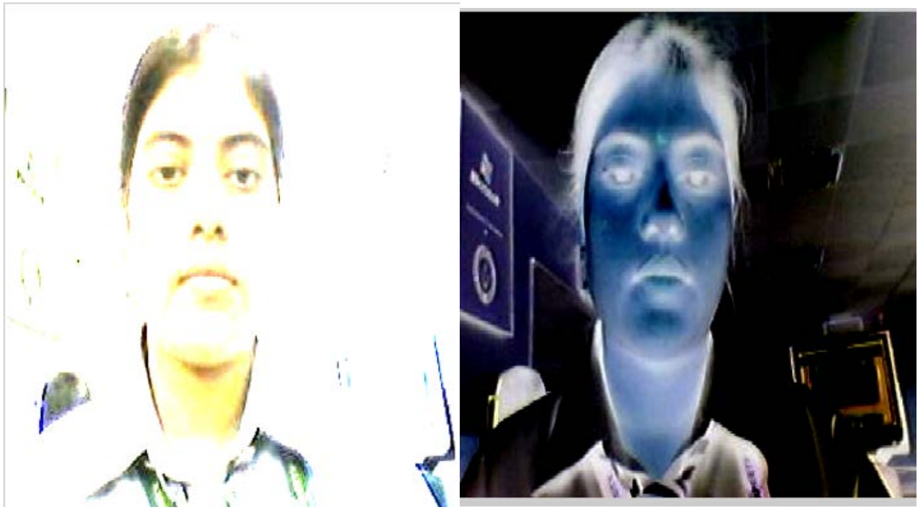


Figure 5: Five major components of System

While some may regard face detection as simple pre-processing for the face recognition system, it is by far the most important process in a face detection and recognition system. However face recognition is not the only possible application of a fully automated face detection system. There are applications in automated color film development where information about the exact face location is useful for determining exposure and color levels during film development. They are even uses in face tracking for automated camera control in the film and television news industries. In this project the author will attempt to detect faces in still images by using image invariants. To do this it would be useful to study the grey-scale intensity distribution of an average human face. The following 'average human face' was constructed from a sample of 30 frontal view human faces, of which 12 were from females and 18 from males. A suitably scaled color map has been used to highlight grey-scale intensity differences.



(A) **(B)**

Figure 6: Average human face (A) bright image (B) negative image

The grey-scale differences, which are invariant across all the sample faces, are strikingly apparent. The eye-eyebrow area seems to always contain dark low intensity gray-levels while nose forehead and cheeks contain bright high intensity grey-levels. After a great deal of experimentation, the researcher found that the following areas of the human face were suitable for a face detection system based on image invariants and a deformable template.

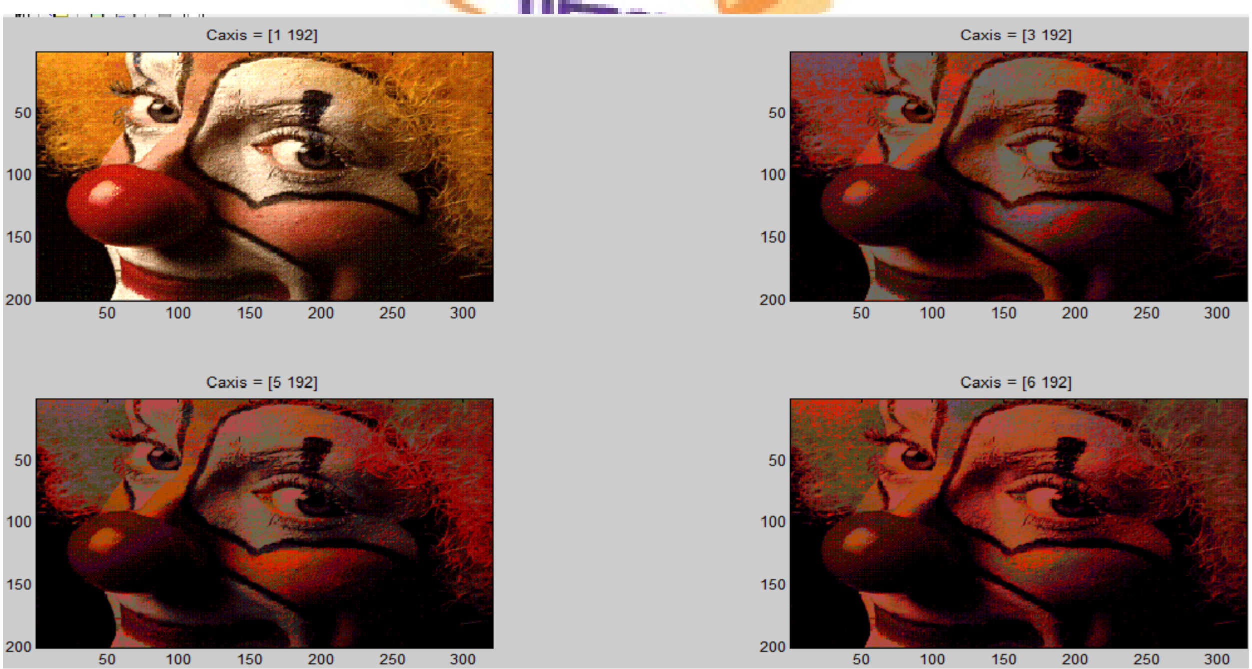


Figure 7: Area chosen for face detection with color axis scaling

The above facial area performs well as a basis for a face template, probably because of the clear divisions of the bright intensity invariant area by the dark intensity invariant regions. Once this pixel area is located by the face detection system, any particular area required can be segmented based on the proportions of the average human face After studying the above images it was subjectively decided by the author to use the following as a basis for dark intensity sensitive and bright intensity sensitive templates. Once these are located in a subject's face, a pixel area 33.3% of the width of the square window below this area will be segmented.

Figure 8: Basis for dark intensity invariant sensitive template

Figure 9: Basis for a bright intensity invariant sensitive template

Note the slight differences which were made to the bright intensity invariant sensitive template compare **Figures 8 and 9**, which were needed because of the pre-processing done by the system to overcome irregular lighting. Now that a suitable dark and bright intensity invariant templates have been decided on, it is necessary to find a way of using these to make 2 A-units for a perceptron, i.e. a computational model is needed to assign neurons to the distributions displayed in **Figures 8 and 9**.

3. Face recognition Problem:

Over the last few decades many techniques have been proposed for face recognition. Many of the techniques proposed during the early stages of computer vision cannot be considered successful, but almost all of the recent approaches to the face recognition problem have been creditable. According to the research by [6], all approaches to human face recognition can be divided into two strategies:

1. Geometrical features
2. Template matching

4.1 Face recognition using geometrical features:

This technique involves computation of a set of geometrical features such as nose width and length, mouth position and chin shape, etc. from the picture of the face we want to recognize. This set of features is then matched with the features of known individuals. A suitable metric such as Euclidean distance finding the closest vector can be used to find the closest match. Most pioneering work in face recognition was done using geometric features [13], although [14] did relatively recent work in this area.

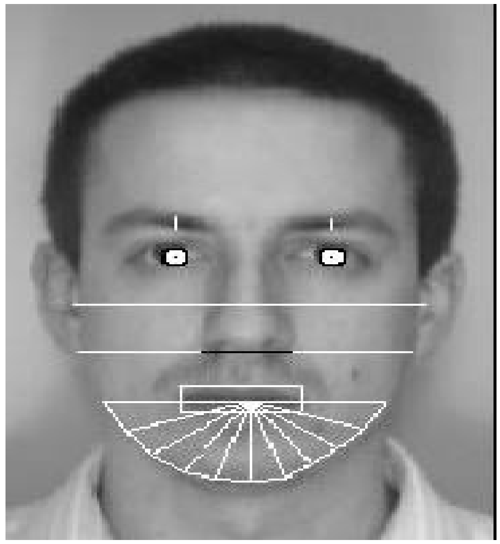


Figure 10: Facial appearance as white that could be used for face recognition problem

The advantage of using geometrical features as a basis for face recognition is that recognition is possible even at very low resolutions and with noisy images with many disorderly pixel intensities. Although the face cannot be viewed in detail its overall geometrical configuration can be extracted for face recognition.

The technique's main disadvantage is that automated extraction of the facial geometrical features is very hard. Automated geometrical feature extraction based recognition is also very sensitive to the scaling and rotation of a face in the image plane [6]. This is apparent when we [13] results where he reported a recognition rate of between 45-75 % with a database of only 20 people. However if these features are extracted manually as in [15] [16] satisfactory results may be obtained.

4.2. Face recognition with template matching:

This is similar the template matching technique used in face detection, except here we are not trying to classify an image as a 'face' or 'non-face' but are trying to recognize a face.

Figure 11: Whole face, eyes, nose and mouth regions that could be used in a template matching approach

The basis of the template matching strategy is to extract whole facial regions such as matrix of pixels and compare these with the stored images of known individuals. Once again Euclidean distance can be used to find the closest match. The simple technique of comparing grey-scale intensity values for face recognition was used by [17]. However there are far more sophisticated methods of template matching for face recognition. These involve extensive pre-processing and transformation of the extracted grey-level intensity values. **For example:** Turk and Pentland used Principal Component Analysis, sometimes known as the eigen faces approach, to pre-process the gray-levels and [18] used Elastic Graphs encoded using Gabor filters to pre-process the extracted regions.

An investigation of geometrical features versus template matching for face recognition by [6] came to the conclusion that although a feature based strategy may offer higher recognition speed and smaller memory requirements, template based techniques offer superior recognition accuracy.

4. Problem scope and system specifications:

The following problem scope for this project was arrived at after reviewing the literature on face detection and face recognition, and determining possible real-world situations where such systems would be of use. The following system(s) requirements were identified:

- A system to detect frontal view faces in static images
- A system to recognize a given frontal view face
- Only expressionless, frontal view faces will be presented to the face detection and face recognition systems
- All implemented systems must display a high degree of lighting in variency.
- All systems must possess near real-time performance.
- Both fully automated and manual face detection must be supported
- Frontal view face recognition will be realized using only a single known image from each individual.
- Automated face detection and recognition systems should be combined into a fully automated face detection and recognition system. The face recognition sub-system must display a slight degree of in variency to scaling and rotation errors in the segmented image extracted by the face detection sub-system.
- The frontal view face recognition system should be extended to a pose invariant face recognition system.

Unfortunately although we may specify constricting conditions to our problem domain, it may not be possible to strictly adhere to these conditions when implementing a system in the real-world.

5. Implementation of face detection model:

Fully automated face detection of frontal view faces is implemented using a deformable template algorithm relying on the image invariants of human faces. This was chosen because a similar neural-network based face detection model would have needed far too much training data to be implemented and would have used a great deal of computing time. The main difficulties in implementing a deformable template based technique were the creation of the bright and dark intensity sensitive templates and designing an efficient implementation of the detection algorithm.

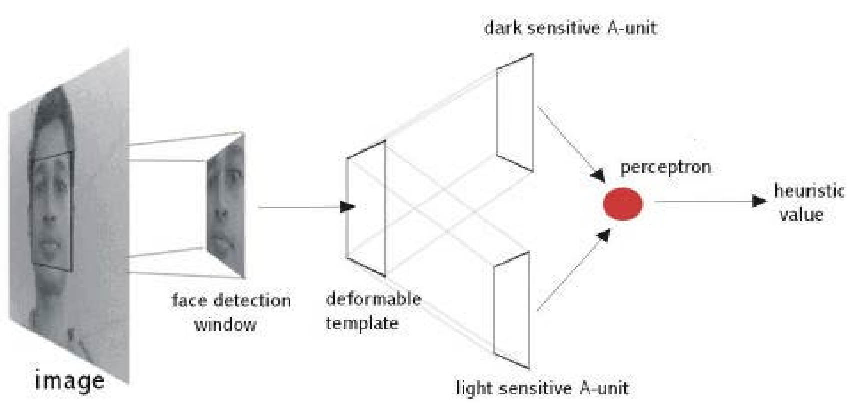


Figure 12: Implemented fully automated frontal view of face detection model

A manual face detection system was realized by measuring the facial proportions of the average face, calculated from 30 test subjects. To detect a face, a human operator would identify the locations of the subject's eyes in an image and using the proportions of the average face, the system would segment an area from the image.

A template matching based technique was implemented for face recognition. This was because of its increased recognition accuracy when compared to geometrical features based techniques and the fact that an automated geometrical feature based technique would have required complex feature detection pre-processing.

6. Conclusion

Human being can visually identify people by human face. People can be fairly identified even in the extremely serious picture stimulated condition. Faces may be large or small and be positioned anywhere from the upper left to the lower right of the image.

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