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Face Detection in Color Images using Principal Components Analysis with Video Compressions Techniques

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Abstract—*Detecting and recognizing human faces automatically in digital images strongly enhance content-based video indexing systems. In this project, a novel scheme for human faces detection in color images under non constrained scene conditions, such as the presence of a complex background and uncontrolled illumination, is presented. Color clustering and filtering using approximations of the YCbCr and HSV skin color subspaces are applied on the original image, providing quantized skin color regions. A merging stage is then iteratively performed on the set of homogeneous skin color regions in the color quantized image, in order to provide a set of potential face areas. The wavelet decomposition is then applied to extract the feature vector of potential face areas. The extracted feature vector is classified using Bhattacharyya distance to obtain the face region, and then face feature is extracted.*

In this paper we present a face detection algorithm for colour images with complex background. We include colour information into a face detection approach based on principal components analysis (PCA). A skin colour probability image is generated by doing a colour analysis and the PCA is performed on this new image instead of the luminance image. Experiments show that colour information improves the robustness of the detection significantly.

1. INTRODUCTION

In the recent past there is a growing interest in image content analysis, given a large number of applications like image retrieval in databases, face recognition or content-based image coding. The automatic detection of human faces in images with complex background is an important preliminary task for these applications (see for example Chellapa et al [1]). A problem closely related to face detection is face recognition. One of the basic approaches in face recognition is the eigen space decomposition (e.g. Turk and Pentland [8]). The image under consideration is projected into a low dimensional feature space that is spanned by the eigenvectors of a set of test faces. For the recognition task, the resulting coefficients (principal components) are compared to those of images in the database. Principal components analysis (PCA) can also be used for the localization of a face region. An image pattern is classified as a face if its distance to the face space is smaller than a certain threshold. However, our experiments show that the background leads to a significant number of false classifications if the face region is relatively small. For the detection of facial regions in color images, several techniques have been proposed so far, using texture, shape and color information, e.g. Sobottka and Pitas [6], Saber and Tekalp [5], Wang and Chang [9]. Due to the fact that color is the most discriminating feature of a facial region, the rst step of many face detection algorithms is a pixel-based color segmentation to detect skin-colored regions. The performance of such a hierarchical system is highly dependent on the results of this initial segmentation. The subsequent classification based on shape may fail if only parts of the face are detected or the face region is merged with skin colored background.

In this paper we incorporate color information into a face detection scheme based on principal components analysis. TO performing a pixel-based color segmentation and also we create a new image which indicates the probability of each image pixel belonging to a skin region (skin probability image). Using the fact that the original luminance image and the probability image have similar grey-level distributions in facial regions, we apply the back propagation algorithm for image discrimination and employ a principal components analysis to detect facial regions in the probability image. The utilization of color information in a PCA framework results in a robust face detection even in the presence of complex and skin colored background. Our detection algorithm find frontal views of human faces in color images over a range of scales. Our approach of face detection and recognition is based on machine learning by implementing artificial neural network for gray scale basis with an extensibility of working with colour images and then converting as gray scale label and the method works. A novel approach of building artificial neural network for face recognition is being applied by means of providing training to the neural network by extracted feature set rather than pattern recognition which reduces the overhead and complexity and makes the machine intelligent enough to sustain the fault tolerances.

2. MODULATION OF THE PROBLEM

We know that an enormous amount of data is produced when 2D light intensity function is sampled and quantized to create a digital image. Hence the users of digital image processing technology have to handle a large volume of data. Storing image/video data need large storage space and transmitting image data in reasonable time needs with channel capacity (bandwidth). This is illustrated through the use of Table1.1. This shows the storage size, transmission bandwidth, and transmission time needed for various types of uncompressed images.

Table 1.1: Storage and transmission need for uncompressed images.

Image Type	Size	Bits/Pixel	Uncompressed Size	Transmission Bandwidth	Transmission Time (using a 28.8K modem)
Grayscale	512 x 512	8 bpp	262 KBytes	2.1 Mbit/image	1 min 13 sec
Color	512 x 512	24 bpp	786 KBytes	6.29 Mbit/image	3 min 39 sec
Medical	2048 x 1680	12 bpp	5.16 MBytes	41.3 Mbit/image	23 min 54 sec
Super High Density (SHD)	2048 x 2048	24 bpp	12.58 MBytes	100 Mbit/image	58 min 15 sec

Therefore compression is the solution available to reduce these requirements. Increasing the bandwidth is another method, but the cost sometimes makes this a less attractive solution. Platform portability and performance are important in the selection of the compression/ decompression technique to be employed. Compression solutions today are more portable due to the change from proprietary high end solutions to accepted and implemented international standards.

The general block diagram of video compression is as shown in Fig. 1.1.

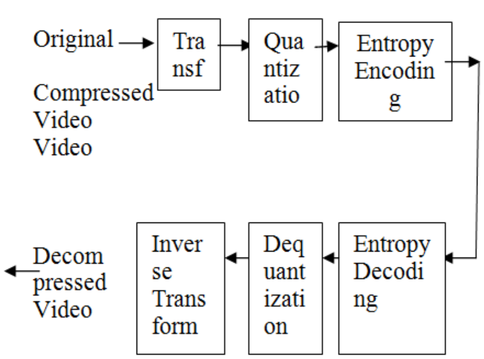

Fig. 1.1: Block diagram of video compression.

3. VIDEO COMPRESSION TECHNIQUES

Compression can be achieved by reducing the redundancy data present in the video.

There are three types of redundancy, they are

- **Spatial redundancy:** The near by pixels or neighboring pixels are often correlated with each other.
- **Spectral redundancy:** The correlation exists between different color planes or spectral bands.
- **Temporal redundancy**: The correlation exists between adjacent frames in a sequence of images (i.e.) video.

Video compression can be viewed as the compression of a sequence of images; the other words, image compression with a temporal component. However, there are limitation to this approach .We do not perceive motion video in the same manner as we perceive still image. Motion video may mask coding artifacts that would be visible in still image. On the other hand, artifacts that may not be visible in the reconstructed still images can be very annoying in reconstructed motion video sequences.

We know that video contains much spatial and temporal redundancy. Hence video compression can be achieved by exploiting these redundancies inherent in video.

4. CLASSIFICATION

Two categories of compression technique can be distinguished: **lossless and 'lossy'.**

5. LOSSLESS CODING TECHNIQUES

Lossless coding guaranties that the decompressed image is absolutely identical to the image before compression. This is an important requirement for some application domains, e.g. medical imaging, where not only high quality is in demand, but unaltered archiving is a legal requirement. Lossless techniques can also used for the compression of other data types where loss of information is not acceptable, e.g. text documents and program executables.

Data obtained from satellite often are processed later to obtain different numerical indicators of vegetation, deforestation, and so on. If the reconstructed data are not identical to the original data, processing may result in “enhancement” of the differences. It may not be possible to go back and obtain the same data over again. Therefore; it is advisable to allow for any difference to appear in the compression process.

Examples of lossless coding techniques are

- Run length encoding
- Huffman encoding
- Entropy coding (Lempel/Ziv)
- Area coding

There are many situations that require compression where we want the reconstruction to be identical to the original. There are also a number of situation in which it is possible to relax this requirement in order to get more compression. In these situation we look to lossy compression technique.

6. LOSSY CODING TECHNIQUES

Lossy compression techniques involve some loss of information, and data that have been compressed using lossy technique generally cannot be recovered or reconstructed exactly. In turn for accepting this distortion in the reconstructed, we can generally obtain higher compression ratio than is possible with lossless compression.

In most of applications we have no need in the exact restoration of stored image. For example when storing and transmitting speech, the exact value of each speech is not necessary. Depending on the quality required for the reconstructed speech, varying amount of loss of information about the value of each sample can be tolerated. If the quality of the reconstructed is to be similar to that heard on the telephone, a significant loss of information can be tolerated. Similarly, when viewing a reconstruction of a video sequence, the fact that the reconstructed is different from original is generally not important as long as the difference do not result in annoying artifacts. Thus video is generally compressed using lossy compression technique.

This fact can help to make the storage more effective, and this way we get to lossy compression methods. Lossy technique causes image quality degradation in each compression or decompression step careful consideration of the human visual perception ensures that the degradation is often unrecognizable.

Examples of Lossy coding techniques are

- Transform coding (DCT/Wavelets/Gabor)
- Vector quantization
- Segmentation and approximation methods
- Spline approximation methods (Bilinear Interpolation /Regularization)
- Fractal coding (texture synthesis, iterated functions system [IFS], recursive IFS)

Lossy image coding techniques normally have three components:

- **Image modeling**: Which defines such things as the transformation to be applied to the image
- **Parameter quantization:** Whereby the data generated by the transformation is quantized to reduce the amount of information
- **Encoding:** A code is generated by associating appropriate codeword to the raw data produced by the quantizer.

Each of these operations is in some part responsible of the compression. Image modeling is aimed at the exploitation of statistical characteristics of the image (i.e. high correlation, redundancy). Typical examples are transform coding methods, in which the data is represented in a different domain (for example, frequency in the case of the Fourier Transform [FT], the Discrete Cosine Transform [DCT], the wavelet Transform [WT], and so on), discussed in next chapter where a reduced number of coefficients contains most of the original information. In many cases this first phase does not result in any loss of information.

The aim of quantization is to reduce the amount of data used to represent the information within the new domain. Quantization is in most cases not a reversible operation: therefore, it belongs to the so called 'lossy' methods. Encoding is usually error free. It optimizes the representation of the information (helping, sometimes, to further reduce the bit rate), and may introduce some error detection codes.

7. CONCLUSIONS

We have presented a novel scheme for human faces detection in color images under non-constrained scene conditions, such as the presence of a complex background and uncontrolled illumination. The major focus of the paper is on developing preattentive pattern recognition capability that does not depend on having three-dimensional information or detailed geometry.

Morphological operations such as conversion of gray-scale to binary images, removal of noise, detection of facial edges and the skin segmentation techniques were employed for face detection. Practical implimentation QCIF video is used for compression and implementation is done in ‘c’ under Linux platform. A QCIF video contains a ‘y’ frame of 144 X 176. In the quarter common interchange format (QCIF), the luminance of the image is represented by an array of 144 X 176 pixels, and the two chrominance are represented by two arrays consisting of 72 X 88 pixels.

C compiler supports computer ranging a lowly 8051 micro controller to a super computer capable of 100 million IPS has had much to do with this.

Many programmers who use other language can still manage to code in C, or even more can read in C.

The few constructs it uses as basic language elements are easily translated to other language so data compression programs that illustrate using C can be converted to a working Pascal through straight forward translation procedure.

Allows programmer to get close to hardware.

Felxible, portable, many library function and we can create our own library function.

Implementation

Video preparation

A QCIF video is taken.

Transformation

Divide each frame into 8 X 8 blocks. For every block apply transformation to all the rows of a frame. Now apply transformation to every column of a frame. The transformed frame now contains four subbands LL, LH, HL, HH, standing for low-low, low-high, high-low, and high-high respectively. The LL can be further decomposed to yield yet another level of decomposition. This process can be continued until the desired number of decomposition level is reached or the LL component only a single element is left.

Quantization

JPEG quantization follows these steps:

User has to enter the quality factor Quantization table is updated according to the quality factor. Divide the values in each coefficient block with the elements of a quantization table.

a[i][j]=round (a[i][j] / q[i][j])

Coding

Convert the quantized coefficient block into a 64-element linear array using "zig-zag scan". Code the data in the form of (element, runlength). Write the encoded data in a file.

Decoding

Decode the encoded values using the RLE Convert the decoded values into a N XN block using "zig-zag scan".

Dequantization

Multiply the values in each decoded block with the elements of a quantization table which was used in quantization.

a[i][j]=a[i][j] * q[i][j]

Inverse Transform

The inverse transform simply reverses the step of the forward transform. i.e column transform is performed first & then row transform is done. Calculate the compression ratio, MSE, PSNR.

8. RESULTS

Practically implemented results

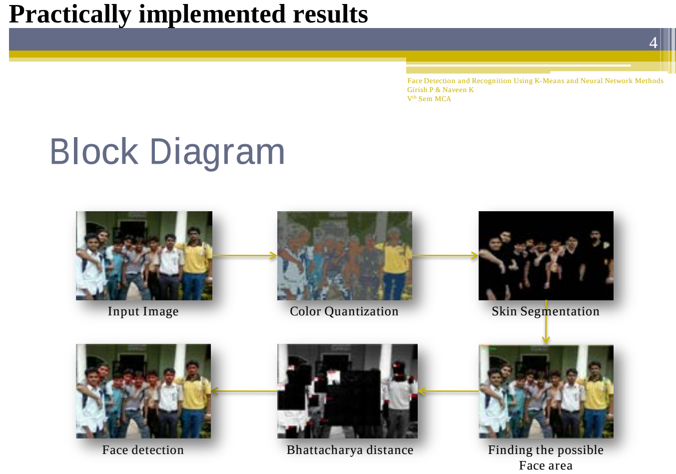

Figure 1:Block Diagram of Face Detection.

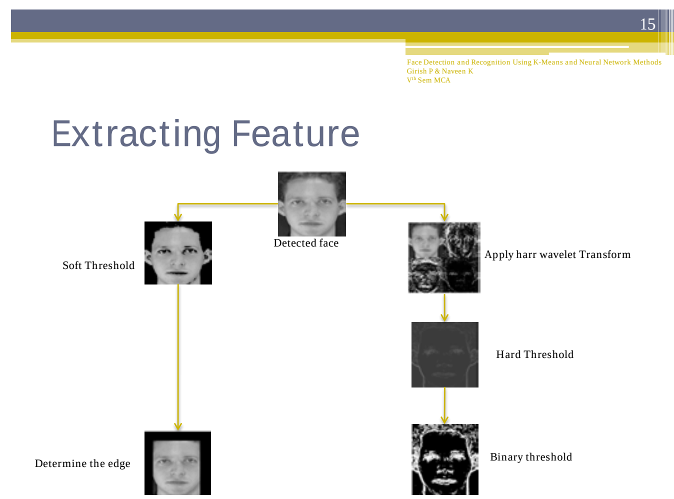

Fig. 2

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