Local Enhancement for Robust Face Detection in Poor SNR Images

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Summary
Face detection is an important preprocessing stage for automated facial recognition systems. Imaging in real world environment experience substantial variation in lighting and weather conditions. Surveillance systems are a typical example of real world imaging systems. Face detection is based upon typical haar like patterns appearing in facial images. Performance of even most successful face detection algorithms such as viola's work, typically fail in poor lighting or in low SNR (Signal to Noise Ratio) images. Therefore subsequent stage of image enhancement after image acquisition is employed to enhance the faces or face patterns in low lighting images.Proposed research work addressed the face detection in automotive environment. Algorithm addressed the situation of low lighting condition and enhanced the images captured in low lighting conditions with lights switched on. Faces of people in automobile cabin go in complete darkness and difficult to enhance. Proposed scheme is based upon local enhancement method and considerable results are achieved.

Keywords
Face Detection, Low light, Infrared, Local enhancement.

1. Introduction

Face detection is a machine based process of determining a presence of a face in a still image or video sequence. For last few decades an extensive research trend has emerged in this discipline [1]. Face detection is first of the steps taken for a wide variety of operations on digital images. In bio information systems, visual databases, surveillance systems, Identification systems etc use face detection as a basic operation. Need arises for a robust face detection algorithm. Face detection is prior operation in face recognition system.

Currently face detection systems are very efficient and can work on images and video sequences in a smart manner [2] for face localization. Viola and johns presented the most successful face detection algorithm. They used cascaded classifier approach for robust and fast face detection [3]. All this happens with images having good illumination and human intelligible scenes where human eye can also see and detect a face.

2. Literature Review

In terms of environment variations face containing images can be described in many different ways [5]. Such variations can be weather effects, snowfall, good light and bad light conditions. The low light images either come with very dull face boundaries and sometimes they mix up the face with background making no sensible barrier between human face and other objects in the image. To detect a face out of an image like this one is not possible using current face detection algorithms. Face classifiers are mostly edge detection based models [2]. They either use local features like eyes, nose and lips etc and their relative distance to detect a face or they use template based techniques for the purpose [6]. Whatever may be the case these classifiers can very easily skip relatively dark and low contrast areas in the image. Enhancement techniques can help greatly in this regard we firstly have to discriminate between the foreground faces and the background of the image using local enhancement techniques and then put the stuff for the face detection algorithm that is a part of our overall plan.

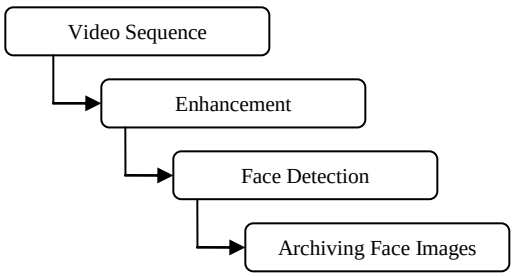

Fig.1 Image Enhancement in a Surveillance System

Roadside surveillance camera captures very good intensity images but at dusk and night the image intensity falls badly to a level that makes it unsuitable to be used in a face detection algorithm.

Light conditions varying rapidly and quality of captured images and video sequences change with it. This work proposes a system of face detection that is more robust and versatile to incorporate these changes occurring to the

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image quality due to changing light intensities. Quality in CCTV camera images vary greatly by Light condition variations. Abrupt changes in light intensity occur in different parts of the day along the roadside and open areas. This makes the performance of surveillance system poor under changing environment. Many schemes have been tried to counter this shortcoming. Targeting the need to develop a face detector that works equally well under all light conditions this work is carried out. [7] presents a skin color segmentation method for face detection in varying light conditions. In excessive light a color compensation technique is proposed but in poor light this scheme becomes less successful too. Using multi context fusion environment These shortcomings are changes are addressed in [8]. Taking images using two sensors IR and visible band sensor and later combining both types of images to extract faces, is the scheme they followed. Image fusion, despite its usefulness has a major drawback of having use of twice the number of sensors for the same task. The method we present here is based upon spatial image enhancement. Prior to submitting the image to the classifier part it is suggested to screen the image for possible enhancements. The scheme works as under

3. Proposed Method

Some objects in images captured by normal CCTV cameras are well exposed to light others are not. Capturing the scene like this the camera gets an image that hides much of the detail from face detection algorithm. Because of low SNR in images the face detector algorithm can hardly find a face hidden in dark parts of image while some parts of the image are very well lit. In order to make the image more intelligible for the classification we suggest a local enhancement method. Local enhancement treats the image captured in low light conditions to enhances the dark area of the image while keeping the well lit ones intact hence the image gets a balanced pixel intensities and becomes balanced and very well visible to the face detection system[4]. This algorithm works on those images that are more likely to have information hidden under low intensity. If we try to enhance the overall image the dark areas are exposed but the illuminated ones become excessively bright to be examined. We used the local enhancement scheme that checks out if the certain area of the image is good to be used as a candidate for enhancement. It simply does not alter the well illuminated areas but seeks for the dark ones and apply the procedure to enhance them. To search the candidate areas for enhancement the algorithms uses the local histogram matching techniques.

4. Implementation

A subimage of 3×3 pixels is defined inside the image with its center at the pixel to be examined. Here we need to perceive two aspects of pixel groups. Need to find first the global average and variance of intensities in the image. Secondly the local average and variance in subimage pixel intensities. Then by comparing these features algorithm decides if the pixel under examination is eligible for enhancement. Following are the features we are most interested to know from the division discussed above. Local histogram processing gives us the following.

1. It calculates the normal grey level in image.
2. It finds out a barrier grey level between low intensity and normal intensity grey level .
3. Least grey value that we may enhance, all the grey levels below this one are ignored.

To achieve the desired values a statistical analysis is carried out for the over all image namely global image and for the local regions we call the local image. We found the following statistical quantities of our interest.

M_G : Global Mean
D_G : Global Standard Deviation
$m_{S_{xy}}$: Local Mean
$\sigma_{S_{xy}}$: Local Standard Deviation

$$g(x,y)=\begin{cases} E\cdot f(x,y) & \text{if} \quad m_{S_{xy}} \le k_o M_G \\ & \quad AND \\ & \quad k_1 D_G \le \sigma_{S_{xy}} \le k_2 D_G \\ f(x,y) & \quad otherwise \end{cases}$$

We are interested only to enhance those areas where intensities are low and contrast is also relatively less.

4.1 Pseudo code

Read in the image
Check the image info
Get row count M
Get column count N
Global Mean M_G
Global variance D_G
For (every 3x3 sub S_{xy} image)
Local mean m_{sxy}
Local variance $\sigma_{S_{xy}}$
If (($m_{S_{xy}} <= k_o M_G$)
AND
($k_1 D_G <= \sigma_{S_{xy}} <= k_2 D_G$))
Multiply the pix value with E
Output the enhanced image

Fig.2 Low illumination low contrast input image

Fig.3 image after enhancement applied

The first half of the scheme is to decide if the point is a candidate for enhancement on the basis of luminance level if the local mean is less than or equal to a k_o times fraction of global mean i.e $m_{Sxy} \leq k_o M_G$ where k_o is constant value less than 1. Second half of the decision comes from the contrast measurement out of the given image we use the measure $k_1 D_G \leq \sigma_{Sxy} \leq k_2 D_G$ This expression deals with contrast the expression $\sigma_{Sxy} \leq k_2 D_G$ with k_2 positive value greater than 1 if light areas are needed to be enhanced and k_1 less than 1 if dark areas to be enhanced. To determine the minimum amount of contrast considerable in decision making the expression $k_1 D_G \leq \sigma_{Sxy}$ is vital with $k_1 < k_2$

Hence by finding the candidate area for enhancement and putting all the required conditions together if the given pixel at (x,y) requires to be enhanced it is multiplied with a constant E otherwise it stays the same. With the given set of parameters E=4.0, k_o=0.4, k_1=0.02,k_2=0.4 we got very encouraging results shown in fig.2 over the given images.

5. Conclusion

Using the local image enhancement techniques and image segmentation we are finally able to make up for most of the inefficiency of the face detection system working in dark. It is a successful scheme for the systems using CCTV cameras working in natural light conditions where lighting conditions vary in different times of the day. This algorithm works very efficiently with low light images where there is no intelligible information for human eyes it begins with image enhancement to facilitate face detection in the.

Keeping in view the need of industry for a minimal cost system for roadside street and dark area surveillance this algorithm is a solution. Our proposed solution has great potential to assist in the fields of crowd management, forensic analysis, surveillance systems etc.

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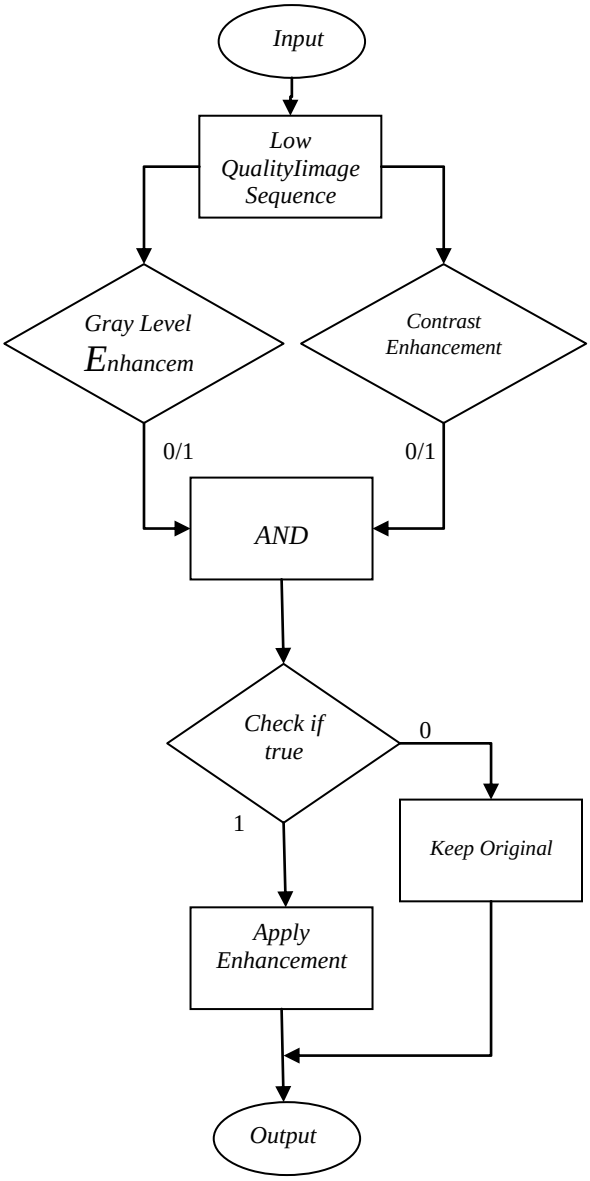

Fig.4 Flowchart of the enhancement process

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