Automatic Redeye Detection and Correction in Digital Images

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Abstract: ***Red eye effect is still a major problem in digital photography. The red eye effect in photography is the common appearance of red pupils in colored photographs. The effect is caused when the camera captures the flash light reflecting from the red blood vessels of the subject pupil. This artifact is more common when the camera lens is close to the photographic flash just like mobile phone. Various new techniques have been developed to remove this artifact. This paper discuss the latest technique which is Support Vector Machine (SVM) in which both the skin region detection as well as the red eye detection is carried out by SVM technique.***

Keywords: face detection, red eye location, SVM technique, red eye removal

1. Introduction

The light of the flash occurs too fast for the pupils to close, much of the very bright light of the flash passes into the eye through the pupil and reflects back to the camera and it records the red light. The amount of light emerging from the pupil depends upon the amount melanin in the skin behind the retina. The amount varies strongly between the people. Light skinned people with blue eyes have relatively low melanin in the fundus and they show a much higher red eye effect than dark skinned people with brown eyes.

Many software applications in the market offer red eye removal solutions. However many of them are semi-automatic or manual solutions. This paper discuss a fully automatic SVM technique for the red eye red eye removal. Firstly, the skin region is detected by using the pixel based support vector technique. If any extra non skin area is left then morphological operation is carried out for removal. Many new features like geometric and color metrics are also proposed for better classification of the image. Finally support vector machine is used to classify the output of skin detected images by the use of presented features.

Figure 1: An example of red eye effect in image

2. Literature Survey

Recently, large number of techniques have been developed for detecting red eye effect in digital photographs. Most of them are based on the detection of face and then correction of the red eye artifacts. In 2001 hardeberg [1][2], presented a semi-automatic method in which the red-eye region had to be selected manually. Later he also proposed a fully automatic technique based on preliminary color segmentation based on thresholding[3]. In 2003Loffe et al[4] presented a learning based method which combined both face and pupil detector for localizing red eye regions. In the same year Smoka et al[5] proposed a threshold based technique in which skin like region is detected first followed by red eye detection. Lea et al [6] in 2004 used Adaboost method to detect the red eye region. Yoo et al [7] used biometric method information for correcting red eyes. Wang et al [8] in 2006 used morphological filters and several heuristic exclusive principles to detect the red-eye region and corrected it by adaptive correction technique. The main cause or the red-eye effect is the flash light which picks red color from the blood in the retina. To reduce this effect, many advancements have been made in the cameras. Pre-flashes have been used in cameras before the picture is captured which contracts the pupil, thus minimizing the area of reflection. But there are some drawbacks of this. Firstly it will not completely remove the red-eye effect. Secondly this technique is more power consuming. In 2004 ,Lue et al [9]proposed a two module approach include: red eye detection and its correction.Marchesotti[10] focused mainly on red eye detection than the correction part as it was more tedious task. He proposed three correction methods and made a comparison between them. In the field of correction, Dobbs and Goodwin were the first to propose the re-recoloring of the selected image in handheld devices.

3. SVM (Support Vector Machine) Technique

The block diagram of a fully automatic red eye removal technique using SVM technique is shown below.SVM is a classification procedure based on linear optimization theory. It efficiently trains a linear learning machine in a kernel-induced feature space, while its generalization capability is assured and overtraining is evaded.

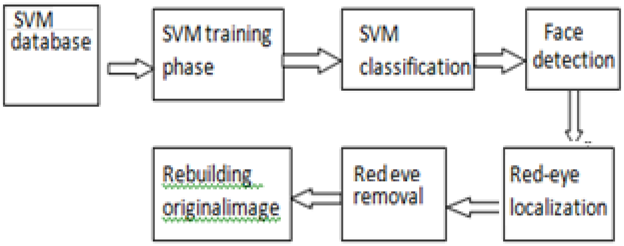

Figure 2: Fully Automatic Red Eye Removal technique using SVM

The main work of SVM is to find the decision space which best classifies the data points into two classes.The SVM algorithm is a learning based method in when it has to b trained first. Then skin detection is done followed by red eye detection and then correction. The decision function is classified as follows.

$$y = \operatorname{sgn}\left(\sum_{i=1}^{N} y_i \alpha_i K(x, x_i) + b\right) \quad (1)$$

3.1 Face Detection

Detection of the face area is the most tedious task. There may b multiple eyes in a single digital image. The effective method is to determine the rough position including the red eye by the face detection. It reduces the amount of calculation on red eye location and also improves the efficiency. Color is the main feature which is considered in the detection of face. There are different skin colors like blackish, yellowish etc. Hence the classifier should b capable of detecting all types of skin. SVM is best suited for this purpose. This is proven as an efficient tool for feature classification purpose. The image is then classified by attempting the performance for each pixel and making a decision about which of the pixels it resembles the most. Classification is done as follows.

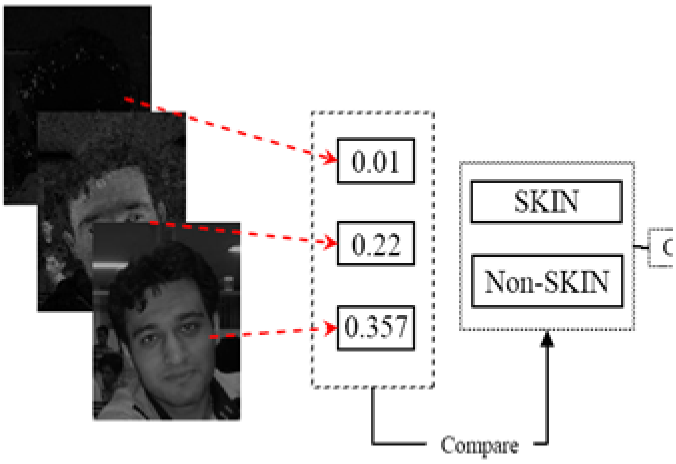

Figure 3: Steps for the skin classification

In this classification procedure each pixel is classified independently from its neighbors. For the skin classification the RGB(red-green-blue) color mode is changed into HSI(hue-saturation-intensity) form. HSI color mode is favorable for skin classification as it is high intensity invariant. RGB is changed into HSI by using following formulae:

$$H' = \begin{cases} undefined, if C = 0 \\ \frac{G-B}{C} \bmod 6, if M = R \\ \frac{B-R}{C} + 2, if M = G \\ \frac{R-G}{C} + 4, if M = B \end{cases}$$

$$H = 60^{\circ} \times H'$$

$$S = \begin{cases} 0 & If, C = 0 \\ \frac{C}{V}, & O.W. \end{cases}$$

$$I = \frac{1}{3}(R + G + B)$$

the structure of the classifier is the vector of 3xn pixel(hue saturation intensity) coefficients from each image either skin or non skin image. It will produce output between 0 to 255. So the output of the neural network is to be modified to either 0 or 1. After then morphological operation is performed to remove if any extra non skin area in left as well as filling holes. Following figure shows the output of SVM operation and morphological filtration.

Figure 4(a): Input Image

Figure 4(b): Output Image after SVM classification

Figure 4(a) shows the input image and figure 4(b) is the output image after SVM classification and morphological operation.

3.2 Red-eye location

After obtaining the skin area, second step is red-eye detection. The red eye detector comprises of six features to remove the non red eye pixels. They are divided in two separate sections.

1) Color metric: the color metric deals with the change in red color in the face area. It records the change in luminance conditions and redness of the skin parts.
2) Geometric constraints: There may exist some areas in which has same color as the red eye but not the part of it, hence they have to be removed. This can bring about serious difficulty in locating the red eye accurately. In order to overcome these false hits, geometric constraints are carries out. Morphological operation is carried out again to improve the performance.

New when the red eye is located the image is rebuilt again. Figure 5(a) shows the image after red eye location and figure 5(b) shows the rebuilt image.

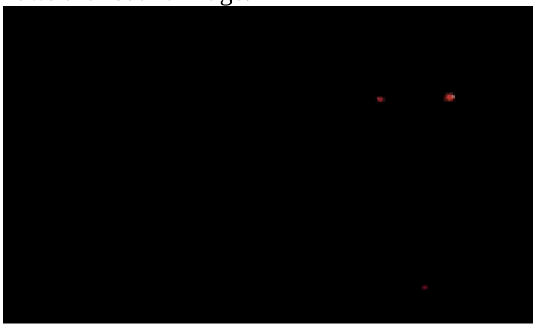

Figure 5(a): Red Eye Located Image

Figure 5(b): Rebuilt Image

3.3 Red-eye Removal

The final step is the red eye correction to get a natural looking eye. In the red eye region the color value needs to be adjusted. The main step is to absorb the light of this area and make it dark. A color based procedure is performed to transform the red region into dark region. The following equation is used to all the dimensions of R, G, B:

$$\alpha R - \beta(G + B) \quad (4)$$

Where

$$\alpha = \min\{mean\{skin.like.pixels\}\}, \beta = \max\{mean\{skin.like.pixels\}\}$$

(5)

These equations are applied on the mask area for the red eye removal. Fig.6(b) shows the final image after red eye removal.

Figure 6(a): Input Red Eye Image

Figure 6(b): Output Image

4. Comparison Metric

The experimental result of the proposed technique are compared with Redigone [10], Phixr [11] and stop red eye. To evaluate the performance, three performance metrices are considered. These are CDR (correct detection rate), false acceptance rate(FAR) and false rejection rate(FRR). The CDR, FAR and FRR are expressed in equation (12), (13), (14) respectively.

CDR=no. of pixels correctly classified/Total pixels in databset (12)

FAR= no. of non potato pixels classified as potato pixels classified/ Total pixels in test dataset (13)

FRR= no. of potato pixels classified non potato pixels classified/Total pixels in the test dataset (14)

5. Future Work

The paper presents an automatic red eye detection and correction method, which is the SVM algorithm. This is a software based technique in which the skin is detected with a pixel-based support vector machine processing. Morphological operation is carried out to remove the extra areas. In the second step new features like the color metrics and geometric constraints are proposed for the better classification of the artifact. When red-eye area is detected, then correction part is done. The future work intends to do the hardware implementation using Xilinx FPGAs of this algorithm. As the hardware implementation is carried out, we will try to optimize the speed and power consumption.

6. Conclusion

In this paper an automatic red eye removal algorithm has been presented based on SVM technique. The experimental results are satisfied with high correction rates. In the proposed work hardware implementation is carried out to improve the speed and reduce power.

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