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Exudates Localization from *Retinoblastoma* Diseased Fundus Image

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1. ABSTRACT

Retinoblastoma is becoming a major incurable disease when not detected at its earlier stage. The Retinoblastoma is a form of cancer mostly occurs in young children retina. The leakage from the retinal blood vessels called exudates is considered to be one of the major symptoms of this cancer. The identification and extraction of the exudates from the retinal fundus image is a complicated task in computerized and automated methods. This research work is proposed to localize the exudates from the retinal fundus image using image processing techniques. Finally, the performance of the proposed algorithm is analyzed using the calculation of accuracy and execution time.

Keywords: Exudates, Image processing, Retinoblastoma, Retinal fundus image

2 Introduction

Retinoblastoma is a type of melanoma that occurs in young one's eye (retina). Usually, this type of cancer is widely diagnosed in infants between 18 to 24 months. If this is not diagnosed at its early stage then they may grow and occupy much of the eyeball. As a result, the cells that are present in the retina may have the chances of breaking out from the main malignant and reaches other parts of the eyeball. This result in the development of melanoma in other parts of the eye. These tumors might block the blood vessels present within the eye, raising the pressure inside it. This may result in glaucoma, which leads to heavy pain and blindness in the eye that is affected. RB may present with single or multiple nodular, cream or white colored masses called exudates often associated with increased vascularization. So, these tumors can result in exudative retinal detachments.

RB will be identified using the health of blood vessels, optic disc, optic cub, exudates, etc., which should be examined to analyze the severity of the RB disease. The exudates are the blood leakages from the retinal blood vessel. This research paper is presented to localize the exudates so that retinal detachment and further spread of the malignancy can be avoided. The proposed DIP based algorithm uses the channel extraction from the input retinal fundus image and the noises present in it are removed using the mean filter. The resultant images are fused and compared with the templates that are created to localize the exudates.

3 Literature Review

Retinoblastoma has become one of the common intraocular malignancies in children [1] in recent times. The cause of the occurrence of this type of malignancy

is considered to be a mutation in the RB1 (Retinoblastoma protein or PRB) gene in Deoxyribonucleic acid (DNA). The responsibility of this gene is to maintain the cell division at a particular rate. So, any defects (mutation) in this protein lead to uncontrolled cell division which is usually called as cancer or tumor or malignant. The mutation of this gene can be of two types, sporadic and familial are found in children. The forms of retinoblastoma are sporadic [2] non-inherited form and familial is inherited form. Further, this is classified as unilateral and bilateral retinoblastoma. In unilateral only one eye will be affected whereas in bilateral both the eyes will be affected. The unilateral form of RB found widely. In most cases the unilateral retinoblastoma is sporadic, and the remaining is familial. In addition, bilateral also observed in children, which occur due to the germ-line mutation. The clinical descriptions of retinoblastoma are the white reflection in the pupil (Leukocoria) and lack of muscle control in the eye (strabismus). Strabismus if present it becomes consistent and there will be vision reflection impairment. Other symptoms include exophthalmia, orbital cellulitis, buphthalmia, hyphema, hypopyon, and iris rubeosis. If this tumor is not treated, they may grow and occupy major regions of the eyeball. Histogram matching based optical disc localization [3] is proposed to fasten the execution, to increase the accuracy and to reduce the computation value by not using the segmentation algorithm. DRIVE and STARE datasets are used for the optic disc localization. The exudates lesion detection in the retinal image [4] is proposed to detect the exudates automatically in diabetic retinopathy. This work uses a morphological operator for the detection of exudates. The database used to localize the lesion in Diabetic retinopathy is E-ophtha-ex which is a color eye fundus image finding its application in the scientific research on Diabetic Retinopathy. The detection of lesions automatically in the retinal image of Diabetic Retinopathy [5] is suggested to detect the bright exudates present in the retinal image automatically. To avoid the confusion between the lesion and the optic disc first the optic disc is localized and fitted with a black circle. Detection of the optic disc is performed by computing the radius in all four directions from the center. The bright lesions are localized from the green channel extracted image. Fuzzy C-means Clustering (FCM) based detection of lesions from diabetic retinopathy's retinal image by non-dilating the pupil [6] is formulated to detect the lesions successfully. Contrast enhancement of the retinal image is performed using the CLAHE method is applied for contrast enhancement. The quick detection of the optic disc is conveyed by entropy feature on the pre-processed image. Region-Based detection of exudates in retinal images using neighborhood and block operation automatically [7] is suggested to detect the lesion from the poor quality retinal image and to increase the accuracy. In this work exudates are segmented from the retinal color images and the preprocessed techniques including color normalization, enhancing the contrast, removal of noise and localization of optic disc in the retinal image are performed.

3.1 Proposed System

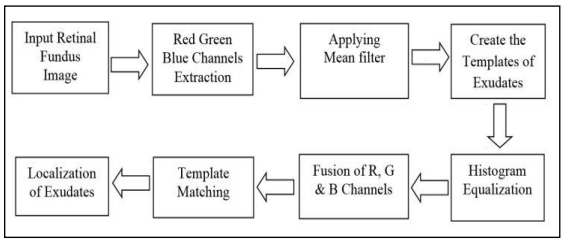

Fig1: Block Diagram for localization of the exudates in Retinal Fundus Image

The proposed algorithm is described in Figure 1 – Block Diagram. The block diagram represents the sequence in which the localization of the exudates is performed. The first step of the pre-

processing is the acquisition of the image and the extraction of Red; Green and Blue channels are performed. After the channel extraction, the filtering process is performed on each channel by the use of the mean filter. The templates of exudates are created and the filtered channels will undergo the histogram equalization techniques for contrast enhancement. The enhanced images are fused together to form the RGB image and then compared with the templates to localize the exudates.

4 Methodology

Step 1:

The retinal fundus image is taken as the input and denoted as I (m, n), which must not be null and should be finite and the value is given as $0 < I(m, n) < \infty$.

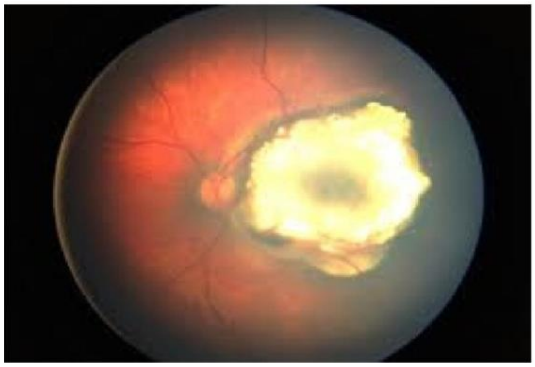

Fig2: Retinal Fundus image of retinoblastoma affected eye

Step 2:

The colored images will be having red, green and blue pixels. So, the extraction of each channel is important for the template matching.

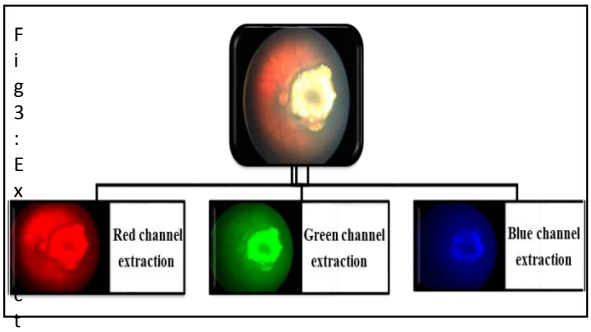

fig3: Extraction of Red, Green, and Blue Channels from Retinal Fundus Image

The red channel extracted image is defined as

$$I_r(m,n) = I(m,n)(:,:,1) \qquad (1)$$

Where $I_r(m,n)$ is the red channel extracted from the retinal image, $I(m,n)$ is the input image.

The green channel extracted image is defined as

$$I_g(m,n) = I(m,n)(:,:,2) \qquad (2)$$

$I_g(m,n)$ Denotes the green channel extracted from the retinal image.

The blue channel extracted image is defined as

$$I_b(m,n) = I(m,n)(:,:,3) \qquad (3)$$

$I_b(m,n)$ Denotes the blue channel extracted from the retinal image.

Step 3:

The image filtering is done by using Mean filter.

$$I_f(m,n) = \frac{1}{mn}\sum_{(s,t)\in S_{mn}} I(s,t) \qquad (4)$$

Here I(s,t) is the sub-image of the of I(m,n) with dimension m x n and $I_f(m,n)$ is the filtered image.

Step 4:

The templates of the exudates are created.

Step 5:

The histogram equalization is a discrete function, which is used to enhance the contrast in the input image. It is defined as

$$H(i_n) = N_n \qquad (5)$$

Where N_n represents the total number of pixels in the image with intensity value n and i_n is the nth intensity value. The retinal image will be convoluted with the histogram equalization equation as follows,

$$I_{h1}(m,n) = I_{fr}(m,n) * H(i_n)$$
$$I_{h2}(m,n) = I_{fg}(m,n) * H(i_n)$$
$$I_{h3}(m,n) = I_{fb}(m,n) * H(i_n) \qquad (6)$$

Where $I_{h(1,2,3)}(m,n)$ are histogram equalized images and the $I_{f(r,g,b)}(m,n)$ is the mean filtered image.

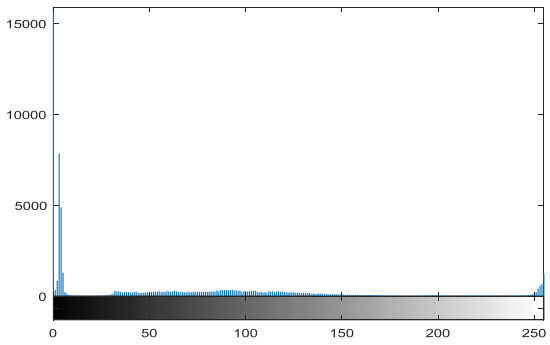

Fig4: Histogram of green channel extracted image.

Step 6:

The fusion of red, green and blue histogram equalized images are defined as

$$I_H(m,n) = I_{h1}(m,n) + I_{h2}(m,n) + I_{h3}(m,n) \quad (7)$$

Step 7:

The template matching of exudates is performed on the fusion image of Red, Green and Blue channels.

Step 8:

The exudates are localized in the Retinoblastoma diseased Retinal Fundus Image, shown in Figure 5.

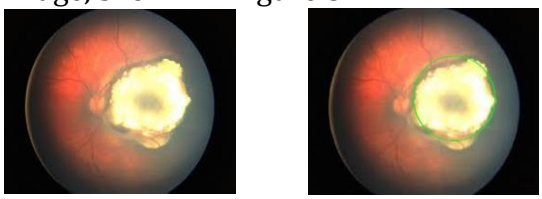

Fig 5: Original Retinal Image and Exudates localized Image

5 Result and discussion

The possible outcome of the proposed algorithm to localize the exudates from the RB diseased retinal fundus image is shown in Figure 6. The original image is arranged in the first column. The cropped templates of the input images are arranged in the second column. The exudates are localized in the third column, which is marked by the green color circle.

The performance of the proposed algorithm is analysed using accuracy and execution time calculations, both are tabulated in Table 1. The proposed method has the average accuracy of 93.1 which is better than the work by Kittipol Wisaeng et al [7], the accuracy mentioned is 92.1. The proposed work has less average accuracy compared to the work of Akara Sopharak et al [6], the mentioned accuracy is 99.1. By this comparison, the suggested algorithm is performing more accurately than the other algorithms, except [6]. The execution time is calculated, the average execution time of the suggested algorithm is 5.4095 seconds.

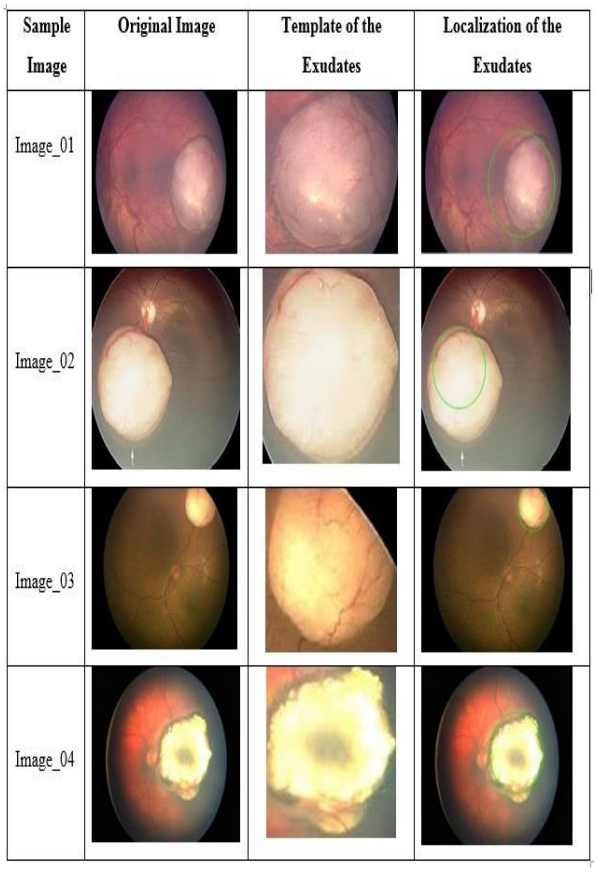

Fig 6: Results for the Localization of the exudates from the Retinal Fundus Image

Table 1: Calculation of Accuracy and Execution Time values for the proposed algorithm

Sample Image	Accuracy	Execution Time (In Seconds)
Image_01	91.5	5.3214
Image_02	87.16	6.1550
Image_03	97.24	5.0189
Image_04	96.65	5.1427
Average Value	93.16	5.4095

Thus the exudates are localized in the RB diseased retinal fundus image, which is done by the proposed algorithm. The performance of this algorithm is analyzed with the help of accuracy values and execution time.

6 Conclusions

The main objective of this research paper is localizing the exudates in the retinal fundus image of Retinoblastoma disease. Template matching and Histogram equalization methods are used to design a more accurate and precious system. The performance of the proposed algorithm is analyzed using accuracy and execution time calculations. Finally, this algorithm has proven to be efficient than existing methods. The average execution time of the proposed algorithm is 5.0495 seconds, which should be reduced to the rapid performance of the exudates localization.

7 References

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