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Detection of Glaucoma and Diabetic Retinopathy using Image Processing Technique by Raspberry pi

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Abstract

Objectives: This study is centered on detection of eye diseases like glaucoma and diabetic retinopathy. **Methods:** This work proposes an Image processing based Embedded System to detect the diseases which cause blindness. At present, detection and tracing are performed physically, which can be a cause of poor repeatability. For feature extraction, hybrid algorithm is proposed for low cost automated glaucoma and retinopathy diagnosis. Artificial neural network classifier is used for classify the datasets. For hardware implementation Raspberry Pi 3 is used. **Findings:** The system disturbed with increasing automated techniques of producing measurable descriptions of the retinal images, used in diagnosis and assessment. About 90 images are used in datasets for classification. **Application/Improvements:** For low cost glaucoma and retinopathy diagnosis automatically. A camera module can be used in future.

Keywords: ANN Classifier, Detection, Hybrid Algorithm, Eye Diseases, Raspberry Pi.

1. Introduction

Diabetic Retinopathy (DR) and glaucoma are two most ordinary retinal disorders that are major causes of blindness. The proposed system is about automated assessments of retinopathy and glaucoma using retinal fundus images. Automatic screening aid, quickly distinguishes the condition of the patient precisely. The abnormalities in eye, caused due to diabetic retinopathy can be spotted by morphological operations, filters and thresholds on the fundus images of the patient. The assessment of pair of cranial nerves, CDR arrangement is important in early detecting glaucoma in clinical practice. Due to growth in IOP, the cup is directly relative to the CDR, because while the cup increases, CDR also increases that affects the (NRR). NRR is the area located amid the edge of the disc and cup. In the existence of glaucoma, region ratio covered by NRR in superior and inferior region becomes thin as compared to region covered by NRR in nasal and temporal region. Classic fundus photo of given retina looks as shown in Figure 1. Digital image processing techniques enable ophthalmologists to detect and treat several eye diseases like diabetic retinopathy and glaucoma[1]. Glaucoma is a primary cause of permanent blindness. Hence, the detection and diagnosis has to be done in its earlier stages[2-3].

2. Proposed System

Thus, the existing literature discloses about the concepts of image processing technique to identify Glaucoma and DR, based on domain features such as CDR ratio and ISNT ratio and texture and intensity based features. In the proposed work, texture features are extracted and classified to perceive the disease.

In this study, the DR and glaucoma detection are achieved by applying the features, such as intensity value, shape and size. The features that essential to be detected

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Figure 1. Normal fundus image.

are vessels, hemorrhages and exudates. The technique used in the proposed algorithm are image pre-processing, blood vessels and hemorrhages detection, optic disc removal and exudates detection, as shown in Figure 2.

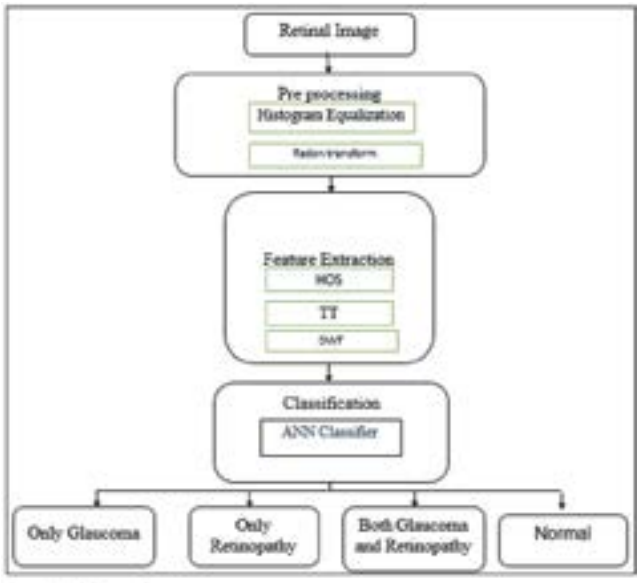

Figure 2. Proposed system.

3. Pre-Processing

Pre-processing involves two major steps:

1. Histogram equalization, and
2. Radon transformation.

3.1 Histogram Equalization

Histogram is a graphical representation of the intensity distribution of an image. It describes the amount of pixels for all intensity value. It is the process of adapting coloured fundus images into grey scale images and intensification in image contrast.

3.2 Radon Transform

The Radon transformation transforms 2D images into 1dimensional signals. The RT is used in designed tomography to form a 2D image from the measured projections. In RT improvement of noise and of some helpful artifacts from the RT sinograms is presented (Figure 3).

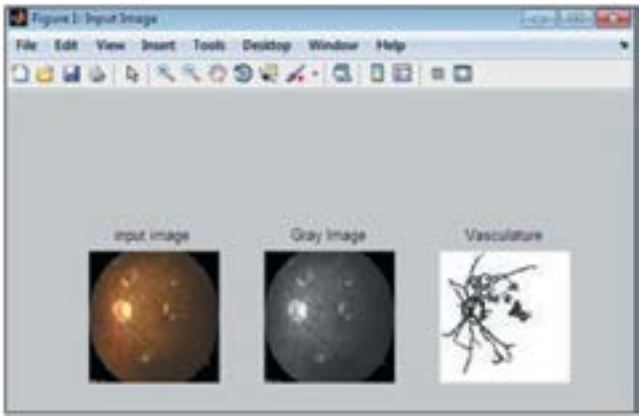

Figure 3. Pre-processing image.

4. Feature Extraction

In image processing, feature extraction had a major role. Before attainment of extraction, various image pre-processing techniques like linearization, thresholding, resizing, normalization etc. are used on the sampled image. After that, extraction techniques are practical to get features that useful in classify and recognition of images.

4.1 Higher Order Spectra Based Features

HOS captures indirect changes in image size in a nonlinear method. The algorithm starts with 2nd order statistics which calculate both mean value (m) and variance (σ).

4.1.1 Area of MA

The area of the MA is evaluated and computed by including the pixels in an iterative manner by row wise or by column wise.

$$area = \sum_{i=0,j=0}^{m,n} p^{(i,j)}$$

4.1.2 Mean

$$mean = \frac{\sum_{i=0}^{m}\sum_{j=0}^{n} p(i,j)}{m+n}$$

4.1.3 Standard Deviation

$$\sigma = \sqrt{\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left[P(i,j) - \quad\right]2}$$

4.1.4 Entropy

$$E = -\sum p \log_2 P$$

4.1.5 Homogeneity

$$H = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} \frac{P_{i,j}}{(1+|i-j|)}$$

4.2 Trace Transform (TT)

TT is a generalized approach to the Rt, and consists of outlining an image with straight lines along which certain functional, so called image functional. A TT of the image is tracing line of 2D image. The functional is to characterize a function by a number in two ways. Different functional are used to characterize rotation, translation and scaling features of an image. In many cases these features correlate well with the visual textures

$$II = (F;C_1) = \varphi(P(T(F(C_1;\varphi; p; t))))$$

where, $F(C_1;\varphi; p; t)$ specifies the values of the function along the line. C_1 is the coordinate system (φ; p; t), two triple features using the invariant functional. They are as follows:

$$II_1 = T\text{-}> IF_1;\ P\text{->}IF_2;\ \varphi\text{->}\ IF_3$$

$$II_2 = T\text{-}> IF_3;\ P\text{->}IF_2;\ \varphi\text{->}IF_1$$

The rotation, scale and translation invariant texture features that are used to quantify a visual texture measure in our application.

4.3 Discrete Wavelet Transform Energy Features

In FT, a signal is convertinton a spectrum of frequencies. Multi resolution analysis can be done using Continuous Wavelet Transforms (CWT) and DWT.

$$D(n) = \sum_{k=-\infty}^{\infty} x(k) H(2n-k)$$

$$A(n) = \sum_{k=-\infty}^{\infty} x(k) L(2n-k)$$

The frequency declaration is further enlarged by cascade the two basic filter operation. The output of the low pass filter is fed into low and high pass filter combination. The comprehensive coefficients are output at each level and they form the level coefficients. In general, the number of samples and doubles the frequency resolve. Consequently, in the final level, both detailed and approximation coefficients are obtained as level coefficients as shown in Figure 4.

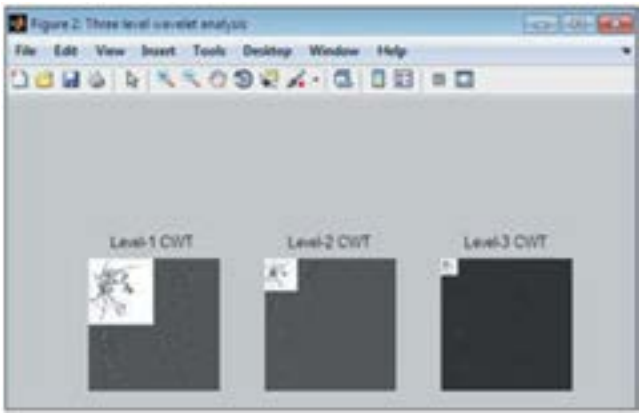

Figure 4. Result of DWT.

$$\text{Average (Dh)} = \frac{1}{Nx\,M}\Sigma_{x=(N)}^{M}\Sigma_{x=(M)}^{N}\left|Dh_1(x,y)\right|$$

$$\text{Average(Dv)} = \frac{1}{NxM}1/\Sigma_{x=(N)}^{M}\Sigma_{x=(M)}^{M}\left|Dv_1(x,y)\right|$$

$$\text{Engery=}\ \frac{1}{Nx\,M}\Sigma_{x=(N)}^{M}\Sigma_{x=(M)}^{M}\left|(Dh_1(x,y))^2\right|$$

$$\text{Engery} = \frac{1}{Nx\ M}\Sigma_{x=(N)}^{M}\Sigma_{x=(M)}^{M}\left|(Dv_1(x,y))^2\right|$$

4.4 Micro Aneurysm and Hemorrhage Detection for Diabetic Retinopathy

While processing, the image is converted into grey scale and channel is extracted. Enhancement is achieved by HE method. Segmentation involves edge detection of MA and blood vessels. Thresholding is to removal of noise. Blood vessels are eradicated. Finally, optic disc is detected and eliminated using active contour, leaving micro aneurysms in the resulting images.

The MA is in reddish in colour in the retina, diameter $\gamma > 10\mu m$. According to the distance size and red color pixels with fixed intensity, are detected as a MA. The wavelet transformation is then applied to MA candidates in order to eliminate the features that are later used by an Artificial Neural Network classifier to detect whether the candidate is an MA as shown in Figure 5.

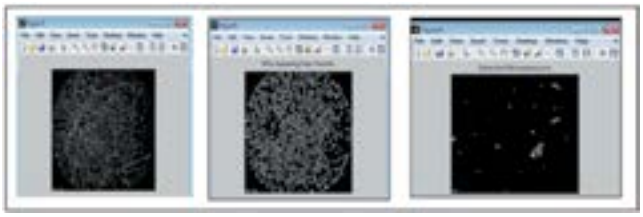

Figure 5. Micro aneurysm and hemorrhage detection for diabetic retinopathy.

4.5 Cup to Disc

The approach based on processing, the processing step involves the segmentation of CDR ratio of given image to detect glaucoma in the image.

Cup to Disk Ratio (CDR) is a very significant risk feature used to diagnose glaucoma in its early stages. Normal CDR Range below 0.3 and CDR greater than 0.3 is consider as glaucoma. Figure 6 & 7 shows segmented cup image& disc image. T

$$CDR = \frac{Number\ of\ pixels\ present\ in\ cuparea}{Number\ of\ pixels\ present\ in\ cuparea}$$

4.6 Glaucoma Diagnosis

Quantitative evaluation or description of optic disc in retinal fundus image will add as vital information for early and accurate diagnosis of disease at different stages as shown in Figure 8-11.

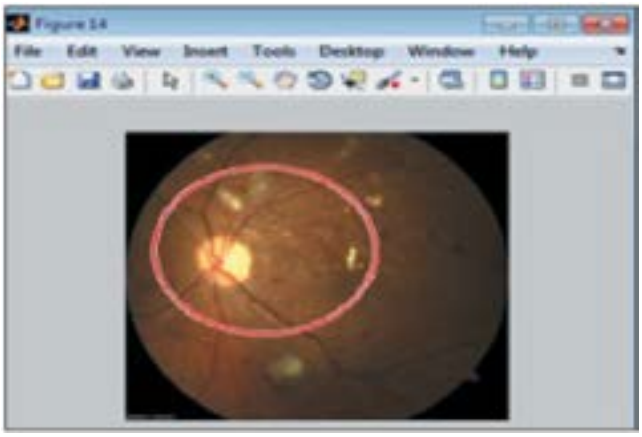

Figure 6. Retinal fundus images with the defined ROI by masking.

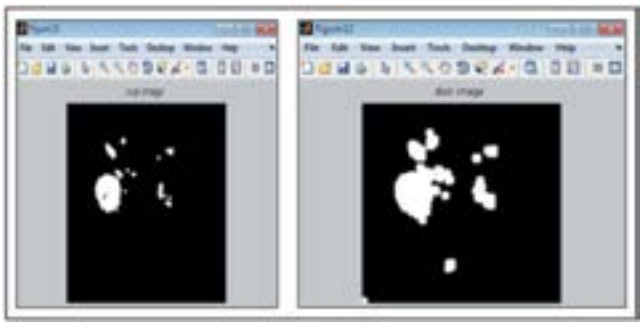

Figure 7. Segmented cup image and disc image.

4.7 GLCM Feature Extraction

The first order statistics and second order statistics or Gray Level Co-occurrence Matrix (GLCM) is formulated to obtain statistical texture features. The statistical results are shown in Figure 12.

Figure 8. Result of CDR.

5. Artificial Neural Networks

ANN consists of lots of nodes, processing units similar to neurons in the brain a single layer net there is a single

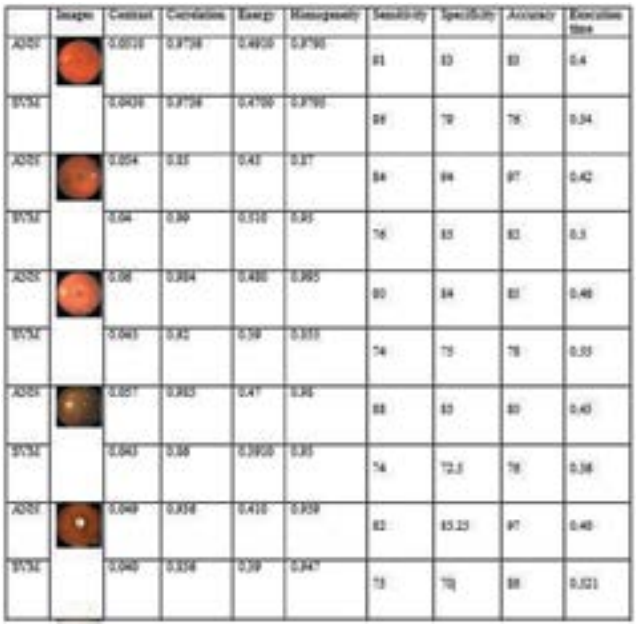

Figure 9. Performance evaluation in matlab.

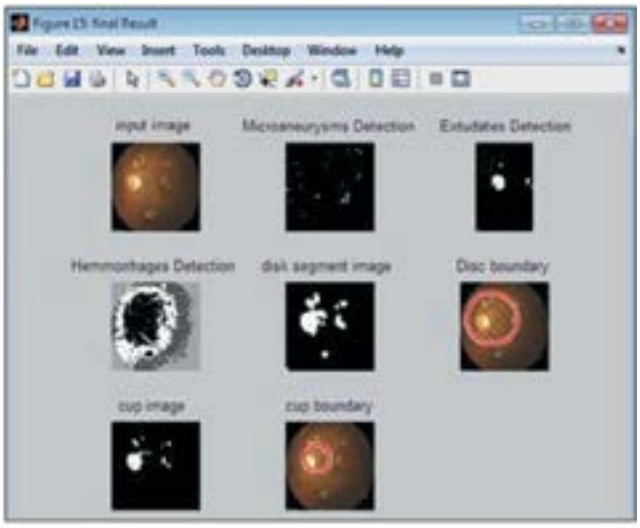

Figure 9. Detection of diseases.

Figure 10. Stages of diseases.

Figure 11. Mat lab output.

layer of biased interconnections. A multi-layer artificial neural network comprises an input layer, output layer and hidden (intermediate) layer of neurons.

GLCM Feature Extraction

Figure 12. GLCM.

5.1 Performance Evaluation

To process a fundus image in MATLAB software can take least of 14 second using PC with core i5 processor and 4 GB RAM. All the database setoff images are separately called for training and testing the detection as well as classification processes. At last of the algorithm, classifier is trained with the fundus image data set. Then the each testing image is compared with the trained images and classify. To evaluate the performance of the CHT using evaluation metrics such as sensitivity, specificity and accuracy which are computed using the following equations given below and computed values are shown in figure.

Sensitivity (%) = $TPTP+FN$ x 100 %

Specificity (%) =$TNTN+FP$ x 100 %

Accuracy (%) = $TP+TNN$ x 100 %

Where,

TP -> True Positive

TN -> True Negative

FP -> False Positive

FN -> False Negative

6. Conclusion

Detection on diabetic retinopathy and glaucoma detection from fundus image has been done. Performance Evaluation is more effective and reduces the need of more ophthalmologists. Diabetic retinopathy and glaucoma are detected from fundus images which have retina, optic disc, macular edema and blood vessels. It is experiential that elimination of optic disc and exudates from fundus images are more resourceful way to detect diabetic retinopathy and glaucoma.

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