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White and Red Lesions Detection for Diabetic Retinopathy

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Abstract :*Exudates That Appears As Bright Yellow Or White Lesions In Color Fundus Images, Is An Important Symptom Of Diabetic Retinopathy. In This Paper, An Efficient Image Based Method For The Automatic Detection Of Exudates, Is Presented And Validated. To Identify The Exudates, The Proposed Approach Performs A Hierarchical Correlation Clustering On The Input Retinal Images. Ten Different Features, Based On Dynamic Shape, Colour, Contrast And Brightness, Are Extracted For Each Patient Segment. Based On The Values Of The Feature Vectors, Each Patient Segment Is Categorized As Mild, Moderate And Severe Using Random Forest (Rf) Classifier. The Proposed Matlab App. Is Validated On Per-Image Basis Using Four Different Publicly Available Databanks. While Interpreting The Obtained Result, It Is Inferred That The Developed System Achieves An Area Under Receiver Operating Curve(Roc) Of 0.87 And The Average Computational Time Of 6.38s Is Achieved. This Approach Outperforms The Other State Of Art Approaches And May Play An Efficient Clinical Role In The Detection Of Diabetic Retinopathy.*

Index Terms *: Color Fundus Images, Diabetic Retinopathy, Exudates, Lesions, Random Forest Classifier.*

I. Introduction

Diabetes Mellitus Is A Vital Cause Of Visual Morbidity That Affects An Estimated 11.8 Million Diagnosed And 4.9 Million Undiagnosed Persons In The Us [1, 2]. Among Them 40.3% Have Some Degree Of Diabetic Retinopathy And 8.2% Have Vision Threatening Retinopathy. The Rates Of Retinopathy And Vision-Frightening Retinopathy Are Higher In Persons With Type 1 Diabetes, Occurring In 82.3% And 32.2% Of Affected Persons, Respectively [3-6]. Persons With Diabetic Retinopathy (Dr) Are 29 Times More To Become Blind Than Those Without Diabetes And It Is Estimated That Diabetic Retinopathy Is Responsible For 5% Of All The World's Blindness Cases The Medical Cost Of Dr Has Been Estimated To Be Us$500 Million Per Year In The Us Alone [6-8]. Diabetic Retinopathy Is A Microvascular Complication Of Diabetes And The Common Cause Of Damage To The Retina Of The Eye Of The Diabetic Patient. The Prevalence Of Retinopathy Varies With The Age Of Diabetes And The Duration Of Disease. For The Detection Of Diabetic Retinopathy Color Fundus Photographs Of The Retina Is Required.

If The Symptoms Are Identified In Earlier Stage, Then Proper Treatment Can Be Provided . The Effective Treatment Of Diabetic Retinopathy Can Inhibit The Progression Of The Diseases. Many Patients Are Not Aware Of This Disease. It Is Point Out That At Least 90% Of The New Cases Of Diabetic Retinopathy Could Be Reduced By Giving Proper Treatment And Regular Monitoring Of The Eye . Diabetic Retinopathy Can Be Diagnosed By The Defects Of The Retina. The Defects May Include Microaneurysms, Haemorrhages And Exudates. Microaneurysms Are The Primary Abnormality Occurring In The Eye Because Of Diabetes.

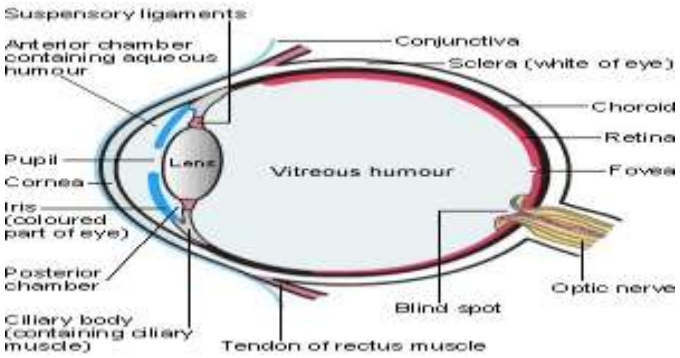

Figure 1:Anatomy Of The Eye

These Are Recognized By Tiny, Dark Red Spots Or Haemorrhages That May Occur As Alone Or In Clusters And Light Sensitive To Retina. Haemorrhages Are Round In Shape, Which Are Found In Deep Layer Of The

Retina. Exudates Are Two Types: Hard Exudates And Soft Exudates. Hard Exudates Are The Fat And Protein Leaking Out From The Blood Vessel, Which Prevents Light From Reaching The Retina And Causes Visual Impairment. There Are Some Spots Termed As Soft Exudates Are Seems In The Severe Stages Of Diabetic Retinopathy Called Cotton Wool Spots. These Caused By Nerve Fiber Layer Blocked And The Local Nerve Fiber Axons Get Blown Up . Fig.1 Shows The Features Of Diabetic Retinopathy.
The Aim Of This Paper Is To Review The Existing Method Of

Automated Diagnosis Of Diabetic Retinopathy And To Discuss On Future Research Direction Of Automated Diagnosis Of Diabetic Retinopathy. The Rest Of The Paper Is Organized As Follows. Section Ii Describes The Detection Methods And Section Iii Discussions On Existing Techniques And Future Research Directions.

II. Diabetic Retinopathy Detection Methods

Figure 2 Shows The Flow Diagram Of Diabetic Retinopathy Detection System. A. Detection By Exudates Automatic Detection Of Hard And Soft Exudates Using Histogram Thresholding Is Described By Kavitha And Duraiswmy . They Preprocessed The Fundus Images Using Cielab Colorspace And Then Used Mathematical Morphology For The Detection Of Hard And Soft Exudates. Sopharak Et Al. Described A System To Detect Exudates Based On Mathematical Morphology On Non-Dilated Retinal Image. At First, Retinal Image Was Converted From Rgb To Hsi Color Space. Then Median Filtering Was Used To Reduce Noise And An Adaptive Histogram Equalization Was Applied For Contrast Enhancement. Then Fuzzy C-Means Clustering And Mathematical Morphology Were Applied. The Accuracy Of The System Is 99.11%. Basha Et Al. Proposed A Method For Automatic Detection Of Hard Exudates In Diabetic Retinopathy From Color Fundus Images Through Morphological Segmentation And Fuzzy Logic. But Their Algorithm Still Gives Some False Detection Due To Color Similarity Among Exudates, Optic Disc And Blood Vessel. Fig. 3 Shows The Detection Of Hard Exudates In Diabetic Retinopathy.

Figure 2: Normal Fundus Image

Sargunar And Sukanesh: Described Classification Of Diabetic Retinopathy Using Fuzzy C-Means Clustering, Fractal Techniques And Morphological Transformations. The System Involves Preprocessing Retinal Images By Local Contrast Enhancement Using Mean And Variance. Then The Preprocessed Image Is Segmented And Textural Features Are Extracted For Classification. The Classification Accuracy Of The System Is 85%.

Figure 3 Fundus Image Of Retinitis Pigmentosa Disease

Sae-Tang, Et Al.: Proposed A System For Exudates Detection In Fundus Images With Non-Uniform Illumination. The Authors Divided The System Into Two Parts: In The First Part Background Illumination Was Estimated And In The Second Part Background Subtraction Was Performed For Exudates Detection.

Akter Et Al: Describe A Morphology-Based Exudates Detection For Early Diagnosis Of Diabetic Retinopathy.

Detection By Lesions, Microaneurysm And Vessels Sanchez Et Al. Described Detection Of Diabetic Retinopathy Through Lesions. Their Method Uses Two Features (Color And Shape) Of The Lesion To Detect Lesions. The Sensitivity Of The System Is 79.62%.

Esmaeili Et Al: Described A Curvelet Transform Based Method For Extraction Of Red Lesions For Diagnosis Of Diabetic Retinopathy. They Applied Digital Curvelet Transform [23] To Produce Enhanced Image And Modify Curvelet Coefficients In Order To Lead Red Objects To Zero By Thresholding. The Sensitivity Is 94% And Specificity Is 87% Of The Method.

Quellec Et Al: Described An Optimal Filter Framework For Automated Detection Of Lesions. But The Performance Of The Method Is Not Mentioned.

Automatic Retinal Lesion Detection Was Described By The Authors On The Selection Of Features Around Locally Invariant Interest Points And Visual Dictionaries Of Images. T6hey Describe Diabetic Related Lesion Detection Into Two Phases. One Is Training Consisting Of Learning The Behavior Of The Lesions That Makes The Images With Lesions Different To Normal Images. The Other Is Detection Which Consists Of Using The Learned Knowledge For Testing Unknown Images. The Performance Of The System Is 98.1%. Karnowski Et Al. Report A Method For Lesion Segmentation Based On The Morphological Reconstruction Methods Because Of Its High Adaptability To Local Contrast Changes. They Adapt The Method To Include Segmentation Of Dark Lesions With A Given Vasculature Segmentation And Used Ground Truth Data To Create Post-Processing Filters For Different Lesion Types. A Simple Bayesian Classifier Is Used To Classify Different Lesions. The Sensitivity And Specificity Of The System Is 90%. Comparisons Of Other Method Was Not Performed.

Niemeijer Et Al: Present International Microaneurysm Detection Competition, Organized In The Context Of The Retinopathy Online Challenge (Roc). They Asked An Expert To Assign Each Reference Image Identified Microaneurysm Into Three Classes Based On Their Local Contrast And Compare The Results Of Five Different Methods. The Results Of Their Work Was Submitted Through A Website After Which Standardized Evaluation Software Was Used To Determine The Performance Of Each Of The Methods.

Supervised Method Of Segmentation Of Retinal Images By Using Gray-Level And Moment Invariant-Based Features Are Used By The Authors For Early Detection Of Diabetic Retinopathy. They Use A Neural Network System And Moment-Invariant-Based Feature For Pixel Classification. The Classification Procedure Assigns As Vessel Or Nonvessel To Each Candidate Pixel. The Authors Distribute The Training Set Data In The Feature Space For The Selection Of A Suitable Classifier. Osareh And Shadgar Describe An Automatic Blood Vessel Segmentation Of Color Fundus Images Of Retina For The Detection Of Diabetic Retinopathy. They Use A Bayesian Classifier With Conditional Probability Density Function. And The Accuracy Of Their Optimum Classifier Are Evaluated Using Roc Curves Analysis. The Sensitivity And Specificity Of The System Is 95.5% Is 97.1% Respectively.

Detection By Optic Disk Aquino Et Al : Described An Automated Optic Disk Detection In Retinal Images With Diabetic Retinopathy. Their Detection Procedure Is Divided In Two Independent Methodologies. One Is Location Methodology Consists Of Maximum Difference Method, Maximum Variance Method And Low-Pass Filter Method Which Work On The Green Channel Of The Rgb Color Space Providing The Best Contrast. The Other Methods Is A Boundary Segmentation Methodology Estimating A Circular Approximation Of The Optical Disk That Applies Mathematical Morphology, Edge Detection And The Circular Hough Transform. In Fig.4. A) Shows The Determination Of The Optical Disk Detected By The Methods Given In Reference . In Fig.3, We Shows The Detected Optic Disk Region By Morphology-Based Exudates Detection. The Success Rate Of Optic Disk Location Are 98.83% And 99%,

Respectively. The Severity Of The Disease Can Be Detected By Processing Both The Fundus Image And The Electroretinogram Signal.

III. .Analysis Of Work

A. Critical Comments On Detection Through Exudates Hard And Soft Exudates Detection Described By Kavitha And Duraiswmy Method's Accuracy Is Low Due To False Detection. However, The Accuracy Of The Authors Method Is Low Due To Artifacts, Additive Noise And Fainted Exudates.

Exudates Detection By Color Histogram Thresholding, The Authors Basha And Prasad Algorithm Has Some False Detection Because The Color Of Exudates Are Similar To Optic Disc And Edge Of Blood Vessel.

Application Of Automatic Image Processing Methods To Fundus Has The Problems Of Varying Image Quality Such As Contrast And Brightness, And Characterization Of Color Differences Due To Inhomogeneous Illumination Of The Eye Background.

Sae-Tang Et Al. Describe Exudates Detection Through Non-Uniform Illumination Background Subtraction. But Their Method Has Some Limitations. Their Proposed Method Cannot Detect Some Of The Soft Exudates Because Intensity Is Not Very Distinct From The Intensity Of The Background And Some Soft Exudates Are Not As Bright Lesions.

The Method Described By Akter Et Al. Should Test Their System With More Retinopathy Images. Critical Comments On Detection Through Lesions, Microaneurysm And Vessels The Detection Of Diabetic Retinopathy Through Lesions Has Some Problems. Their Algorithm Depends On The Detection Of Optic Disk And Blood Vessels And Makes The Results Dependent On The Detection Of Optic Disk And Blood Vessels. The Authors Did Not Compare Their System With Existing Methods. The Limitation Of The Method Is That The Authors Did Not Compared To Existing Method And Classification Feature Were Not Good. Karnowski Et Al.Select The Initial Parameter And The Chosen Parameter Were Used For The Remaining Experiments For Robustness. To Save The Processing Time, The Larger Images Were Resized. Niemeijer Et Al. Describe The Results Of The Various Methods To Show The Best Performance For The Microaneurysms. But The Human Expert Is Well Ahead Of The System. So There Is Still Scope For Improvement In The Automatic System Performance. Diego Et Al. Describe A New Supervised Method For Blood Vessel Segmentation In Retinal Images. But Their System Produce Special Distribution Of The Classification Errors By The Segmentation Algorithm.

Critical Comments On Detection Through Optic Disk The System Of The Authors Have To Be Able To Analyze Low Quality Images, But Images Several Megabytes In Size Would Not Be Acceptable Because, It Needs Large Storage Requirements. The Accuracy And Robustness Of Locating The Optical Disk To Be Increased.

IV. Results And Discussion

Critical Comments On Detection Through Neural Network Sivakumar Et Al. Have To Extend To Further Applications In Medicine. Jayanthi Et Al. Described A Survey Of The Classical And The Methods For Classifying And Diagnosing The Type Of Retinal Disease And Detecting Its Features After Diagnosis At An Earlier Stage Of The Disease. Although A Lot Of Work Has Been Done, Automatic Diagnosis Of Retinal Diseases At An Earlier Stage Still Remains An Open Problem.

Vijayamadheswaran Et Al. Classified The Exudates. But They Did Not Present The Performance Of The System. Critical Comments On Detection Through Other Methods The Classification Of The System Accuracy Requires More Range Images And A Larger Number Of Neighborhood Windows. One Solution Is To Perform A Feature Selection Procedure During The Training Stage To Identify The Most Distinctive Histogram Features. Then The Range Images With Less Distinctive Histogram Features Need Not To Be Calculated.

Gang Luo Et Al. Proposed System Utilized To Extract Abnormalities Of Diabetic Retinopathy Without Over Segmentation Problem. But They Did Not Tell About The Performance Of The System. F. Future Research Directions From This Review, We Found That There Is A Good Number Of Different Approaches For Diabetic Retinopathy. All Have Some Merits And Demerits. Among These Methods Detection By Exudates, Lesions And Detection By Neural Network Are Somehow Somehow Benchmarks In This Research Domain. In Future Researcher Should Concentrate On

1) Developing Improved Camera System For Early Diagnosis Retinopathy.
2) 2) Effectiveness Of The Existing Techniques Are Questionable. For More Accuracy Hybridization Of Methods May Be Effective.
3) 3) In Addition, Researchers May Focus On Developing Novel Approaches Overcoming The Demerits Of Existing Technology.

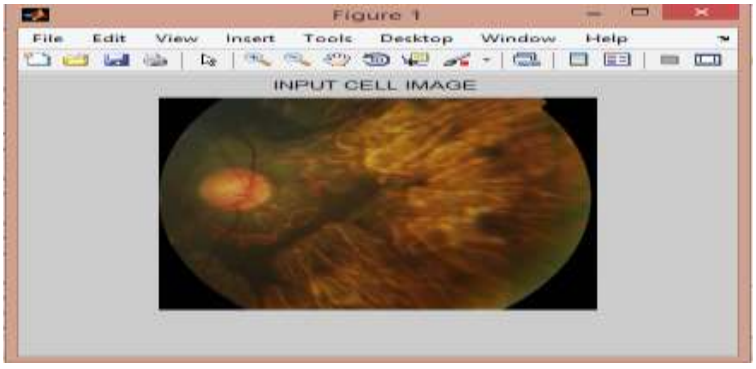

Figure 4: Input Image

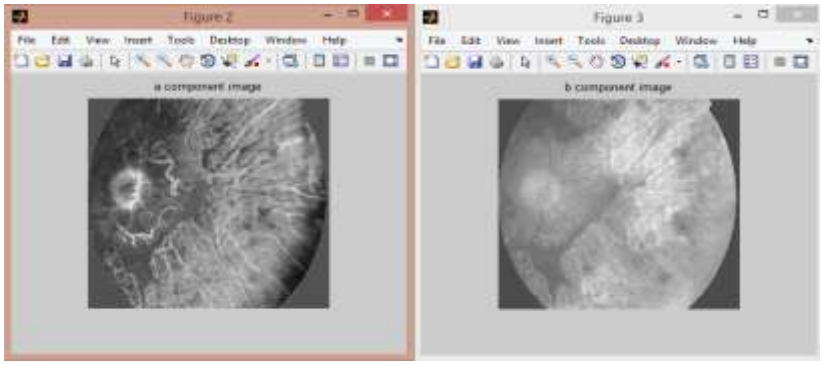

Figure 5 : Preprocessed A,B Type Images

Figure 6: Fussy C Means Clusters Images

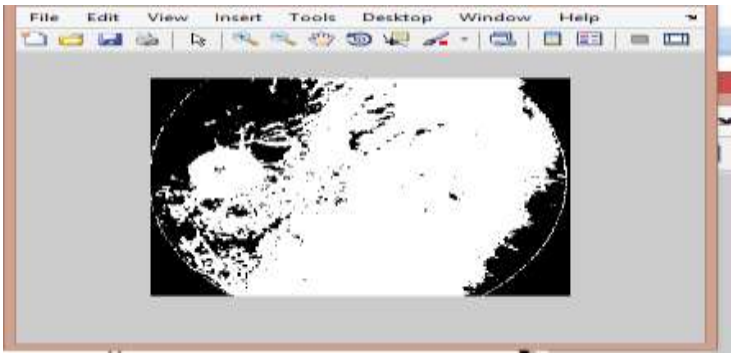

Figure7 Shape Extraction

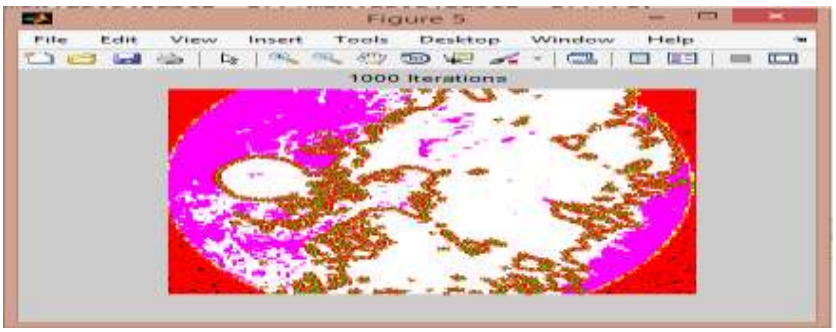

Figure 8 Roi Segmented Image

Figure 9 Feature Exatrction

V. Conclusions

We Have Presented The Current Status Of Automated Diagnosis Of Diabetic Retinopathy. The Imaging System Of The Fundus Camera Needs To Be Developed In Effective Manner With High Resolution So That The Diagnosis Of Diabetic Retinopathy Can Be Detected At Early Stage. The Performances Of Existing Techniques In Practical Situations Are Not Up-To The Mark. So Researchers Would Concentrate On Developing A System That Would Be Effective In Real Life. In Addition, Researchers May Focus On Developing A Hybrid System, Which Is Suitable For Real Life Application.

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