International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 4 Ver. III || April 2018 || PP 19-24

Automatic Diabetic Retinopathy Detection Using FCM

[1]Lokesh Gowda J, [2]K V Viswanatha
[1],Research Scholar, CMR University Bangalore
[2]Professor, CMR University Bangalore
Corresponding author:Lokesh Gowda J

Abstract: *Diabetes Is A Chronic Disease That Occurs Due To The Pancreas Does Not Able To Make Insulin. Nowadays Diabetic Retinopathy Is A Common Eye Disease In Diabetic Patients. Diabetic Retinopathy (DR) Is The Leading Cause Of Blindness In The Working-Age Population.Early Detection Of Diabetic Retinopathy Protects Patients From Losing Their Vision. The Risk Of Severe Vision Loss Can Be Significantly Reduced By Timely Diagnosis And Treatment. This Paper Directly Uses Shape, Color, And Domain Knowledge Of Diabetic Retinopathy findings To Detect The Diabetic Retinopathy And Then, The Fuzzy C-Means Clustering Method Has Been Applied To Identify The Exact Region Of The Diabetic Retinopathy. Finally, The Experimental Results Give Promising Outputs As Compared To Previous Existing Methods.*

Date of Submission: 31-03-2018 Date of acceptance: 16-04-2018

I. Introduction:

Since 40 Decades, The Diabetes Occurs In Most Of The People Due To Their Life Culture. The Diabetes Is A Disease, Where Glucose Level In A Blood Is High. Insulin Is A Hormone Produced By Pancreas,This Hormone Helps To Maintain The Normal Glucose Level In The Blood. But, If Sufficient Insulin Is Not Produced By A Pancreas, Then The Blood Glucose Level Increases This Is Called As Diabetes. Diabetic Retinopathy Is Also A Type Of Disease Caused By Diabetes. Diabetic Retinopathy (DR) Is A Disease With An Increasing Incidence And The Main Cause Of Blindness. The Danger Of Severe Vision Loss Can Be Significantly Reduced By Timely Diagnosis And Treatment. Systematic Screening For DR Has Been Identified As A Cost-Effective Way To Save Health Services Resources. Automatic Retinal Image Analysis Is Emerging As An Important Screening Tool For Early DR Detection, Which Can Reduce The Workload Associated To Manual Grading As Well As Save Diagnosis Costs And Time. Many Research Efforts In The Last Years Have Been Devoted To Developing Automatic Tools To Help In The Detection And Evaluation Of DR Lesions. Most Screening Programs Use Nonmydriatic Digital Color Fundus Cameras To Acquire Color Photographs Of The Retina. These Photographs Are Then Examined For The Presence Of Lesions Indicative Of DR, Including Microaneurysms (Mas), Hemorrhages (Hems), Exudates (Exs), And Cotton Wool Spots (Cwss). In Any DR Screening Program, About Two-Third Of Patients Have No Retinopathy. TheApplication Of Automated Image Analysis To Digital Fundus Images May Reduce The Workload And Costs By Minimizing The Number Of Photographs That Need To Be Manually Graded. ButThe Abnormalities Can Also Be Found Indirectly By Detecting Changes Between Two Fundus Images Taken From The Same Eye In Different Time Moment. Computer-Assisted Diagnosis Based On The Digital Processing Of Retinal Images In Order To Help People Detecting Diabetic Retinopathy In Advance. The Main Goal Is To Automatically Classify The Grade Of Non-Proliferative Diabetic Retinopathy At Any Retinal Image. For That, An Initial Image Processing Stage Isolates Blood Vessels, Microaneurysms And Hard Exudates.

The Diabetic Retinopathy Causes Due To The Poor Blood Supply To The Vessels. In The Early Stages, There Is No Vision Problems And Symptoms, But Later It Causes Blindness Ultimately. The Initial Clinical Indication Of DR Is The Recognition Of Microaneurysms Which Are Occurred Due To The Outflow Of Blood From Capillary. MicroaneurysmsAre The Small And Red Dots Which Spread On The Lightweight Retinal Layers (PaingEt Al., 2016) [1]. When The Walls Of Microaneurysm Get Broken, The Hemorrhages Happen Which Is Also Small Dots. The Fragment Of Hemorrhages Which Occur In The Lightweight Nerve Fiber Layer Known As Flame-Shaped Hemorrhages. The More Outflow Of Blood From Injured Capillaries Can Lead To Exudates That Are Normally In Yellow Color Lipid And Unequal-Shaped On The Retina. The Exudates Differ From The Microaneurysms And Hemorrhages In Terms Of Brightness. Medical Image Diagnosis In Image Processing Plays A Vital Role In Healthcare Applications. VermaEt Al., (2011) [2] Proposed A Technique For Detection And Classification Of DR Based On Retinal Images. The Technique Is Used To Identify Blood Vessel, Hemorrhages And Categorize The Various Stages Of DR From Normal Retinal Images. Harini&Sheela, (2016) [3] Proposed The Morphological Image Processing And Fuzzy C-Means Clustering Technique For DR Detection. Manojkumar&Sheshadri, (2016) [4] Proposed A Retina Image

Segmentation Technique Using Pillar K-Means Algorithm That Provides More Accurate And Faster Segmentation.

In This Paper A Robust Technique Is Applied To Histograms Of Intensity-Normalized Color To Increase The Gap Between Affected Region And Not Affected Region. TheFuzzy C Means Algorithm Is Employed To Detect The Diabetic Retinopathy. Section 2 Deals With The Review Of The Literature. Section 3 Describes The Detailed Process Of The Proposed Work. Section 4 Discusses Results And Performance Evaluation. Finally, Section 6 Concludes The Paper.

II. Literature Survey:

Many Studies Can Be Found In The Literature Regarding Digital Image Processing For DR. Most Algorithms Comprise Several Steps. First, A Preprocessing Step Is Carried Out To Attenuate Image Variation By Normalizing The Original Retinal Image.[1] Second, Anatomical Components Such As The Optic Disk (OD) And Vessels Are Removed. Finally, Only Those Remaining Pathological Features Of DR Are Retained For Subsequent Classification. This Review Gives An Overview Of The Available Algorithms For DR Feature Extraction And The Automatic Retinal Image Analysis Systems Based On The Aforementioned Algorithms.

SingalavanijaEt Al., (2006) [5] Conduct A Feasibility Study Of Computer-Aided Screening For Diabetic Retinopathy By Developing A Computerized Program To Automatically Detect Retinal Changes From Digital Retinal Images. Inoue Et Al., (2013) [6]Proposed An MA Detection Method Based On Eigenvalue Analysis Using A Hessian Matrix, With An Aim To Improve MA Detection. The MA Candidate Regions Were Detected By Eigenvalue Analysis Using The Hessian Matrix In Green-Channelled Retinal Fundus Images. Then, 126 Features Were Calculated For Each Candidate Region.

AkramEt Al., (2014) [7] Introduced A System Consisting Of A Novel Hybrid Classifier For The Detection Of Retinal Lesions. This Method Consists Of Pre-Processing, Extraction Of Candidate Lesions, Feature Set Formulation, And Classification. In Pre-Processing, This Method Eliminates Background Pixels And Extracts The Blood Vessels And Optic Disc From The Digital Retinal Image.

RoychowdhuryEt Al., (2014) [8] Developed A Computer-Aided System To Detect Diabetic Retinopathy. This Method Examines The Fundus Images With Fluctuating Illumination And Generates A Severity Grade. Besides, A Two-Step Hierarchical Classification Algorithm Is Presented In Which The Non-Lesions Images Are Rejected. Then, The Bright Lesions Are Classified Into Hard Exudates And Cotton Wool Spots, And The Red Lesions Are Classified Into Hemorrhages And Microaneurysms. Adaboost Is Used To Reduce The Feature Vectors, And It Is Feed To The Classification Techniques Such As Gaussian Mixture Model (GMM), K-Nearest Neighbor (Knn) And SVM Using The Dempster-Shafer Theory. From These, The SVM Classifier Produces More Classification Error Than The GMM And Knn Classifiers.

RibeiroEt Al., (2015) [9] Proposed An Algorithm To Describe The Procedures Of A Nonmydriatic Diabetic Retinopathy (DR) Screening Program In The Central Region Of Portugal And The Added Value Of The Introduction Of An Automated Disease/No Disease Analysis.WelikalaEt Al., (2015) [10] Introduced An Automated Detection Approach Of Blood Vessels From Retinal Images. InThis, Genetic Algorithm (GA) Has Used For The Feature Selection Purpose.

SahaEt Al., (2016) [11] Proposed An Approach For Early Diagnosis Of DR For Detection And Classification Of The Bright And Dark Lesions Of Fundus Retinal Images. In This, The Segmentation Of The Retinal Images Is Achieved Through The Fuzzy C-Means (FCM) Clustering Technique. The Classification Of The Bright And Dark Lesions Are Classified Using Naive Bayes And SVM Classifiers Respectively. . DoshiEt Al., (2016) [12] Proposed The Design Of Deep CNN For Diagnosing And Classify Retinal Images Into Five Different Stages Of DR. Also, To Improve The Accuracy The Developed Model Based On Deep CNN With Quadratic Weighted Kappa Metric Is Presented.

OtáloraEt Al., (2017) [13] Developed A Label-Efficient Convolutional Neural Networks (CNN) Model For The Automatic Classification Of DR. This Method Considered The Expected Gradient Length, Selection Of Most Informative Patches Using An Active Learning Algorithm And A Local Optimum Scheme. So, This Technique Used For The Detection And Segmentation Of DR. Gargeya&Leng, (2017) [14] Introduced A Deep Learning Algorithm For Automatic Diagnosis Of DR Which Is Processed A Color Fundus Retinal Images

III. Proposed Methodology:

In This Paper, The Method Directly Uses The Color And Domain Knowledge Is Used. The Histogram Is Generated For The Normalized Color Intensities. ThisHistogram Increases The Semantic Gap Between Normal Region And Abnormal Region. HistogramRatio And Back-Propagation Extracts The Feature Sets And Complete Region Is Extracted By Mapping The Density Quantiles. Finally, The Fuzzy C Means Algorithm Is Employed To Detect The Actual Diabetic Retinopathy. The Figure 1 Shows The Block Diagram Of The Proposed Method.

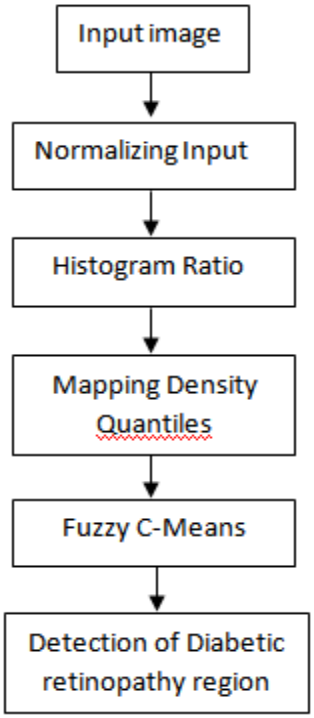


Fig 1: Block diagram of proposed algorithm

IV. Histogram Ratio And Back Projection:

The Histogram Is Generated For The Normalized Color Intensities. The Numerical Data Distribution Is Represented By Histogram. The Input Color Intensity Values Are Normalized To Red And Green Bands By Using Histogram Process. This Histogram Process Estimates The Probability Distribution Of A Given Input Intensity Values.AfterNormalizing The Input Data, The Back Projection Concept Is Employed To Back Project The Image Information. This Mapping Algorithm Back Projects Each Pixel Into Two Dimensional Vectors. The Likelihood Threshold Value Is Fixed By Mapping The Density Quantiles To Probability Density Function. This Stage, Pre-Process The Input Image And Extracts The Affected Region With More Density, Whereas The Normal Region Gives With Lower Density Distribution. This Process Retains The Shape And Color Information Of The Affected Region And Eliminates The Non-Affected Region. But Still, There Were A More False Alarms, Which Are Difficult Increase The Gap From Affected Region. Hence, The Fuzzy C- Means Algorithm Helps To Eliminate The False Alarms.

Fuzzy C-Means Cluster (FCM):

The fuzzyC-Means Clustering Method Has Been Used To Detect The diabetic Retinopathy. The Cluster Method Divides The Data Points In To Similar Type Of Classes, Hence Inter Class Similarity Will Be Low And Intra Class Similarity Will Be High. Different Clustering Methods Will Be Applied Based On The Type Of Data And Applications. In Common Clustering Method, Each data Element Will Be A Member Of Exactly One Class But In Fuzzy Clustering, Each Data Elements Associated With Membership Levels And That Data Element May Be Member Of More Than One Class. The Fuzzy C-Means Is Popular Fuzzy Clustering Algorithm To Make The Partition Of N Elements Into A Collection Of C Fuzzy Clusters Based On Some Criterion.

Fuzzy C-Means Algorithm Is Widely Used Fuzzy Clustering Procedure And It Is Introduced By Dunn In 1973, Later It Is Improved By BezdekIn 1981. The Main Purpose Of Fuzzy C-Means Algorithm Is To Minimize The Objective Function And Intra Class Variance. The Fuzzy C-Means Algorithm Is Used In The Field Of Image Processing And Pattern Recognition To Handle The Clustering Problems Efficiently.

The Fuzzy C-Means Algorithm Assigns The Membership Levels For Each Data Point Corresponds To Each Cluster Center Based On The Data Point And The Distance Between The Cluster Centers. The Summation Of Membership Of Each Data Point Is Equal To One. The Fuzzy C-Means Algorithm Allows One Data Element May Be A Member Of Two Or More Classes. The FCM Gives Best Result For Overlapped Data Elements And It Is Better Than K-Means Algorithm, But The Main Disadvantage Is To Specify The Cluster Number Apriority.

The Algorithmic Steps Of FCM:

The Fuzzy C-Means Algorithm, Partition The Collection Of N Elements ($X=\{X_1,X_2,\ldots\ldots X_n\}$) In To A C Fuzzy Clusters ($V=\{V_1,V_2,\ldots\ldots V_n\}$) Based On Some Criterion.

1) Randomly Select *'C'* Cluster Centers.

2) Calculate The Fuzzy Membership $'\mu_{ij}'$ Using:

$$\mu_{ij} = 1 / \sum_{k=1}^{c} (d_{ij} / d_{ik})^{(2/m-1)}$$

3) Compute The Fuzzy Centers $'V_j'$ Using:

$$v_j = (\sum_{i=1}^{n} (\mu_{ij})^m x_i) / (\sum_{i=1}^{n} (\mu_{ij})^m), \forall j = 1, 2, \ldots.c$$

4) Repeat Step 2) And 3) Until The Minimum *'J'* Value Is Achieved Or $||U^{(K+1)} - U^{(K)}|| < B$.

Where,

'K' Is The Iteration Step.

'B' Is The Termination Criterion Between [0, 1].

'U' = (μij)N*C' Is The Fuzzy Membership Matrix.

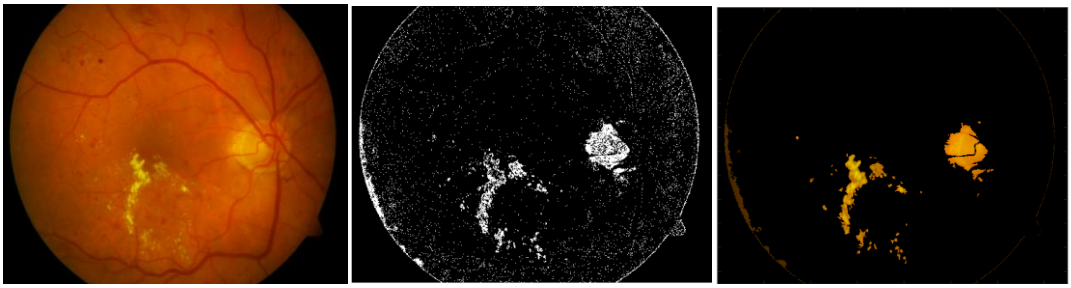
'J' Is The Objective Function.

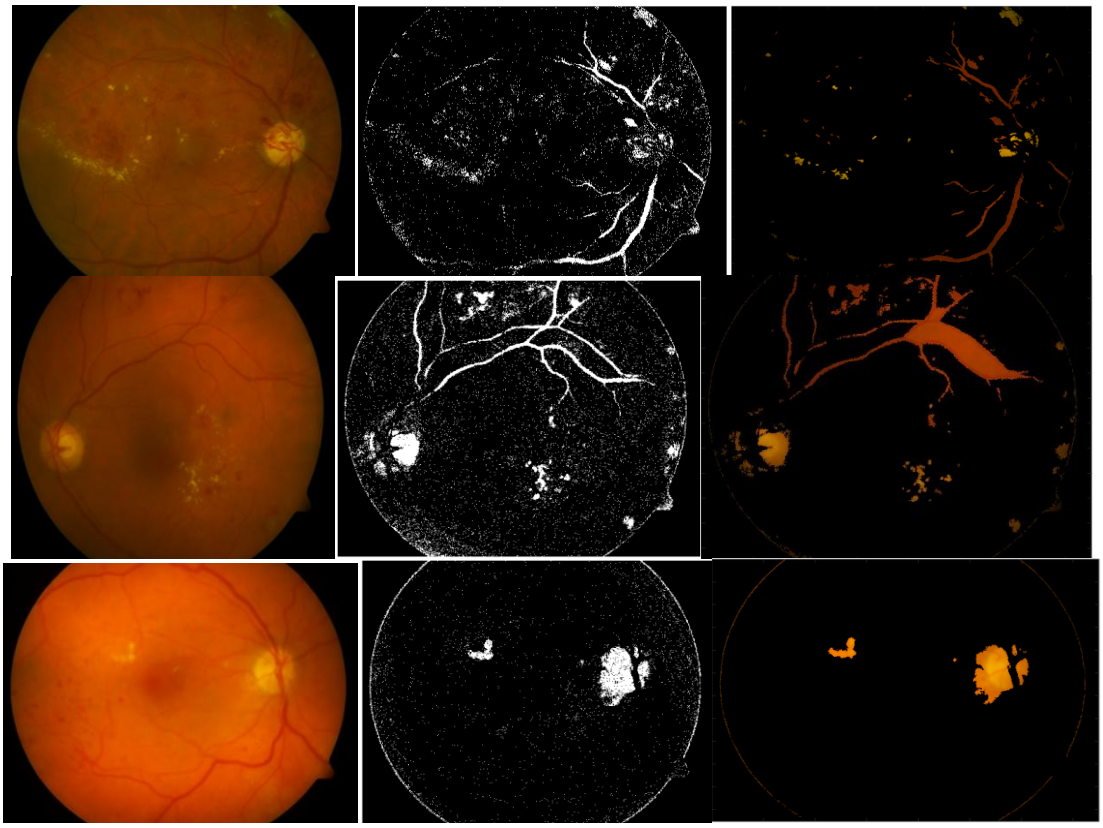
In This Work, The Fuzzy Means Algorithm Returns Three Parameters Such As Centers, Patrician Matrix And Objective Function, Where Center Provides The Final Cluster Centers, The Proximity Matrix Gives The Membership Function And Objective Function Represents The Values Of Objective Function During Iterations. The Maximum Of Proximity Matrices Are Selected To Make Separate Clusters And Then Lowest Mean Is Determined As First Cluster Among The Three Clusters, Largest Mean Is Determined As Last Cluster Among The Three Clusters And Middle Mean Cluster Is Determined As Middle Cluster.

V. Results And Discussion:

The Experimentation Of Diabetic Retinopathy (DR) Detection Is Conducted On The Processor Intel (R) Core (TM) I5 LenovoPlatform With 2.50ghz Main A Processor Speed And 8 GB Memory. The Algorithm Is Developed In Matlab2017ba.The Datasets Consist Of 80 Abnormal Retinal Images And 20 Retinal Images From Each Category.Each Image Size Is 868×922 Which Are Downloaded From The Standard Diabetic Retinopathy Database (Http://Www.It.Lut.Fi/Project/Imageret/Diaretdb1/).

TheHistogram Proses Remove The Most Of All Noise From The Given Input And Then Back Projection Retains The Affected Regions. Then Density Mapping Technique Extracts The Features. In The Segmentation Stage, The Abnormal Area Of Retinal Image Is Accurately Segmented Using Active Contour With Fuzzy C-Means Algorithm. Fig.2 Shows That The Results Of The Pre-Processing Stage Where (A) Shows The Raw Input Image With The Noise Of Size 868×922, (B) Demonstrates That The Intermediate Results And (C) Shows That The Segmented Region.





a. Input B.Intermediate Result C. Segeneted Region

Fig.2 (A) Input Retinal Image, (B) Intermediate Result, (C) Segmented Region.

The Performance Of Diagnosis Is Examined By Evaluating The Performance Of Sensitivity, Specificity And Accuracy. It Is Measured Based On The True Positive (TP), True Negative (TN), False Positive (FP) And False Negative (FN). In This, TP And TN Defines The Classifier Obtaining Right Classification Outcomes And FP And FN Defines The Classifier Attaining Wrong Classification Results.

$$\text{Sensitivity}=\frac{\text{Number of true positive assessment}}{\text{Number of all positive assessment}}=\frac{TP}{TP+FN}$$

$$\text{Specificity}=\frac{\text{Number of true negative assessment}}{\text{Number of all negative assessment}}=\frac{TN}{TN+FP}$$

$$\text{Accuracy}=\frac{\text{Number of correct assessment}}{\text{Number of all assessment}}=\frac{TN+TP}{TN+TP+FN+FP}$$

Table: I Performance Comparison Of Proposed DR Detection With Existing Techniques.

Reference	Sensitivity	Specificity	Accuracy
AkramEt Al., (2014)	96.1%	94.7%	94.81%
Jahiruzzaman&Hossain, (2015)	98.2%	89.8%	92.3%
Proposed Method	98.38%	96.36%	99.01%

The Comparison Of Proposed DR Detection Method Is Compared With Existing Techniques In Terms Of Sensitivity, Specificity And Accuracy Which Is Shown In Table I. The Proposed Method Achieves The Better Sensitivity, Accuracy, And Specificity Than The Existing Techniques.

VI. Conclusion:

In This Paper, The Propose Method Uses The Color Intensity And Domain Knowledge Is Used To Extract The Abnormal Region. Then Histogram Is Generated For The Normalized Color Intensities. Back-Propagation Extracts The Feature Sets And Complete Region Is Extracted By Mapping The Density Quantiles. Finally, The Fuzzy C Means Algorithm Is Employed To Detect The Actual Diabetic Retinopathy. The Simulation Results Of The Proposed Classifier Obtained The Accuracy Of 99.01%, Sensitivity Of 98.38%, And

Specificity Of 96.36%. Also, It Is Verified That The Performance Of The Proposed Method Is Better Than The Existing Methods.

References:

[1]. Paing, M. P., Choomchuay, S., &Yodprom, M. R. (2016, December). Detection Of Lesions And Classification Of Diabetic Retinopathy Using Fundus Images. In Biomedical Engineering International Conference (Bmeicon), 2016 9th (Pp. 1-5). IEEE.

[2]. Verma, K., Deep, P., &Ramakrishnan, A. G. (2011, December). Detection And Classification Of Diabetic Retinopathy Using Retinal Images. In India Conference (INDICON), 2011 Annual IEEE (Pp. 1-6). IEEE.

[3]. Harini, R., &Sheela, N. (2016, August). Feature Extraction And Classification Of Retinal Images For Automated Detection Of Diabetic Retinopathy. In Cognitive Computing And Information Processing (CCIP), 2016 Second International Conference On (Pp. 1-4). IEEE.

[4]. Manojkumar, S. B., &Sheshadri, H. S. (2016, March). Classification And Detection Of Diabetic Retinopathy Using K-Means Algorithm. In Electrical, Electronics, And Optimization Techniques (ICEEOT), International Conference On (Pp. 326-331). IEEE.

[5]. Singalavanija A, Supokavej J, Bamroongsuk P, Sinthanayothin C, Phoojaruenchanachai S, Kongbunkiat V. Feasibility Study On Computer-Aided Screening For Diabetic Retinopathy. Jpn J Ophthalmol2006;50:361-6.

[6]. Inoue T, Hatanaka Y, Okumura S, Muramatsu C, Fujita H. Automated Microaneurysm Detection Method Based On Eigenvalue Analysis Using Hessian Matrix In Retinal Fundus Images. ConfprocIEEE Eng Med Biolsoc 2013;2013:5873-6.

[7]. UsmanakramM, Khalid S, Tariq A, Khan SA, Azam F. Detection And Classification Of Retinal Lesions For Grading Of Diabetic Retinopathy. ComputbiolMed 2014;45:161-71.

[8]. Roychowdhury, S., Koozekanani, D. D., &Parhi, K. K. (2014). DREAM: Diabetic Retinopathy Analysis Using Machine Learning. IEEE Journal Of Biomedical And Health Informatics, 18(5), 1717-1728.

[9]. Ribeiro L, Oliveira CM, Neves C, Ramos JD, Ferreira H, Cunha-Vaz J. Screening For Diabetic Retinopathy In The Central Region Of Portugal. Added Value Of Automated 'Disease/No Disease' Grading. Ophthalmologica2015; 233:96-103. DOI: 10.1159/000368426.

[10]. Welikala, R. A., Fraz, M. M., Williamson, T. H., &Barman, S. A. (2015). The Automated Detection Of Proliferative Diabetic Retinopathy Using Dual Ensemble Classification. International Journal Of Diagnostic Imaging, 2(2), 72.

[11]. Saha, R., Chowdhury, A. R., &Banerjee, S. (2016, June). Diabetic Retinopathy Related Lesions Detection And Classification Using Machine Learning Technology. In International Conference On Artificial Intelligence And Soft Computing (Pp. 734-745). Springer, Cham.

[12]. Doshi, D., Shenoy, A., Sidhpura, D., &Gharpure, P. (2016, December). Diabetic Retinopathy Detection Using Deep Convolutional Neural Networks. In Computing, Analytics And Security Trends (CAST), International Conference On (Pp. 261-266). IEEE.

[13]. Otálora, S., Perdomo, O., González, F., &Müller, H. (2017). Training Deep Convolutional Neural Networks With Active Learning For Exudate Classification In Eye Fundus Images. In Intravascular Imaging And Computer Assisted Stenting, And Large-Scale Annotation Of Biomedical Data And Expert Label Synthesis (Pp. 146-154). Springer, Cham.

[14]. Gargeya, R., &Leng, T. (2017). Automated Identification Of Diabetic Retinopathy Using Deep Learning. Ophthalmology.

Lokesh Gowda J"Automatic Diabetic Retinopathy Detection Using Fcm"International Journal of Engineering Science Invention (IJESI), vol. 07, no. 04, 2018, pp 19-24