Automatic Diabetic Retinopathy Detection Using FCM

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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.

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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. The Application 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. But The 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.

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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. The Fuzzy 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:


Akram Et 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.


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. This Histogram Increases The Semantic Gap Between Normal Region And Abnormal Region. Histogram Ratio 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.
IV. Histogram Ratio And Back Projection:


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 \(X=\{X_1,X_2,\ldots,X_n\}\) In To A C Fuzzy Clusters \(V=\{V_1,V_2,\ldots,V_n\}\) Based On Some Criterion.

1) Randomly Select ‘C’ Cluster Centers.
2) Calculate The Fuzzy Membership \(\mu_{ij}\) Using:

\[
\mu_{ij} = 1 / \sum_{k=1}^{c} \left( \frac{d_{ij}}{d_{ik}} \right)^{2/(m-1)}
\]

3) Compute The Fuzzy Centers \(V_j\) Using:

\[
V_j = \frac{\sum_{i=1}^{n} (\mu_{ij})^m x_i}{\sum_{i=1}^{n} (\mu_{ij})^m}, \quad \forall j = 1, 2, \ldots, c
\]

4) Repeat Step 2) And 3) Until The Minimum ‘J’ Value Is Achieved Or \(\|f^{(k+1)} - f^{(k)}\| < B\).

Where,

‘K’ Is The Iteration Step.
‘B’ Is The Termination Criterion Between [0, 1].
‘U’ = \((\mu_{ij})^{N*C}\) 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). The Histogram Proses Remove The Most Of All Noise From The Given Input And Then Back Projection Rets 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.
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.**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>AkramEt AL., (2014)</td>
<td>96.1%</td>
<td>94.7%</td>
<td>94.81%</td>
</tr>
<tr>
<td>Jahiruzzaman&amp;Hossain, (2015)</td>
<td>98.2%</td>
<td>89.8%</td>
<td>92.3%</td>
</tr>
<tr>
<td>Proposed Method</td>
<td>98.38%</td>
<td>96.36%</td>
<td>99.01%</td>
</tr>
</tbody>
</table>

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

References: