

Detection and Comparison of Diabetic Retinopathy using Thresholding Algorithm and C-Means Clustering Algorithm

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Abstract

Aim: The aim of this research work is to detect the presence of Novel Diabetic Retinopathy Detection using modern algorithms, and comparing the peak signal to noise ratio (PSNR) between Thresholding Algorithms and C-Means Clustering Algorithms. **Materials and Methods:** The sample images were taken from kaggle's website. Samples were considered as (N=24) for Thresholding Algorithm and (N=24) for c-means clustering algorithm in accordance with total sample size calculated using clinicalc.com by keeping alpha error-threshold value 0.05, enrollment ratio as 0.1, 95% confidence interval, G power as 80%. The PSNR was calculated by using the novel MATLAB Programming with a standard data set. **Results:** Comparison of PSNR is done by independent sample t-test using SPSS software. There is a statistical significant difference between Thresholding Algorithm and C-means clustering algorithm with $p=0.014$, $p<0.05$ (PSNR = 37.290) showed better results in comparison to Thresholding Algorithm (PSNR =14.7327). **Conclusion:** C-Means Clustering Algorithms were found to give higher PSNR than in Thresholding Algorithms for the Novel Diabetic Retinopathy Detection.

Keywords: Novel Diabetic Retinopathy Detection, Machine learning, Thresholding Algorithm, C-Means Clustering Algorithm, MATLAB Programming, Peak Signal to Noise Ratio (PSNR).

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INTRODUCTION

This study helps in detecting the presence of Novel Diabetic Retinopathy at an early stage using modern algorithms like Thresholding Algorithm (Nayak et al. 2008). The main importance of this is the early detection of Novel Diabetic Retinopathy will decrease the damage risk for the eye and reduce the vision loss by applying the modern algorithms (SH. Mohammed and Yousif, n.d.; Elsherbiny et al. 2019). This study can be implemented in healthcare, ophthalmology, diabetics retinopathy screening (Bellemo et al. 2019)(Mookiah et al. 2013). Its concept is based on separate objects of interest in an image from the background depending on their gray level distribution (Narasimhan, Neha, and Vijayarekha 2012).

About 350 Google Scholar and 69 ScienceDirect articles related to this research were followed, which was carried out in recent years. Automatic Thresholding is a well-known and most effective tool in medical image segmentation. As a previous work some researchers used Thresholding in diagnosis. Therefore, one of the most effective methods used for segmenting images is Thresholding. It is simple, but effective in isolating the objects from the background whereas this research work deals with the Novel Diabetic Retinopathy Detection using C means algorithm. The classification technique had achieved 98.5 % accuracy. This methodology additionally characterizes effectively other Novel Diabetic Retinopathy Detection stages or other retinal sicknesses, which influence the vessels or neovascularization appropriation (Abdelsalam and Zahran 2021) The proposed technique is to upgrade the picture and filter the noise, detect blood vessels and recognize the optic disc, extract the exudates and microaneurysms, separate the components and classify various phases of Diabetic Retinopathy. This approach has not achieved good accuracy (Raman, Then, and Sumari 2016). This research describes an effective methodology to study any fundus image using algorithms for the detection of red lesions. The obtained result was of 83% sensitivity and 92% of specificity (Ganguly et al. 2014; Mahmood 2020; Islam et al. 2020). (X. Chen et al. 2012) Detection. The classification and comparison of algorithms into different categories, definition of terms and discussion of evolving techniques will provide guidance to algorithm designers for Diabetic Retinopathy. The obtained specificity is 99.76% sensitivity of 93.1034% and accuracy of 93.33% (S,

Shaziya, and Ravindra 2020). This research paper was considered to be the best one in detecting the Novel Diabetic Retinopathy compared to the other research works. Our team has extensive knowledge and research experience that has translate into high quality publications (Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)

Highly required treatment in later stages for some cases is not possible, therefore it is the major key point that motivated me to work on this project to detect the presence of Novel Diabetic Retinopathy Detection at an early stage. The authors were expertised in the field of machine learning algorithm, MATLAB Programming and able to conduct studies in comparison in Thresholding Algorithm and C means algorithm in the biomedical aspect. The main aim is the early Novel Diabetic Retinopathy Detection with higher PSNR.

Materials And Methods

This study is conducted in a Simulation lab, Saveetha School of Engineering. There is no Ethical concern for this study. There are two groups involved, Thresholding Algorithm and C-Means Clustering Algorithm. Sample size for each group is 24. Sample size calculation was done using clinalcalc.com by applying the parameter values from previous iterations (Ramasubramanian and Prabhakar 2013). The pretest power value is 80% and the threshold value is set to be 0.05 and confidence interval as 95%. There are no dependent variables in this study.

Sample preparation using given algorithms

Sample preparation for the two processes were done for preparing group 2 with 24 samples. First the input images from the dataset rescaled into 630 x 270 pixels. Next feature extraction and classification is carried out by using Thresholding and C-Means Clustering Algorithm (W. Chen et al. 2021). The estimated sample values are exported in MS Excel for further statistical analysis. Algorithm is trained with features of all the images instead of individual images and while testing rather than the predicted label of the testing image a whole label of obtained features is predicted. If the image of the majority of features is matching with that of the expected image it is a successful recognition.

Testing setup and testing procedure

All the experimental setup was done in windows platform CRT monitor with resolution of 1024*768 pixels with configuration 9th gen, intel i5, 4GB RAM, and MATLAB software 2018 version with add ons required for complete training and testing purposes. Low resolution images sample given as an input for testing procedure. In the pre-processing stage, scaling was done to resize the images to 600 x 450 pixels. And detects the Diabetic Retinopathy image for the feature extraction and output contains more feature information and has 433 dimensions, allowing for better retrieval performance. Finally the recognition of the Novel Diabetic Retinopathy Detection image is done. The image enhancement PSNR is obtained by testing the dataset on a Thresholding Algorithm and C-Means Clustering Algorithm. The sample value stored in MS-Excel is used for statistical analysis in the SPSS IBM tool.

Statistical analysis

To validate the results of both the algorithms statistical analysis was done using IBM SPSS software. As the two algorithms are independent of each other, an independent sample t-test was performed for the independent variable PSNR. There are no dependent variables.

Results

In this research of the Novel Diabetic Retinopathy Detection, the C-Means Clustering Algorithm was found to be better than the Thresholding Algorithm giving a higher PSNR. The value of PSNR given by the C-Means Clustering Algorithm is (37.2901) and that given by the Thresholding Algorithm is (14.7327). In Fig. 1 it is observed that the mean PSNR is higher for the C-Means Clustering algorithm than the mean of the Thresholding Algorithm. C-Means Clustering Algorithm had the highest PSNR 37.2901 in comparison to Thresholding Algorithm, 14.7327. Table 1 represents the PSNR of the samples collected using the Thresholding Algorithm and C-Means Algorithm. The descriptive statistics in Table 2 demonstrated that C-Means Clustering

Algorithms had less error rate than the Thresholding Algorithm. The figures given below Fig. 2a represents the thresholded image for the given sample image of Diabetic Retinopathy. Fig. 2b represents the c-means clustering algorithm image for the given sample image of Diabetic Retinopathy.

There appears to be a statistically significant difference ($P=0.014$, $p<0.05$) in both the methods using independent sample t-tests as shown in Table 2. This strategy suggested that the Novel Diabetic Retinopathy Detection can be done early. These results show that C-Means Clustering Algorithms can be used to detect Diabetic Retinopathy at an early stage in comparison with Thresholding Algorithms.

DISCUSSION

In this research work of detecting Diabetic Retinopathy using C-Means Clustering Algorithm had the highest Peak Signal to Noise Ratio (PSNR) (37.2901) in comparison to Thresholding Algorithm (14.7327). There appears to be a slight increase in the significant difference but not statistically significant (Table 3). The sensitivity and accuracy of the detector is obtained as 98.2% and 92.3% respectively with less computational time compared to usual retinal vessels based Diabetic Retinopathy detection (ManojKumar and Sheshadri 2016). The results obtained here were validated by comparing it with expert ophthalmologists. The classification of accuracy 93%, sensitivity of 90%, and specificity of 100% was obtained (Nayak et al. 2008). Maximum sensitivity for detection of any retinopathy on a per patient was 95.1% accompanied by specificity of 46.3% (S, Shaziya, and Ravindra 2020)(S, Shaziya, and Ravindra 2020; Sopharak et al. 2010). From the results of the experiment the highest accuracy value is 82%. Hybrid approach produced a precision score of 0.8119 (Zaaboub and Douik 2020). Some of the factors that are affecting this study might be due to the color contrast where subjective image consistency is critical for human perception, pixel size, aspect ratio of the image contrast changes depending upon the medium and image brightness. The aspect ratio and size of the image is considered to be one of the most important parameters. Although the above performed algorithm have several advantages over the other algorithms used for the Novel Diabetic Retinopathy Detection and differentiating the other diabetic eye diseases, its limitations are caused due to a certain factors inefficient real time algorithm which can be considered as more convenient to detect the Diabetic Retinopathy and modifications in algorithm to obtain real time application and further more better PSNR. In the near future, we will examine the application of the Novel Diabetic Retinopathy Detection in the healthcare field and improve the peak signal to noise ratio (PSNR) for the taken diseased images. As a result, this project will have a glowing future in continuation to this aspect, where the manual work can be simplified and reduced and can be easily converted into the computerized output at a low cost. A better dataset of real time and application with various other machine learning of deep learning algorithms such as Thresholding Algorithm and C-Means Clustering Algorithm may give better results.

Conclusion

In this study of the Novel Diabetic Retinopathy detection, the c-means clustering algorithm (37.2901) that operated using the MATLAB Programming was found to give better results compared to Thresholding Algorithm (14.7327). The signal to noise ratio gets improved by considering more and more datas, which is not seen in any other algorithm. This project has great potential and can be efficient in holding, improving and detecting the diabetic eyes images, hence it can be implemented in hospitals and ophthalmology sectors.

Declarations:

Conflict of interests

No conflict of interests in this manuscript

Authors Contributions

Author FN was involved in data collection, data analysis, manuscript writing. Author DJR was involved in conceptualization, data validation, and critical review of manuscript.

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- 5.

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Tables and Figures

Table 1. PSNR of the samples using Thresholding Algorithm and C means clustering algorithm

Samples	Thresholding Algorithm (PSNR)	C means Algorithm (PSNR)
1	46.2067	34.5127
2	6.0381	40.1212
3	6.4980	38.6017
4	6.4980	34.4949
5	13.755	34.8685
6	13.0756	37.557
7	10.2935	36.8585
8	9.5935	34.3082
9	12.5459	37.7555
10	13.7667	36.3005
11	17.4264	39.8551
12	13.7638	38.0517
13	11.7226	38.2657
14	11.6440	38.0137
15	17.4479	38.0439
16	17.7759	35.6542

17	10.0159	38.7169
18	20.3521	38.7941
19	18.2193	37.6215
20	18.1094	37.4815

Table 2. Comparison of mean of Peak Signal to Noise Ratio (PSNR) using C-Means Clustering Algorithms and Thresholding Algorithms. Group statistics comparison of PSNR for Diabetic Retinopathy using Thresholding Algorithm and C-Means Clustering Algorithm is done. C-Means Clustering Algorithm. has higher mean compared to Thresholding Algorithm. C means algorithm =37.2901 and Thresholding Algorithm = 14.7327.

Parameter	Algorithm	N	Mean	Std. Deviation	Std. Error Mean
PSNR	C means algorithm	24	37.2901	1.69835	0.37976
	Thresholding Algorithm	24	14.7327	8.51541	1.90410

Table 3. Independent sample t-test in predicting the PSNR of Diabetic Retinopathy using C-Means Algorithms and Thresholding Algorithm. There appears to be a statistically significant difference ($p < 0.05$) in both the methods.

	Leven’s test for equality of variance		t-test for equality of variance					95% of confidence interval of difference	
	f	sig	t	df	Sig(2-tailed)	Mean difference	Std.error diff	lower	upper
PSNR	6.567	0.014	11.618	38	<0.001	22.55740	1.94160	18.6268	26.48797
			11.618	20.509	<0.001	22.55740	1.94160	18.5137	26.60108

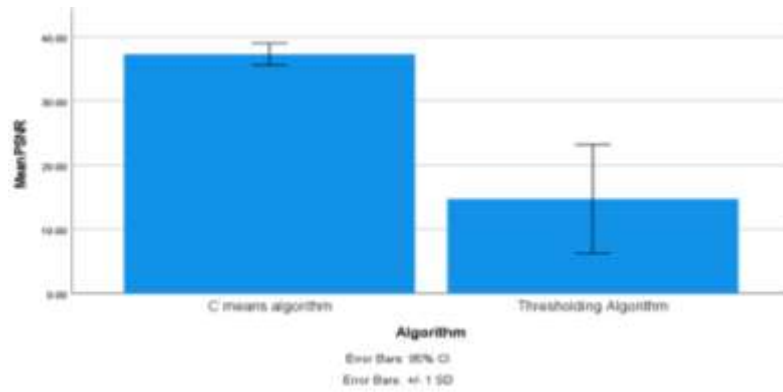


Fig. 1. Simple mean of PSNR by using C-Means Clustering Algorithm and Thresholding Algorithm. Bar chart comparison representing the mean PSNR of Diabetic Retinopathy detection using Thresholding Algorithm and C-Means Clustering Algorithm. The C-Means Clustering Algorithm appears to produce the most consistent result in PSNR with minimal standard deviation when compared to Thresholding Algorithm. X Axis: C-Means Clustering Algorithm vs Thresholding Algorithm, Y Axis: Mean PSNR of detection. Mean PSNR of detection \pm 1 SD.

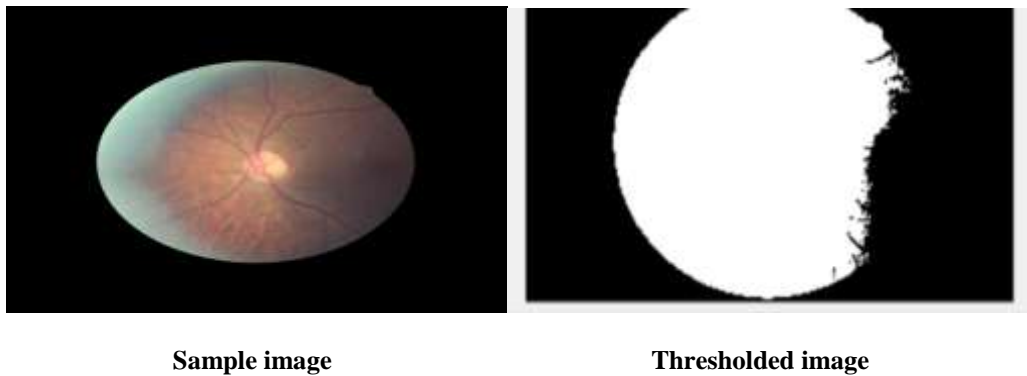


Fig. 2a. Image obtained using Thresholding Algorithm. This figure represents a thresholded image result of the sample image taken from the kaggle’s website for Diabetic Retinopathy.

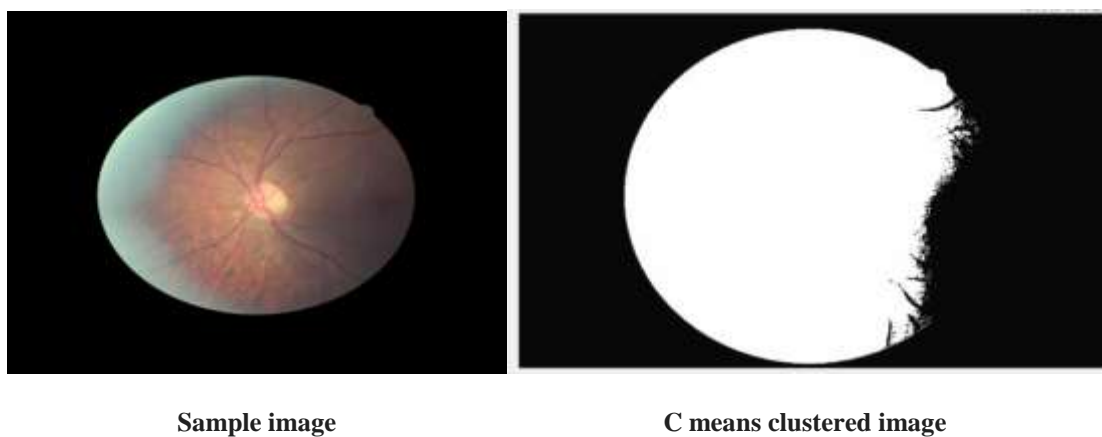


Fig. 2b. Image obtained using C-Means Clustering Algorithm. This figure represents the C-Means Clustering Algorithm image of the sample image taken from the kaggle’s website for Diabetic Retinopathy.