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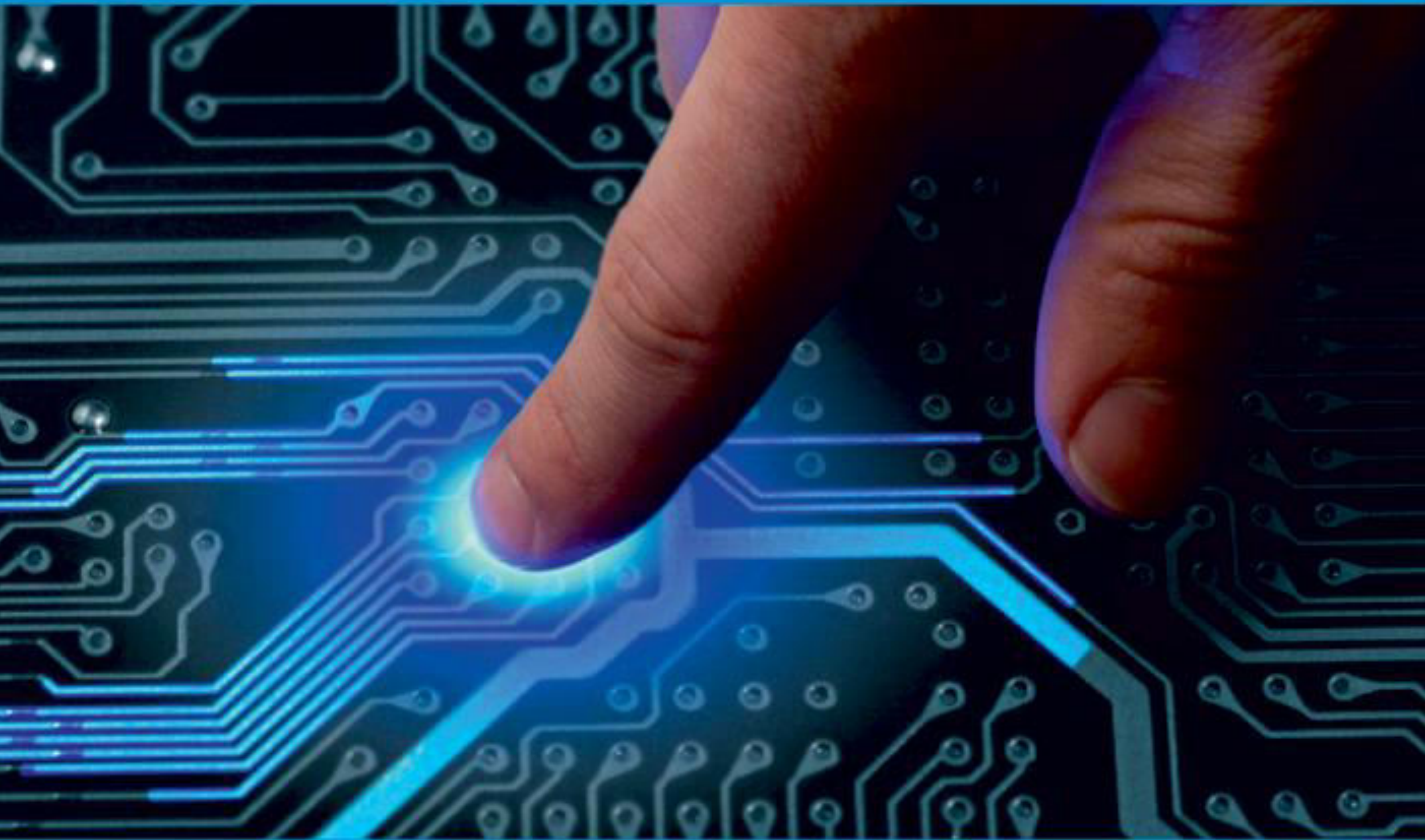

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Evaluation of Different Image Segmentation Techniques for Retinal Oct Images

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ABSTRACT: A critical stage in image processing is image segmentation, which involves breaking an image up into smaller parts for quicker and more thorough examination. For this, a number of methods have been investigated, including thresholding, edge detection, clustering, graph cut segmentation, and flood fill. Flood fill segmentation has shown to be very useful among them for picture separation in OCT images. Furthermore, preprocessing techniques such as the Wiener filter are used to lessen speckle noise. Metrics like MSE and PSNR are calculated during the evaluation of segmentation algorithmsin order to evaluate the quality of the segmented images. These measures are used to compare several techniques, includingflood fill, graph cut segmentation, thresholding, edge detection, and clustering. This examines these segmentation techniques and how well they work in relation to the particular needs of image processing.

KEYWORDS: flood fill, graph cut segmentation, thresholding, edge detection, and clustering.

I.INTRODUCTION

The most crucial stage of image processing is segmentation. It is possible to divide an image into multiple sections, makingit easier to understand and more significant. Once these pieces are joined, the full image will be seen. The many elements in the image could affect segmentation. It might be a texture or a color. An image is separated prior to denoising in order to restore the original. Segmentation is mostly used to organize data so that it may be easily examined. Image analysis and compression benefit from segmentation as well. An image is a powerful instrument for communication that contains a wealth of important information. empathetic the image and extract information from it in order to finish the work is an important area of gadget for the technology of digital images. One of the hottest topics in image processing and computer vision is image segmentation. It offers an essential foundation for image recognition. Several similar criteria are used to classify an input image in order to extract the area where people are engaged. Additionally, it offers the theoretical foundation for the extraction of appreciating visual features and Recognition. This essay's main concentrate will be on segmenting OCT photos using a variety of methodologies. This research will look at flood fill, graph cut, clustering-based, edge-based, and threshold in particular, segmentation methodologies. Several segmentation methods will be evaluated on filtered photos. Speckle noise can be seen in some photos. The image is converted to grayscale once the speckle noise has been reduced. We apply a wiener filter to reduce the speckle noise. After using segmentation techniques, measure the MSEand PSNR value by comparing the segmented image to the filter image.

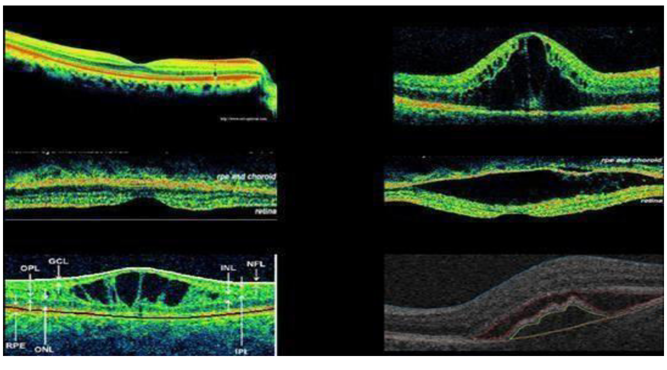

Figure 1: OCT images

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II. LITERATURE REVIEW

Using cross-sectional volume images of the tissues produced by OCT, one can non-invasively analyse the structure and properties of the tissue. The simplest method for segmenting images is threshold segmentation, which is one of the most widely used segmentation techniques. This widely used segmentation technique splits the process of dividing grayscale picture data into multiple target variables with varying grey values. There are two distinct approaches to threshold segmentation: the local threshold method and the global threshold method. The objective and conditions are split into two portions of the image by a specific threshold using the global threshold approach.
Since the local threshold approach splits the image into many target regions and backgrounds, it necessitates the collectionof different segmentation thresholds.

A basic technique for segmenting images is thresholding. It's a way of dividing pixels by to how much grey they have intodifferent categories.

A thresholding technique creates the "threshold" value, which is the level that divides the intended classes. The process of applying a threshold value results in segmentation. Pixels are classified into classes according to their threshold values; if their intensity is higher than the threshold, they are categorized into one class, and if it is lower, they are categorized into another class. The two primary drawbacks are that the basic form produces just two classes and that multichannel photographs cannot be exploited with it.

With the thresholding process, an image can have just two possible values: black or white. Grey values in an MR image span from 0 to 255. Consequently, tumor cells are overlooked when MR image thresholding is being done. Compared to other approaches, thresholding-based segmentation requires less computing power. Histon is the foundation for segmentation. The term "Histon" can be used to describe a collection of pixels from a specific segment. A thresholding technique is used in conjunction with a roughness measure for picture segmentation.

Partitioning involves the use of adaptive thresholding. As a result, the segmentation thresholding surface includes the areasof the gray level where the gradient is strong.

Image processing techniques for edge detection are intricate in and of themselves. Given that a concentration value alonedoes not provide sufficient details about edges, edge-based Segmentation techniques rely on the abrupt changes in an image's intensity value. Edge detection techniques identify the edges where the initial intensity derivative above a preset threshold or crosses a zero line. In edge-based segmentation techniques, edges are first located and then connected to form object boundaries, which are then separated into the relevant parts. Grey histograms and gradient-based algorithms are the basic two edge-based segmentation techniques. One of the fundamental edge detection techniques, such as the Sobel operator, Canny operator, Robert's operator, etc., can be used to locate the edges. Essentially, a binary image is created byusing these techniques. these are based on discontinuity detection .

Following the regional growth method, a recognized serial region segmentation algorithm, the fundamental concept is to combine pixels with comparable qualities into a region. Selecting the procedure begins with a seed pixel and continues with the neighboring, equivalent pixels being combined into the area where the seed pixel is placed.

Techniques based on clustering are ways to divide an image into groups of related individual pixels. The process of putting together data components into groupings that resemble each other more than they do other people in the same cluster. The partition-based method and the hierarchical method are the two primary kinds of clustering approaches.

The tree model serves as the foundation for the hierarchical approaches. Here, the clusters are represented by the internal nodes of the tree, and the entire database is represented by the root of the tree. As an alternative, the partitionbased approach minimizes a purpose function by repeatedly using optimization techniques. With these two approaches, there are.

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III. IMAGE SEGMENTATION TECHNIQUES

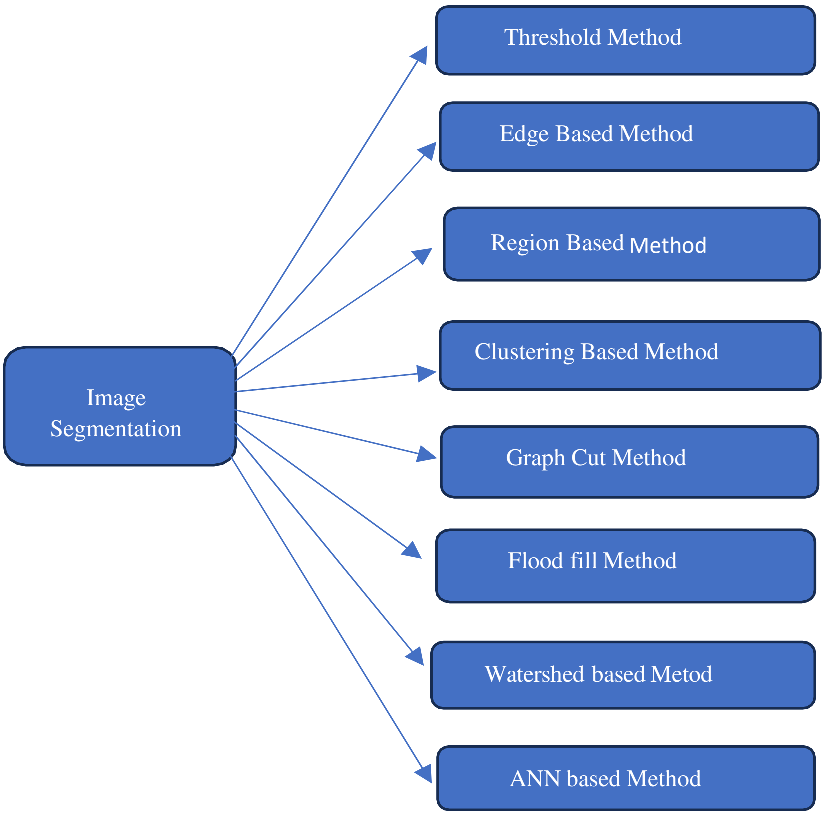

Figure 2: Image Segmentation Method

i) **Simple Thresholding**:

Using this technique, a pixel of an image can be made black or white. When a pixel's intensity (Ii,j) at location (i,j) is below the threshold (T), it is replaced with black; when it is larger, it is replaced with white. This method of thresholding involves use of binary logic.

ii) Global Thresholding:

A histogram with a pair of separate peaks and a gap in the middle is called a bimodal picture. T is selected as the threshold at a valley point. The provided image's pixels, f (x, y), is assessed compared to the threshold. The pixel is assigned a value of 1 if its values are greater than or equal to the threshold value. If not, a picture g with an output threshold value of 0 (x, y) occurs. Using the threshold technique helps one to

$$g(x,y) = \begin{cases} 1 \text{ if } f(x,y) >= T \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

The following are algorithms for selecting a thresholding value:

1. Determine the starting point T=T0, where T0 is the the average pixel value or the mean of the two peaks.
2. Determine the mean (µ1) of the pixel below the threshold and the mean (µ2) of the pixel above it.
3. Examine a fresh cutoff point using T1 = µ1 + µ2 /2. 4. Continue doing steps 2 and 3 until nothing changes.

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iii) Adaptive Thresholding:

Using local picture assets, adaptive thresholding is an image processing approach that automatically separates images into foreground and background regions. Adaptive thresholding computes distinct thresholds for various regions of the image, in contrast to global thresholding, which applies a single threshold value to the entire image. This is especially helpful for photos with uneven illumination or different backdrops. The mean, Gaussian, and median thresholding techniques are frequently used in adaptive thresholding, and each has benefits and uses of its own.

A. Edge Based Method

Method based on the edge, finding edges in an object is the process of edge detection, which is an essential initial step in comprehending visual information. It's thought that edges have important properties and important information. It maintains and focuses solely on an image's fundamental structural elements. Edge-based segmentation algorithms use differences in texture, contrast, brightness, saturation, and other aspects to identify edges in an image. Among the fundamental edge detection operators employed in these methods are the Sobel operator, the Canny operator, the Robert's variable, etc. we hope to at least partially segment the input image, integrating all restricted edges into a new binary image.

B. Region Based Method:

In region-based segmentation algorithms, the method divides the image into various mechanisms with related attributes in order to produce segments. These to put it simply, mechanism is essentially just a collection of pixels. The first step in region- based picture segmentation techniques is to search the input image for some seed locations, which could be smaller or clearly larger portions. Subsequently, the seed points are either reduced in size and mixed with other smaller seed points, or they are supplemented with additional pixels. As result, the next procedure is built around two essential techniques.

- Area expansion or Region growing
- Region splitting and merging

C. Clustering Based Method:

Unlike user-defined groups, attributes, or classifications, unsupervised techniques are used in clustering. Techniques for clustering data can be utilized to extract information. the basic, hidden information from the viewpoint of structures, groups, and clusters that are typically undetectable using a heuristic method. The image is divided into "clusters," or detachable sets of pixels with related properties, using "clustering-based methods." The data components are divided into "clusters" as a result of the basic characteristics of facts clustering, which Favor clusters with comparable things over clusters with dissimilar objects.
Some of the most powerful clustering algorithms, like fuzzy c- means and k-means, are heavily integrated into "clustering-based" systems.

- K-Means Clustering
- Fuzzy C-Means

D. Graph Cut:

Graph cut-based segmentation methods partition images by representing them as graphs, where pixels are nodes and relationships between neighboring pixels are edges. The objective is to minimize cut costs, representing dissimilarity between segments, by optimizing an objective function combining cut costs and segment homogeneity. Popular algorithms include normalized cut, minimizing ratio of cut cost to total dissimilarity, and min-cut/max-flow, finding minimal cost cut by maximizing flow between source and sink nodes. Widely used in computer vision for tasks like image segmentation and object recognition, these methods excel in handling complex structures and achieving precise segmentations.

E. Flood fill:
A traditional computer graphics technique called flood fill is used to fill in connected areas with a particular color or pattern. Beginning at a seed point, the algorithm colorizes nearby pixels in a methodical manner until it reaches the of

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the area delineated by predetermined standards (e.g., comparable colors). The main concept is to visit neighboring pixelscells iteratively, changing their colour until the entire region is fill. Flood fill is frequently used in image processing for segmentation, in paint programs to fill in closed areas with a userselected colour, and in a variety of graphical applications for flood filling tasks.

F. Watershed based method:

The "watershed" ridge approach maintains the idea of topological interpretation. It is a regional strategy as well. We compare and contrast a few features of a picture with a similar hilly and valley terrain. The grey value of the pertinent pixels, also known as the gradient magnitude, quantifies the height and angle of the terrain as illustrated. Based on this shared three-dimensional model of the Earth's surface, the watershed transform divides a picture into areas referred to as "catchment basins."

A catchment basin is made up of all pixels whose biggest decline in grey values ends at a local minimum. **G.**

Artificial Neural Network Based Segmentation Method:

The process of using neural networks for picture segmentation is commonly referred to as "image recognition." The application of artificial intelligence (AI) consistently approaches and identify visual components, including text, faces, objects, and handwritten text, among others. Depending on the method employed, a picture can be viewed as a collection of vectors or as a raster. The "raster," also known as a "vector," is composed of basic components that display the individual objective aspects and attributes that comprise an image. By selecting the most important components of these works, computer vision systems may logically explore them. Following that, techniques for feature extraction and categorization are used to organize the data.

IV. IMPLEMENTATION

A block diagram representing the analytical implementation technique can be found in Figure 3. In order to use the colour image for analysis, we converted it to grayscale. OCT pictures display speckling noise. We used segmentation techniques after applying the wiener filter strategy to remove the speckle noise from the grayscale images. Many segmentation techniques have been proposed for retinal segm1entation. We used threshold, edge-based (Sobel, Canny, Roberts), clustering- based (K-means), graph cut, and flood fill segmentation algorithms on ten different OCT images of a single eye. We looked at the MSE and PSNR to assess the image quality. The effectiveness of each segmentation is assessed using PSNR and MSE values. MATLAB is used to apply the segmentation approaches. Here are some instances of the segmented images that were produced.

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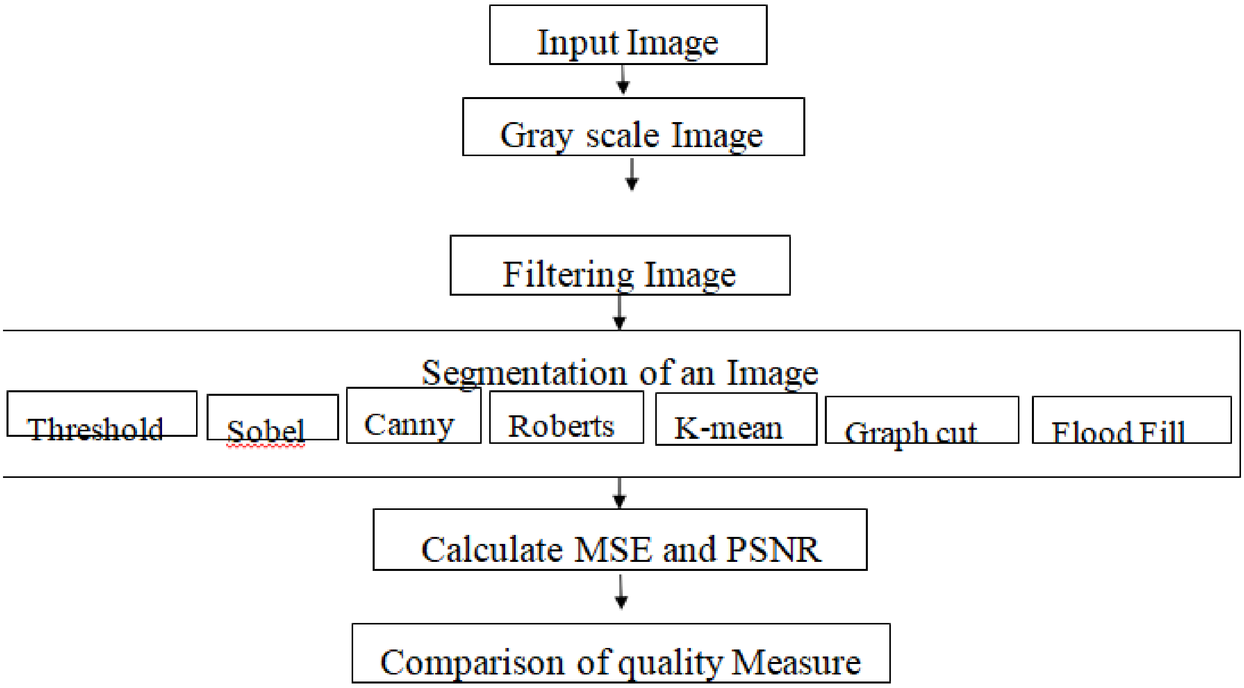

Figure 3: Block Diagram for implementation of image segmentation

V. ANALASIS AND OUTCOMES

The collected OCT image in this investigation was first filtered using the Weiner filter and then segmented using several different techniques. The estimated MSE and PSNR were then applied to determine the optimal segmentation method for identifying OCT images. The sample of OCT images that were generated using various segmentation techniques is shown in the following graphics. Python is used to execute the simulation. The most fundamental technique for segmenting images is thresholding. This approach converts a grayscale image to a binary image by using a threshold setting. Figure 4 displays the threshold segmentation of the OCT image. The OCT picture is suitably separated at the 0.333 threshold value by accounting for the grey level ranging from 0 to 255. A threshold value is select.

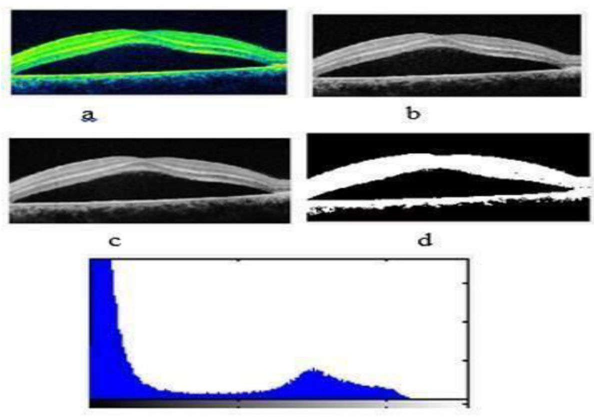

Figure 4: Segmentation by Threshold The images in this order are: a) original; b) grayscale; c) Wiener filter; d) binary; e) histogram of the grayscale image.

We have used the simplest method—Sobel, Canny, and Robert's to identify edges in this one. Edge-based segmentationof an OCT picture is shown in Figure 5.

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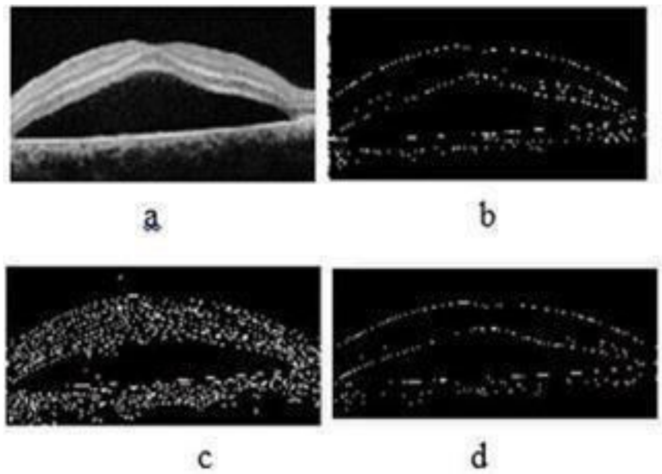

Figure 5: Segmentation based on edges: a) Grayscale b) Sobel c) Canny d) Robert's

Here, K stands for the application of an algorithm. In comparison to the Edge-based method and the Threshold approach,the clustering shows a higher number of missing pixels. The OCT image's clustered segmentation is shown in figure 6.

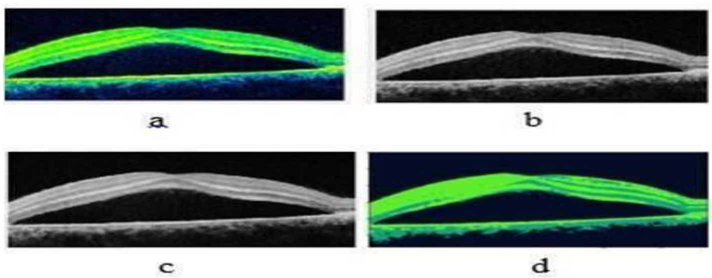

Figure 6: Method based on clustering a) Original picture , b) grayscale, c) Wiener, and K-Means signifies

Graph cut segmentation is an image processing technique that divides an image into discrete areas or objects accordingto predetermined standards. It entails seeing the picture as a graph in which individual pixels are nodes and the connections between them are edges. The objective is to locate a cut in the graph that divides the picture into significant sections.

To commence, an energy function is defined, which measures the degree of similarity between adjacent pixels and the degree of dissimilarity between distinct regions. This energy function favors cuts that reduce the total energy, which directsthe segmentation process network cut segmentation algorithms, such the max-flow min-cut algorithm, locate the path of least resistance through the network to effectively compute the ideal cut.

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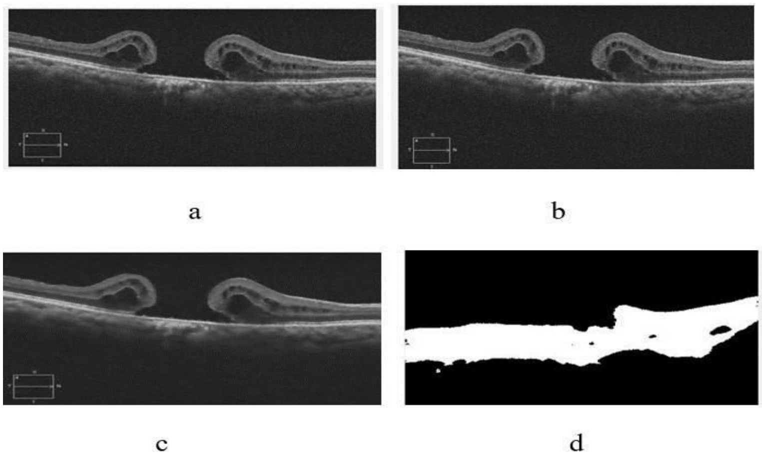

Figure 7: segmentation based on graph cut: a) original image b) gray image c) filter image d) graph cut

Flood fill segmentation is used to divide a picture into sections according to similar pixel attributes. The first step in the process is to choose a seed pixel from the image, which usually indicates where a region of interest begins. The flood fill algorithm then iteratively looks at nearby pixels and compares them to the seed pixel in terms of attributes like color and intensity. A nearby pixel is added to the same region if it resembles the seed pixel sufficiently. Until all related pixels within the region have been recognized, this process is repeated recursively. The results are shown in **figure.**

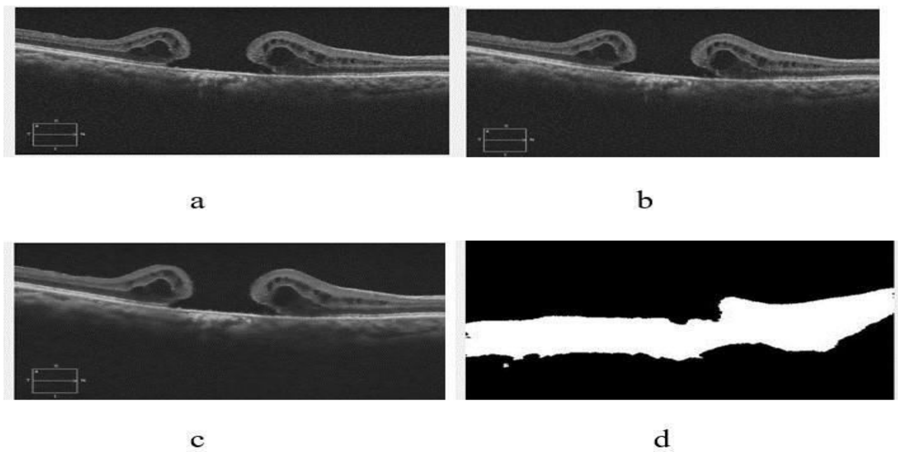

Figure 8: Segmentation based on flood fill a) original image b)gray image c) filter image d)flood fill

The qualitative outcome measures for picture segmentation are displayed in Tables 1 and 2 along with comparisons to alternative approaches. When the PSNR Considering that the segmentation technique produces decent results, and MSE values are both high. The more effective the segmentation, the lower the MSE value, which measures the difference between the segmented image and the source image, also known as the filtering image. An example of MSE in numbers is provided by equation (1). The background noise level is calculated using the PSNR ratio in relation to the maximum value of the image. The formula expresses PSNR in terms of MSE (2). It is evident that the Flood fill strategy produces the greatest outcomes after looking at the PSNR and MSE of all the strategies considered. because threshold, edge-based, and clustering approaches, which have lower PSNR and higher MSE values—are less accurate than flood fill segmentation. For OCT image segmentation, the Flood fill method yields the best results.

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$$MSE = \frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[I(i,j) - Y(i,j)]^2 \quad (2)$$

$$PSNR = 10xln(fmax/MSE)^2 \quad (3)$$

Input images	MSE Values						
	Adaptive Threshlod	Edge detection			Kmeans	Graph cut	Flood fill
		SobelEdge	CannyEdge	Roberts Edge			
1	1856.38	1868.7	1865.88	1869.04	1858.89	1840.78	1840.57
2	3582.46	3597.51	3593.23	3597.88	3575.1	3558.07	3555.88
3	4027.97	4043.79	4039.16	4044.69	4018.93	4001.24	4000.47
4	3120.41	3137.02	3132.69	3137.61	3117.51	3098.12	3097.47
5	3520.97	3540.12	3535.57	3540.76	3518.09	3499.5	3496.7
6	3198.83	3211.22	3207.36	3211.99	3190.96	3175.9	3169.12
7	4131.69	4151.25	4147.21	4151.81	4124.81	4101.61	4096.73
8	1322.78	1333.46	1330.42	1334.1	1326.22	1311.48	1310.18
9	3616.81	3628.53	3623.67	3629.24	3605.03	3587.16	3585.83
10	3763.26	3778.15	3773.82	3779.08	3754.35	3734.57	3731.2
Total	3214.156	3228.98	3224.9	3229.62	3208.99	3190.843	**3188.415**

Table 1: MSE Value of Segmented Images

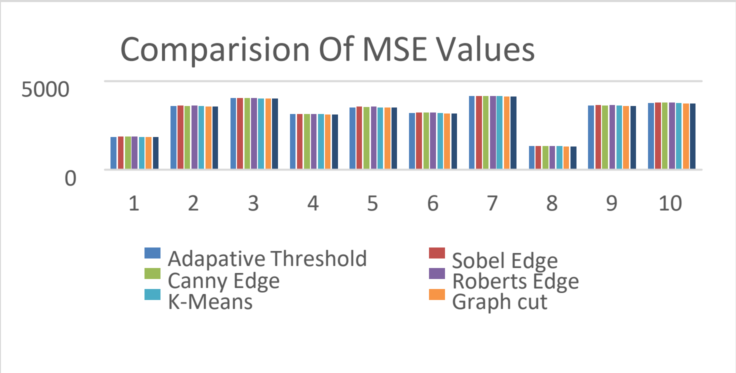

Figure 9: Comparision of MSE Values

Input image	PSNR Values						
	Adaptive Threshlod	Edge detection			Kmeans	Graphcut	Floodfill
		SobelEdge	CannyEdge	Roberts Edge			
1	63.64	63.61	63.62	63.61	63.64	63.68	63.68
2	60.79	60.77	60.77	60.77	60.8	60.82	60.82

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3	60.28	60.26	60.27	60.26	60.29	60.31	60.31
4	61.39	61.36	61.37	61.36	61.39	61.42	61.42
5	60.86	60.84	60.84	60.84	60.87	60.89	60.89
6	61.28	61.26	61.27	61.26	61.29	61.31	61.32
7	60.17	60.15	60.15	60.15	60.18	60.2	60.21
8	65.11	65.08	65.09	65.08	65.1	65.15	65.16
9	60.75	60.73	60.74	60.73	60.76	60.78	60.78
10	60.57	60.56	60.56	60.56	60.58	60.61	60.61
Total	61.484	61.462	61.468	61.462	61.49	61.517	61.52

Table 2: PSNR Value of the Segmented Images

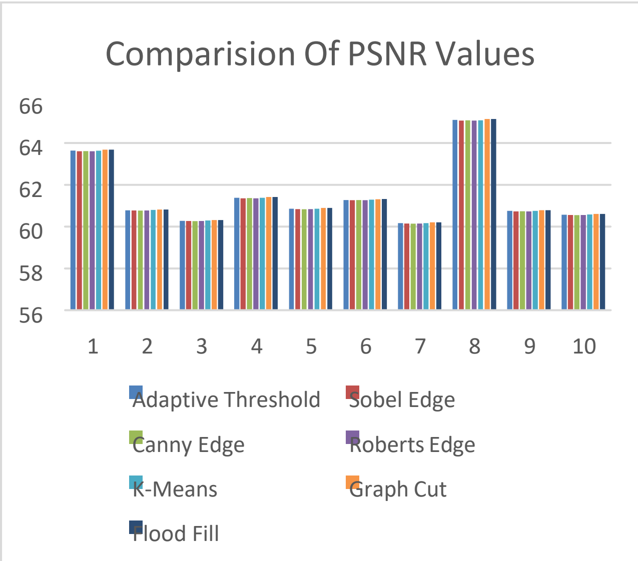

Figure 10: Comparison of PSNR Values

VI. CONCLUSION

The analysis reveals that Flood Fill is the most successful segmentation technique after analysing seven other approaches, including Adaptive Thresholding, Sobel, Canny, Robert's, K- means, Graph Cut, and Flood Fill. It is perhaps because Flood Fill can handle complicated image structures and precisely define borders that it performs better than all the other approaches combined. Thus, among the segmentation techniques examined in this study, Flood Fill emerges as the most effective. When it comes to applications like object detection, where it's crucial to recognize discrete regions inside an image, flood fill segmentation is especially helpful. Applications like image editing and medical image analysis also frequently use it. However, in order to guarantee meaningful segmentation results without over segmentation or under segmentation, the effectiveness of flood fill segmentation largely hinges on selecting suitable seed points and precisely establishing similarity criteria.

REFERENCES

1. R. Yogamangalam, Karthikeyan, "Segmentation Techniques Comparison in Image Processing", International Journal of Engineering and Technology (IJET), Vol 5 No 1 Feb- Mar 2013.
2. Song Yuheng, Yan Hao," Image Segmentation Algorithms Overview",
3. M. Anand and Dr.C. Jayakumari , "Study of Retina Image Segmentation Algorithms from Optical Coherence Tomography (OCT) Images", Jour of Adv Research in Dynamical & Control Systems, Vol. 9, No. 4, 2017.

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4. M. Anand and Dr.C. Jayakumari ,"Automated Detection of Macular Hole in Optical Coherence Tomography Images using Depth-Check Algorithm", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-9 Issue-1, October 2019.
5. Davis L S, Rosenfeld A, Weszka J S. Region extraction by averaging and thresholding[J]. IEEE Transactions on Systems, Man, and Cybernetics, 1975 (3): 383-388.
6. K. M. Hassan, M. R. Islam, T. Tanaka, and M. K. I. Molla, "Epileptic seizure detection from EEG signals using multiband features with Feedforward neural network," Cyberworlds 2019, Kyoto, Japan (in press).
7. J. Selvakumar, A. Lakshmi, and T. Arivoli, "Brain tumor segmentation and its area calculation in Brain MR images using K- mean clustering and Fuzzy C-mean algorithm", IEEE- International conf. on advances in eng. science and management, March-2012.
8. M. O. Baradez, C. P. McGuckin, N. Forraz, R. Pettengell,
9. A. Hoppe, "Robust and automated unimodal histogram thresholding and potential applications," Pattern Recognition,2004, 37, (6), pp. 1131– 1148
10. M. M. Mushrif, A. K. Ray, "Color image segmentation: Rough set theoretic approach," Patt. Reco. Lett.,2008,29, (4), pp. 483–493.
11. S. D. Yanowitz, A. M. Bruckstein, "A new method for image segmentation" on Computer Vision, Graphics, and Image, 1989.
12. S. Saleh, N. V. Kalyankar and S. Khamitkar, "Image segmentation by using edge detection", (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010.
13. Wani M A, Batchelor B G. Edge-region-based segmentation of range images[J]. IEEE Transactions on Pattern Analysis and Machine Intelligence, 1994, 16(3): 314-319.
14. M. Yambal and H. Gupta, "Image Segmentation using Fuzzy C Means Clustering: A survey", International Journalof Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 7, July 2013.
15. M. Anand and Dr.C. Jayakumari," Automated detection of full thickness macular hole in optical coherence tomography images", Journal of International Pharmaceutical Research, ISSN: 1674-0440.
16. V. K. Dehariya and S. K. Shrivastava. C. Jain, "Clustering of Image Data Set Using K-Means and Fuzzy K- Means Algorithms", International conference on CICN, pp. 386-391, 2010.
17. K. S. Tamilselvan, and G. Govindasamy Murugesan, "Image Segmentation", in Medical and Biological Image Analysis. London, United Kingdom: Intech Open, 2018 [Online]. Available: https://www.intechopen.com/chapters/60741Doi: 10.5772/intechopen.76428.
18. [15] M. Yambol and H. Gupta, "Image Segmentation using Fuzzy C Means Clustering: A survey", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 7, July 2013.