



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

Enhancing the Operating Efficiency of Membrane Filter Using Image Segmentation Techniques

Neeti Taneja¹, Sudha Goyal²

M.E (CSE), Dept. of CSE., Chitkara University, Punjab, India¹

Associate Professor, Dept. of CSE, Chitkara University, Punjab, India²

ABSTRACT: This Review paper describes the methodology adopted for the Qualitative analysis of Images for feature extraction. The microscopic image of membrane filter is taken which is made up of different number of polymer beads. Various segmentation techniques such as Thresholding, Edge detection, Active contouring, Watershed algorithm etc. are used for analysing the quality of Membrane filter for its efficient operation.. The main goal is to use this proposed approach for estimating the uniformity of beads in the membrane filter.

KEYWORDS: Membrane Filter, Global Thresholding, Edge detection, Watershed algorithm, Active contouring

I. INTRODUCTION

A membrane is a semi-permeable thin layer of material capable of separating contaminants as a function of their physical/chemical characteristics. Membrane filters are made up of very thin layers of polymers and other advanced synthetic materials. The thickness varies from 100 to 300 micro-meters. Many of them are designed with approximately 70 to 90 percent porosity. Porosity and effective filtration area should be matched for absorption, flow requirements, and medium binding requirements. Membrane filters are available in standard and custom sizes, shapes and materials. The materials used are; MCE (nitrocellulose), Cellulose Acetate, Coated PTFE (Teflon), Hydrophobic PTFE, Nylon, etc. Since the beads are very small so their size cannot be estimated with a naked eye. Thus a microscope has to be used for judging its shape and size. The plan is to take the image of filter, process it to get the area of beads and perform statistical analysis to check the uniformity of polymer beads. Higher is the uniformity in size greater will be the quality of produced filters.

The Membrane Filter (MF) Technique was introduced in the late 1950s. The technique is highly reproducible, can be used to test relatively large volumes of sample, and yields numerical results more rapidly than the multiple-tube procedure. The membrane filter technique is extremely useful in monitoring drinking water and a variety of natural waters. In all membrane filtration techniques such as Micro filtration, Nano filtration and Ultra filtration., the pore size has to be carefully chosen to exclude impurities, and the membrane size has to be designed for optimal operating efficiency.

In waste water treatment, membrane technology is becoming increasingly important. With the help of UF and MF (Ultra/Microfiltration) it is possible to remove particles, colloids and macromolecules, so that waste-water can be disinfected in this way. In pharmaceutical and cosmetics [8] industries the technique focus on monitoring their process water for *Pseudomonas* species. The electronics industry examines for any and all microorganisms because they must keep their process water free from even the smallest organisms.

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014



Fig. 1 Membrane filters

II. RELATED WORK

In [2] authors investigate several local and global feature selection methods since feature filtering approach is widely used for dimensionality reduction in text categorization. So to accomplish this, feature scoring methods are used to evaluate features leading to selection. Thresholding is then applied to select the highest scoring features either locally or globally. Standard Deviation (STD) and Maximum Deviation (MD) as globalization schemes are used for the Comparative study of different techniques. Raman Maini and Dr. Himanshu Aggarwal [4] in their research paper presents “Comparative Analysis of various edge detection Techniques “ i.e Gradient edge detection and Laplacian edge detection .It has been shown that Canny’s edge detection algorithm performs better than all other edge detection operators namely LoG(Laplacian of Gaussian), Sobel, Prewitt and Robert’s operator under almost all scenarios. In [6] authors underwent an exhaustive survey of image thresholding methods, categorize them, express their formulas under a uniform notation, and finally carry their performance comparison. The thresholding methods are categorized according to the information, such as histogram shape, measurement space clustering, entropy, object attributes, spatial correlation, and local gray-level surface. The comparison is based on the combined performance measures. They identify the thresholding algorithms that perform uniformly better over nondestructive testing and document image applications. Authors in [7] proposed an active contour framework for spectrogram track detection. A potential energy that results in feature extraction at a signal-to-noise ratio of 0.5 dB was proposed to be achieved in real time.

III. METHODOLOGY

Interference by signals and artifacts which rose of during sampling, may cause big problems. Therefore, accurate segmentation of medical images is required for correct diagnosis which is a very difficult task. Many methods have been developed for better image segmentation.

The approach followed for the Qualitative Analysis of Membrane Filter is illustrated below:

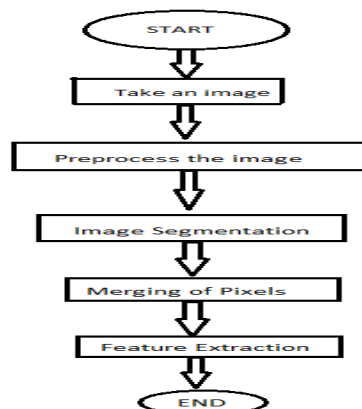


Fig.2. Step by Step approach followed

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

A. Image Pre processing

The image of the membrane filter may be noisy due to low lighting conditions, etc So to make the image useful for different analysis, there is a need to smooth out the image . The pre processing includes removal of any type of noise in the image. The most common noise that corrupts the images is the salt & Pepper noise, which can be removed by using various kinds of filters such as Mean filter, Median filter,etc

B. Image Segmentation

This technique is used for finding object pixels from the background. The object pixels would be black (0 intensity) and background pixels white (max intensity). Segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. The result of image segmentation is a set of segments that collectively cover the entire image. The pixels in a region are similar with respect to some characteristic such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics.

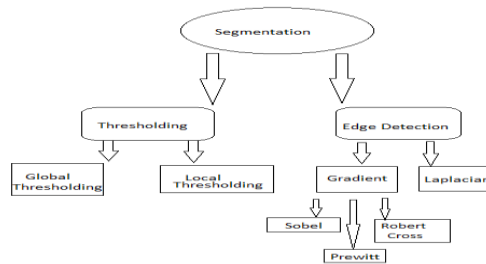


Fig.3 Diagram depicting Image segmentation Techniques

1) Thresholding:

Thresholding is the simplest method of image segmentation used to create binary images from grayscale. In the thresholding[1] process, individual pixels of image are labeled as “object” pixel if their value is greater than some threshold value (assuming an object to be brighter than the background) and “background” pixels otherwise. It is of two types:

- Global Thresholding

Global thresholding [2] is successful in highly controlled environments, where control of the illumination is feasible. e.g Industrial inspection applications.

- Local Thresholding

This approach divides the original image into sub images and use the above said thresholding process to each of the sub images.

The following example illustrates thresholding technique applied on an image. The result of thresholding is the image highlighting object pixels from background pixels.



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

Fig. 4 Image with Thresholding

2) Edge Detection:

Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edge detection [3] is the process of identifying and locating sharp discontinuities in an image. It significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. Edge detection methods may be grouped into two categories:

- Gradient based Edge detection

The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image.

- Laplacian based Edge detection

The Laplacian method searches for zero crossings in the second derivative of the image to find edges.

A pixel location is said to be an edge location [4] if the value of the gradient exceeds some threshold. So once a threshold is set, you can compare the gradient value to the threshold value and detect an edge whenever the threshold is exceeded.

Various Edge detectors:

Sobel Operator

The operator consists of a pair of 3×3 convolution kernels as shown below. One kernel is simply the other rotated by 90°.

-1	0	+1
-2	0	+2
-1	0	+1

G_x

+1	+2	+1
0	0	0
-1	-2	-1

G_y

These kernels respond maximally to horizontal and vertical edges relative to the pixel grid, one kernel for each of the two perpendicular orientations. The gradient magnitude is given by:

$$|G| = \sqrt{G_x^2 + G_y^2}$$

The angle of orientation of the edge is given by:

$$\theta = \arctan(G_y/G_x)$$

Robert's cross operator

The operator consists of a pair of 2×2 convolution kernels as shown below. One kernel is simply the other rotated by 90°. This is very similar to the Sobel operator.

+1	0
0	-1

G_x

0	+1
-1	0

G_y

These kernels respond maximally to diagonal edges relative to the pixel grid, one kernel for each of the two angle perpendicular orientations. The of orientation of the edge is given by:

$$\theta = \arctan(G_y/G_x) - 3\pi/4$$

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

Prewitt's operator

Prewitt operator is used for detecting vertical and horizontal edges in images.

$$h_1 = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}, \quad h_3 = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

Though Prewitt operator is simpler to implement but the fact that masks of Sobel operator have better noise suppression(smoothing) makes them preferable because noise suppression is an important issue when dealing with derivatives.

Edge detection using Sobel operator on an example image is shown below. The result is a boundary extracted image locating discontinuities.



Fig.5 Original image with image showing edge detection using sobel operator

C. Merging of Pixels

The transformation which leads to uniformity of beads[3] is to be performed on gray scale image through morphological operations. Watershed algorithm and active contour method are used primarily for the required transformation in order to extract the desired feature .

1) Watershed Algorithm:

The gradient magnitude of an image is considered as a topographic surface for the watershed transformation. The intuitive idea underlying this method comes from geography: It regards the gradient magnitude image[6] as a landscape where the intensity values correspond to the elevation. Areas where a raindrop would drain to the same minimum are denoted as catchment basins, and the lines separating adjacent catchment basins are called watersheds.

Steps involved:

- Remove some of the weakest edges(e.g. due to noise)
- Compute the gradient map of original image.
- Compute the maximum value (MAX) of gradient map.
- Select the appropriate drowning threshold of watershed method: $DT=MAX * 1/n$.
- For each pixel, we consider its 8-neighbor. If the value of current pixel and its neighbor is smaller DT, we merge current pixel with its neighbor.
- Merge the smaller regions.

The following image is taken and watershed algorithm is applied to it. The result is the image showing catchment basins and finally the image with watershed lines highlighted in red as shown:

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

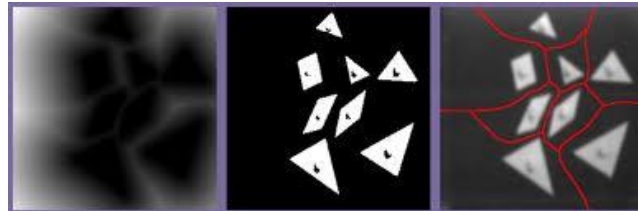


Fig. 6 Image depicting watershed transformation

2) Active Contour Method

Besides challenges due to noise in image [5] and other volume effects, the similar intensity values between neighbouring structures makes it difficult to locate distinct boundaries between the structures. So the active contour method was introduced. It is based on the concept of shape contours. The basic idea in active contour models [7] or snakes [9] is to evolve a curve, subject to constraints from a given image, in order to detect objects in that image.

The following example image depicts active contouring. The result is the closed circular contour of the image.



Fig.7 Image showing active contour

D. Feature Extraction

From the previous step we have obtained the circumference of the polymer beads in the membrane filter. Using circumference, radius can be calculated and finally area of the polymer beads is evaluated. From the area we can analyze the quality of the filter to study its uniformity.

IV. CONCLUSION

The main aim is to statistically analyze the quality of Membrane filter in image processing. It can be done by calculating the area of the beads in the filter. Area is obtained through implementation and analysis of various feature extraction techniques such as:- Noise removal, Thresholding, Edge detection, Watershed Algorithm and Active contouring. Therefore this Research simulates the extraction of area evaluation through the implementation of segmentation techniques on the MATLAB tool.

REFERENCES

- [1] Bradley, D. Roth, G., "Adaptive Thresholding Using Integral Image," Journal of Graphics Tools, vol 12, Issue.2 pp. 13-21. June 2007.
- [2] Nayer M. Wanas, Dina A. Said, Nadia H. Hegazy and Nevin M. Darwish, "A study of local and global thresholding techniques in text categorization", AusDM'06 Proceedings of the fifth Australian Conference on Data Mining and analytics, vol. 61, pp. 91-101,2006.
- [3] Rafael C. Gonzalez, Richard Eugene Woods, "Digital image Processing", 2002 by Prentice-Hall Inc.



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 7, July 2014

- [4] Raman Maini and Dr. Himanshu Aggarwal, "Study and Comparison of Various Image Edge Detection Techniques", International Journal of Image Processing(IJIP) Vol. 3, Issue 1, pp. 1-12, 2003
- [5] A. Yezzi, S. Kichenassamy, A. Kumar, P. Olver, and A. Tannenbaum. "A geometric snake model for segmentation of medical imagery," IEEE Trans. Med. Imag., vol. 16, pp. 199–209, Dec 1997.
- [6] M. Sezgin and B. Sankur, "Survey over image thresholding techniques and quantitative performance evaluation," Journal of Electronic Imaging 13(1), pp. 146–165, 2004.
- [7] T. Lampert and S. O'Keefe, "An Active Contour Algorithm for Spectrogram Track Detection," Pattern Recognition Letters, vol.31, no.10, pp. 1201-1206, Aug 2010.
- [8] Aditya Sharma, Poonam G. Kohli, Divneet S.Kapoor and Amit Kumar Kohli, "Automatic Qualitative Analysis of Membrane Filter using Feature Extraction Techniques" IJCEM International Journal of Computational Engineering and Management, vol. 13, pp. 70-77, July 2011.
- [9] Kim, H.C. Seol, Y.H. Chof, S.Y. Kim, M.G. Oh, J.S. Sun, "Engineering in Medical and Biological Society," 29th Annual International Conference of the IEEE, pp: 4437–4440, 22-26 Aug 2007.

BIOGRAPHY

Er. Neeti Taneja, pursuing M.E(CSE) from Chitkara University, Punjab, India and received B.Tech(CSE) degree from SRMIET, Naraingarh, India under Kurukshetra University. Her area of interest is Image Processing, Pattern recognition, etc.

Ms. Sudha Goyal is Associate Professor in the department of Computer Science and Engineering at Chitkara University, Punjab, India. She has almost fifteen years of academic experience. She has done M.Tech in Computer Science and Engineering from Punjabi University, Patiala. She is also pursuing P.hd from Chitkara University, Punjab, India.