PERFORMANCE EVALUATION OF IMAGE SEGMENTATION TECHNIQUES USED FOR QUALITATIVE ANALYSIS OF MEMBRANE FILTER

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Abstract-This paper presents the analysis and evaluation of different image segmentation techniques on the application of checking quality of membrane filter used for bacteria filtration. Quality of the membrane filter is determined by checking the uniformity of pores which can be done by calculating the area of pores in the filter. The performance of active contour method and mean shift algorithm used for segmentation is compared and evaluated for the area extraction. The simulation results exhibit the better performance of mean shift algorithm and helps in extracting the area of the pores more efficiently.

Keywords –Active Contour, Global thresholding, Mean shift ,Membrane Filtration,etc

1 INTRODUCTION

A membrane is a semi-permeable thin layer of material capable of separating contaminants as a function of their physical/chemical characteristics. Standard membranes can be used for many laboratory applications including filter sterilizing biological fluids, microbiology, contamination analysis and air monitoring.

The membrane's permeability is determined by the size of the pores in it. Membranes retain particles and microorganisms that exceed their pore ratings by acting as a physical barrier and capturing such particles on the surface of the membrane. Successive membrane filtration where particles underwent a series of filters is of great importance .In this pores get smaller and smaller thus removes more impurities from it.

The pore size should be uniform in good [1] quality filters. As the pores in the filter are very tiny, we cannot identify their size with a naked eye .Thus a microscope need to be used for judging its size. The objective is to develop a system for checking uniformity of pores as it directly affects the quality of the filter. Finally we process the image to evaluate the area of pores using segmentation techniques and statistically analyze the quality using mean and variance.

2 METHODOLOGY

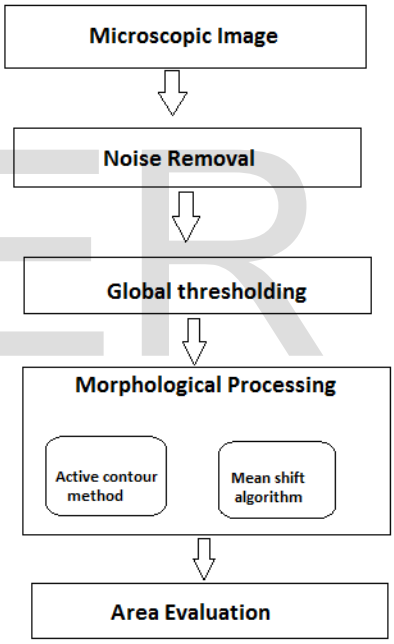

Fig. 1 Flowchart of approach followed

The microscopic image of membrane filter is taken which may be noisy reason being scanned, low contrast, low lighting conditions, etc. So to get it accurately segmented noise need to be removed. Noise can be removed by using various filters such as average, median, etc

Segmentation is the process of dividing an image into multiple parts. For segmentation to be useful in image synthesis, the regions should have visual similarity[4] or homogeneity.

2.1 Segmentation Techniques

Image segmentation techniques are divided into two broad categories:

a)Detecting similarities[5]

b)Detecting discontinuities

Thresholding

Thresholding is used to create a binary image from grayscale. In the thresholding [2][3]technique, each of the pixels in the image is designated as "object" pixel if its intensity value is higher than the threshold value and "background" pixel otherwise.

The basic global threshold, T, is calculated as follows:

(1)Select an initial estimate for T (typically the average grey level in the image)

(2)Segment the image using T to produce two groups of pixels: G1 consisting of pixels with grey levels >T and G2 consisting pixels with grey levels ≤ T

(3)Compute the average grey levels of pixels in G1 to give m1 and G2 to give m2

(4)Compute a new threshold value.

$T=1/2(m1+ m2)$

(5)Repeat steps 2 – 4 until the difference in T in successive iterations is less than a predefined limit T∞

on

2.2 Morphological Processing

This step involves image synthesis by merging the pixels to find the boundaries of region of interest.

Active Contour method

Besides the challenges of noise, poor contrast, etc it becomes difficult to detect or identify true boundaries in the image. So active contour method comes into picture because it extracts shape contours from the image. For evolving contours it considers the forces of attraction, repulsion and competition between object contours and their shapes

The basic idea in active contour models[7] [8] or snakes is to evolve a curve, subject to constraints from a given image, in order to detect objects in that image. For instance, starting with a curve around the object to be detected, the curve moves toward its interior normal and has to stop on the boundary of the object.

Mean shift algorithm

Mean shift is non-parametric feature space analysis technique for locating the maxima of a density function. A search window is used for locating clusters in the feature space and is shifted towards cluster center. The number of shifts and the direction of shift are decided by the difference of the center of the window and the local mean value inside the window. When the shift magnitude [6] becomes lower (according to a threshold) the center of the search window is considered as a cluster center and the algorithm is said to have converged for one cluster. The above process is repeated until all significant clusters have been evolved.

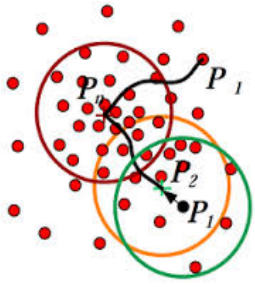

Fig. 2 Mean shift analysis

Using circumference radius can be obtained and finally area of the pores can easily be evaluated.

3 SIMULATION DETAILS

The two techniques we are comparing are worked upon two different images of membrane filter. These must be noisy because of low lighting conditions as shown in fig.3(A),3(B).Noise free images using median filter are shown in fig.4(A),4(B). Output images using thresholding are shown in fig. 5(A),5(B).Original images of membrane filter which are taken as input for morphological processing are shown in fig. 6(A),6(B).Segmented images using active contour method are shown in fig. 7(A),7(B).Boundary extracted images using active contour are shown in fig.8(A),8(B).Corresponding area curves are shown in fig. 9(A),9(B).Similarly segmented images using mean shift are shown in fig. 10(A),10(B).Boundary extracted images and corresponding area plots using mean shift are shown in fig.11(A),11(B) and 12(A),12(B) respectively. It is clear from the results that mean shift algorithm performs better for area extraction of pores.

4 CONCLUSION

In this paper we compared the two well known techniques namely active contour method and mean shift algorithm used for boundary extraction of pores in the membrane filter to analyze its efficiency. It is clear from the simulation results that mean shift algorithm performs better as it accurately extracts the boundaries of even the small pores in the filter which leads to correct area evaluation of pores. Also from the area plots of both techniques it can beconcluded that mean shift results in lesser variance as compared to active contour.

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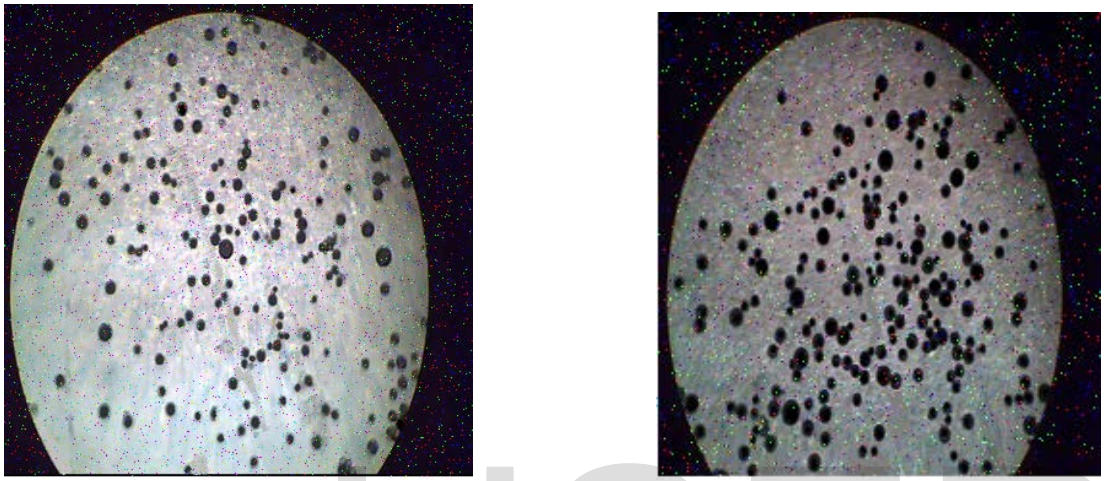

Fig. 3(A),3(B) Input noisy images of membrane filters

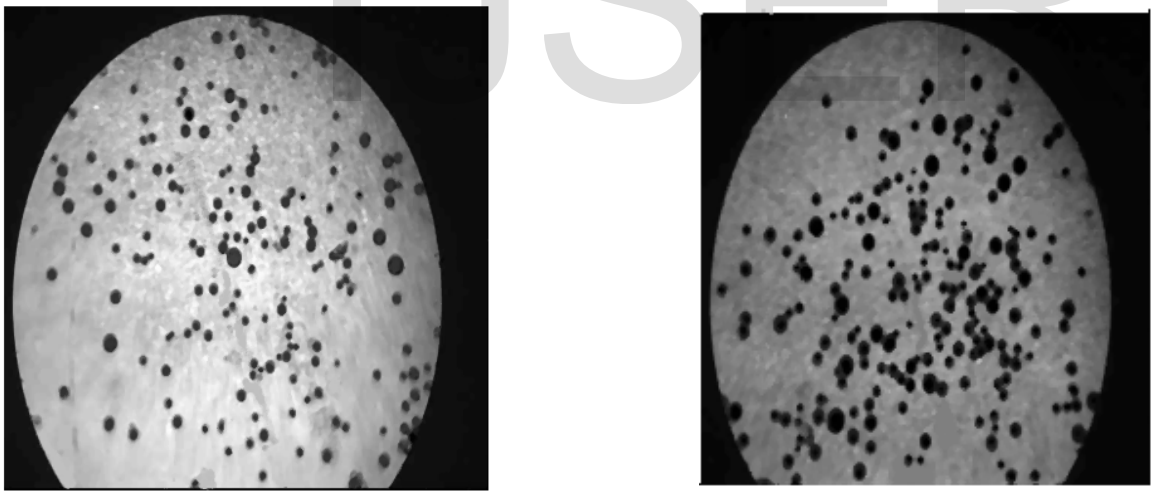

Fig. 4(A), 4(B) Noise Free images using median filter

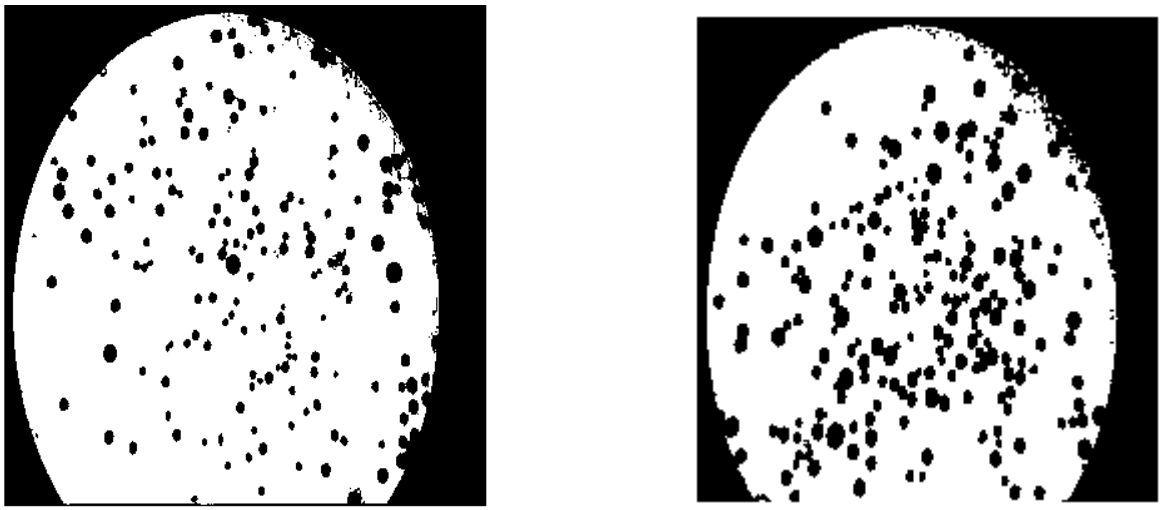

Fig. 5(A), 5(B) Output images using thresholding

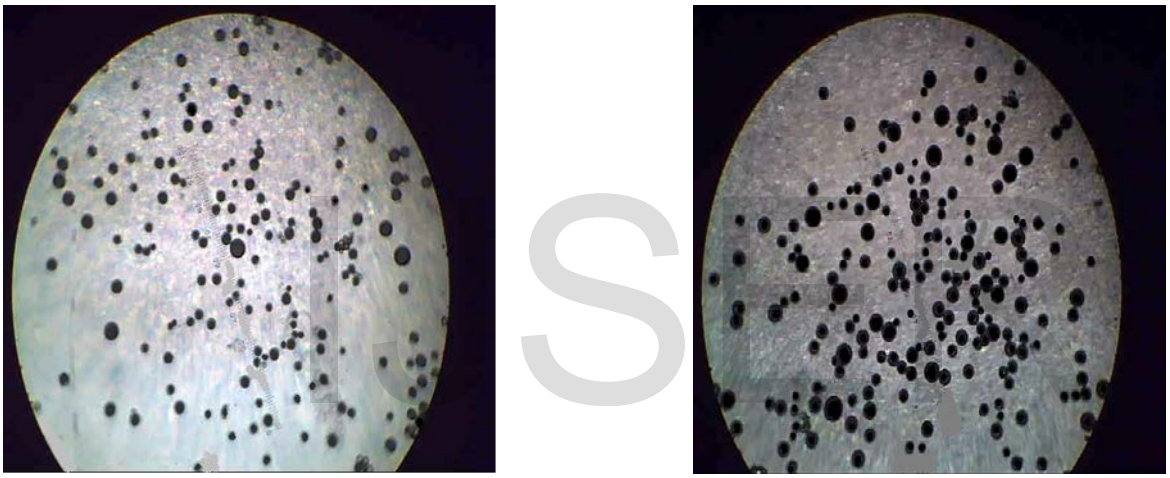

Fig. 6(A), 6(B) Original images of membrane filter for morphological processing

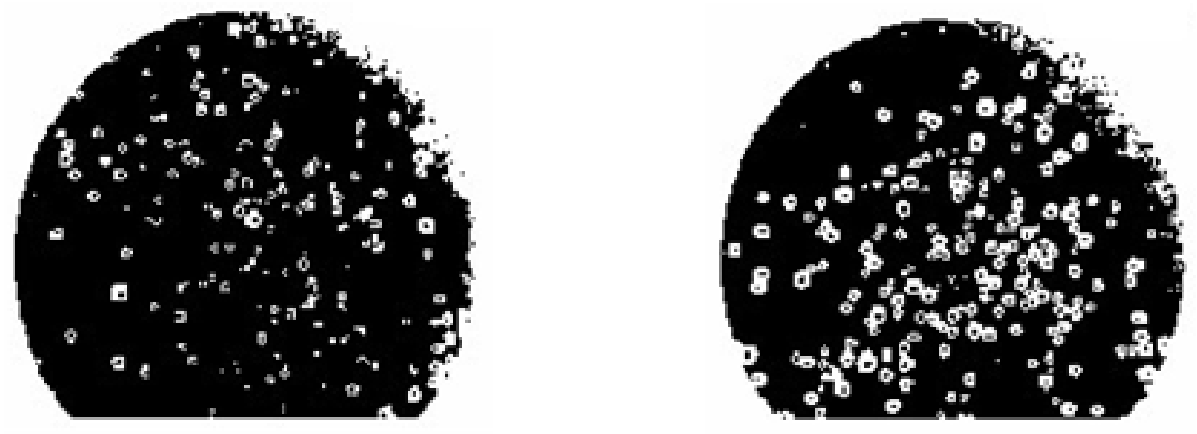

Fig. 7(A), 7(B) Segmented images using active contour method

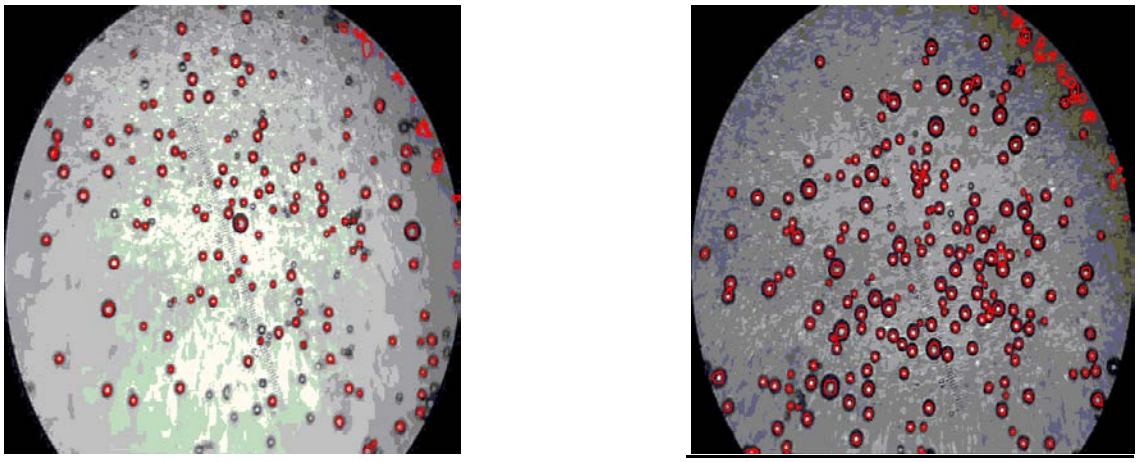

Fig. 8(A), 8(B) Boundary Extracted images using active contour method

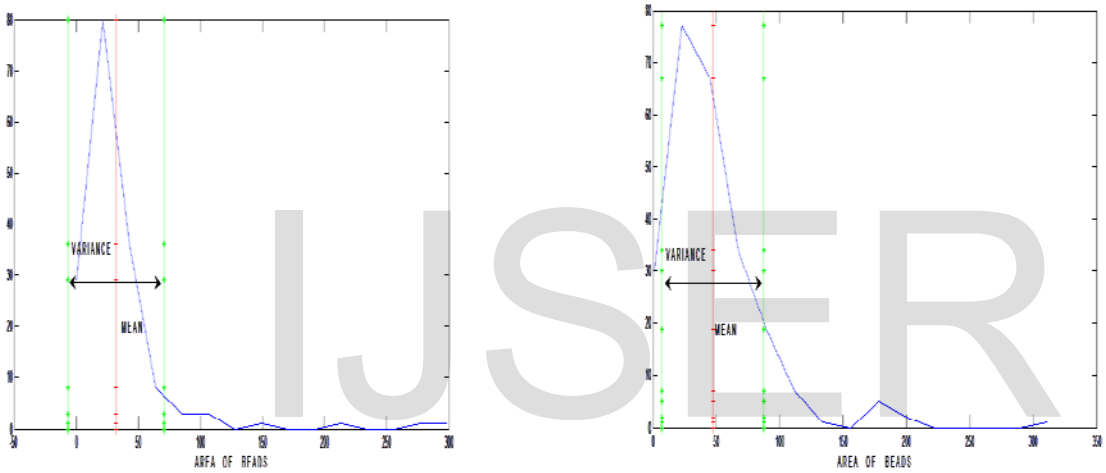

Fig. 9(A), 9(B) Corresponding Area curves using active contour method

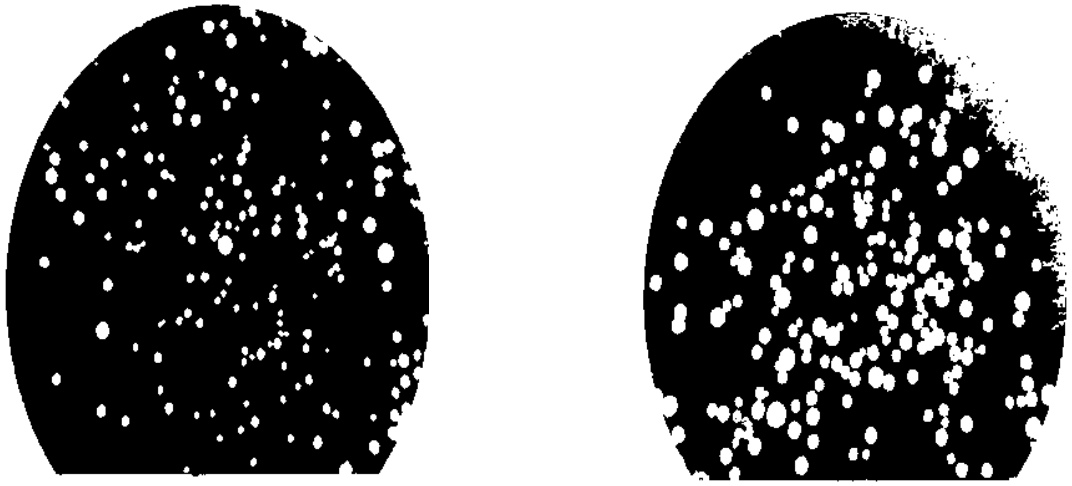

Fig. 10(A), 10(B) Segmented images using mean shift algorithm

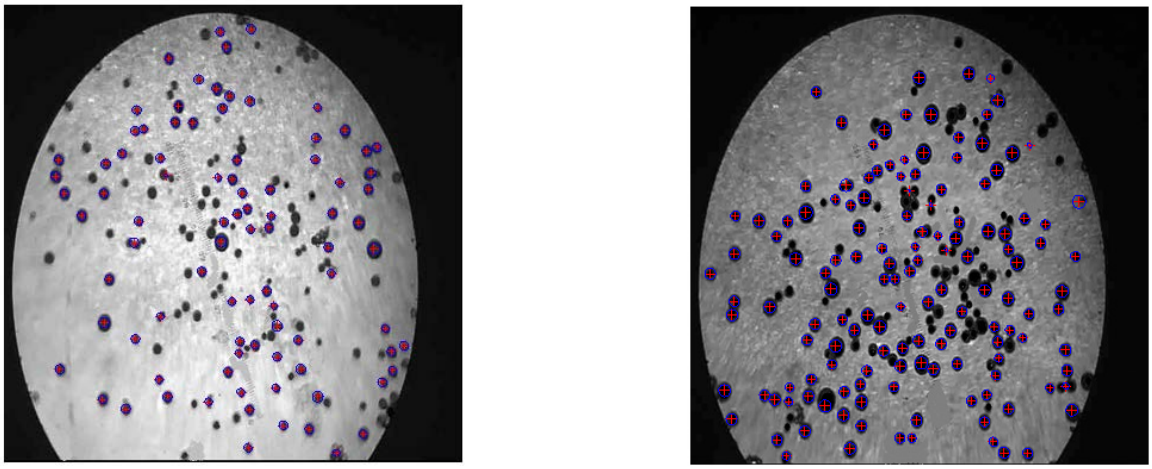

Fig. 11(A), 11(B) Extracted pore boundaries using mean shift algorithm

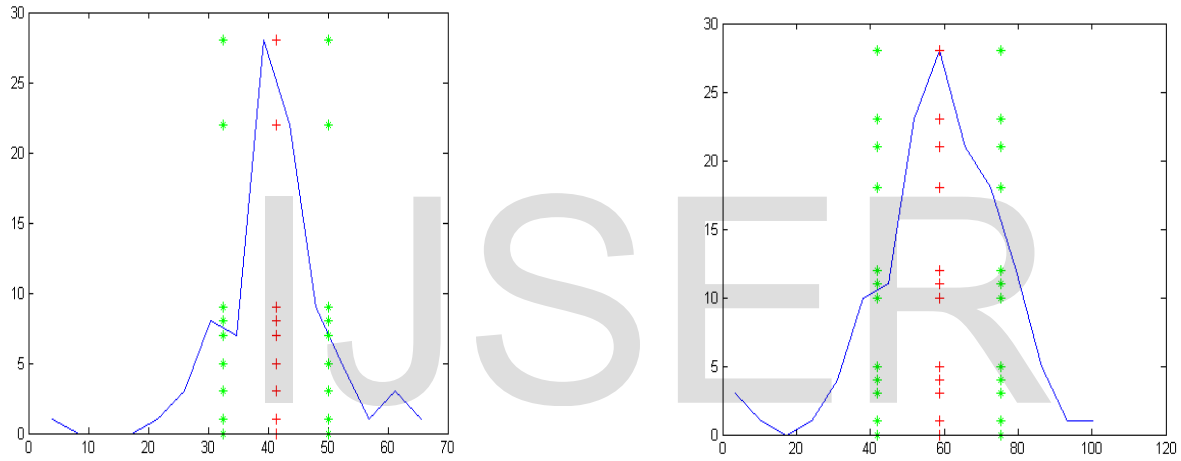

Fig. 12(A), 12(B) Corresponding Area curves using mean shift algorithm