International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS)
Volume VII, Issue IV, April 2018 | ISSN 2278-2540

A Noval Approach to Extract an Image Using Watershed Transform

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***Abstract*---Image segmentation is an important image processing technique which is used to analyze what is inside the image. It means division of an image into meaningful structures. It is process of extracting and representing information from the image to group pixels together with region of similarity [1]. Image segmentation is used to separate an image into several meaningful parts. Image segmentation is process of partitioning the image into multiple segments. It is first important step in many image processing applications like image analysis, image description, recognition, image visualization and object based image compression. Image segmentation means assigning a label to each pixel in the image such that pixels with same labels share common visual characteristics. It makes an image easier to analyse in the image processing tasks. There are many different techniques available to perform image segmentation. The algorithm used in this paper is watershed based image segmentation. It is a hybrid technique because it is the result of threshold based, edge and region based techniques using morphological watershed transform. The watershed transformation is popular image segmentation technique for gray scale images [2]. An efficient watershed algorithm based on connected components [3] shows very good results compare to other watershed based image segmentation algorithms.**

***Keywords*--- Watershed, Thresholding, Morphological, Erosion and Dilation**

I. INTRODUCTION

As we all know that every image is a set of pixels and partitioning those pixels on the basis of the similar characteristics they have is called segmentation (dividing an image into sub partitions on the basis of some similar characteristics like color, intensity and texture is called image segmentation). The goal of segmentation is, to divide an image into parts that have a strong correlation with objects or areas of the real world contained in the image. Fig. 1 shows a basic example of the image segmentation where Fig. 1(a) is an original gray scale image and Fig. 1(b) is a segmented image. All the objects of the original image can be identified in segmented image with their boundaries. There are many techniques available for the image segmentation [4]. Examples are, threshold based segmentation, edge based segmentation, region based segmentation, clustering based image segmentation, markov random field based segmentation and hybrid techniques.

Watershed transformation also called watershed method, is a powerful mathematical morphological tool for the image segmentation. It is more popular in the fields like biomedical and medical image processing and computer vision [5]. In geography, watershed means the ridge that divides areas drained by different river systems. If image is viewed as geological landscape, the watershed lines determine boundaries which separate image regions.

(a) Input Image (b) Segmented Image

Fig. 1: Image Segmentation

The watershed transform computes catchment basins and ridgelines (also known as watershed lines), where catchment basins corresponding to image regions and ridgelines relating to region boundaries [6]. Segmentation by watershed embodies many of the concepts of the three techniques such as threshold based, edge based and region based segmentation.

II. NEED OF SEGMENTATION

Image segmentation is to segment the image into multiple parts. It is useful everywhere whenever we want to analyze what is inside an image. For example, if we want to find if there is a chair or dog inside an indoor image, we need image segmentation technique to separate the objects in the image and analyze each object individually to check what it is, as we already know that because of image segmentation we can identify the diseases in medical imaging and also in many applications like face detection, iris detection, fingerprint recognition and also in brake light detection technique also we used this image segmentation technique.

In image segmentation each technique has its own advantages and also disadvantages, so it's hard to tell which one is better in all the techniques.

III. WATERSHED TRANSFORM

Any grayscale image can be viewed as a topographic surface where high intensity denotes peaks and hills while low intensity denotes valleys. We start filling every isolated valleys (local minima) with different colored water (labels). As the water rises, depending on the gradients nearby, water from different valleys, obviously with different colors will start to merge. To avoid that, we build barriers in the locations where water merges. We continue the work of filling water and building barriers until all the peaks are under water. Then thebarriers we created gives us the segmentation result.

This approach gives us over segmented result due to noise or any other irregularities in the image. So Open CV implemented a marker-based watershed algorithm is an interactive image segmentation where you specify which are all valley points are to be merged and which are not. What we do is to give different labels for our object we know. Label the region which we are sure of being the foreground or object with one color (or intensity), label the region which we are sure of being background or non-object with another color and finally the region which we are not sure of anything, label it with 0. That is our marker. Then apply watershed algorithm. Then our marker will be updated with the labels we gave, and the boundaries of objects will have a value of -1 [7].

There are mainly three stages for watershed based image segmentation approach. First stage is defined as pre-processing, second stage as watershed based image segmentation and last stage as post-processing. Input image is first processed by the pre-processing stage, and then given to watershed based segmentation stage. The resulting image is post processed by the final stage to get a segmented image. Pre-processing and post-processing are necessary to overcome the problem of over-segmentation in watershed based image segmentation.

A. Pre-Processing Stage

The watershed based image segmentation produces mostly an over-segmentation of the image.Pre-processing and post-processing of an image is performed to overcome this problem. Pre-processing is mainly applied to the image before the watershed segmentation. As shown in Fig. 2, pre-processing includes first stage of noise removal using median filter, second stage of morphological gradient calculation and last stage of thresholding a gradient image.

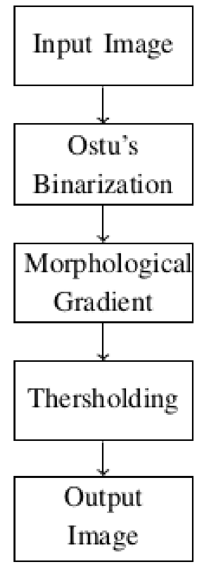


Figure 2: Image of Pre-processing stage

In principle, Image noise is defined as distinct pixels which are not similar in appearance with the neighbourhood pixels. Over-segmentation occurs mainly due to presence of the noise and unimportant fluctuation which produces non real minima. Main objective of the pre-processing stageis to smooth the original image by removing the noise effect.

B. Ostu's Binarization

Otsu's binarization is used to find an approximate estimate of the image. It improves results of non uniform background images. It divides the image into irregular areas with similar characteristics, which are processed individually and afterwards integrated into the global result [8].

C. Morphological Gradient

The morphological gradient is a powerful tool for an edge detection. At the second stage of the pre-processing, the morphological gradient of the filtered image is computed to overcome over-segmentation problem. When the morphological transition is applied to the gray scale image, it returns to high values when sudden transitions in gray level values are detected along the object edges, and returns to low values if neighbourhood pixels are similar. The Watershed transform is then applied to the gradient image so that boundaries of the catchment basin could be located on high gradient points. This operator can perform well only when noise level is effectively reduced before it is applied.

D. Thresholding

The classical approach to get an edge image is to threshold the gradient image. The main objective of third stage in the pre-processing is to reduce the over-segmentation as much as possible. The threshold value is set for the local minimum to prevent creation of large number of catchment basins. In this stage, all the gradient values lower than this threshold value are set as a local minimum and watershed starts from this local minimum. Thresholding also removes small variations within the homogeneous region. For thresholding a given image, all the gradient values of the image pixels are divided by the threshold value, so all the values lower than the threshold value become zero and other values are scaled down relative to the threshold value.

IV. IMPLEMENTATION

Step 1: Input an image i.e., read in the color image and convert it to grayscal**e**

Step 2: We start with finding an approximate estimate of the coins by using the Thresholding i.e., Otsu's binarization.

Step 3: Next step is use the Morphological gradient as the Segmentation Function. Now we need to remove any small white noises in the image. For that we can use morphological opening. To remove any small holes in the object, we can use morphological closing. Erosion is useful for removing small white noises and used to detach two connected objects etc.

Working of Erosion: A kernel (a matrix of odd size (3,5,7) is convolved with the image. A pixel in the original image will be considered 1 only if all the pixels under the kernel is 1, otherwise it is made to zero. Thus all the pixels near boundary will be discarded depending upon the size of kernel. So thethickness or size of the foreground object decreases or simply white region decreases in the image.

In cases like noise removal, erosion is followed by dilation. Because, erosion removes white noises, but it also shrinks our object. So we dilate it. Since noise is gone, they won't come back, but our object area increases. It is also useful in joining broken parts of an object.

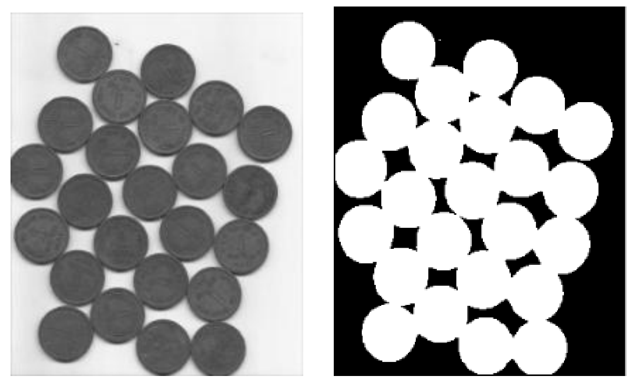
Working of dilation: A kernel (a matrix of odd size(3,5,7) is convolved with the image. A pixel element in the original image is '1' if atleast one pixel under the kernel is '1'. It increases the white region in the image or size of foreground object increases

Step 4: The remaining regions are those which we don't have any idea, whether it is coins or background. Watershed algorithm should find it. These areas are normally around the boundaries of coins where foreground and background meet or even two different coins meet. It can be obtained from subtracting foreground area from background area.

Step 5: Now we know for sure which are region of coins, which are background and all. So we create marker and label the regions inside it. The regions we know for sure (whether foreground or background) are labelled with any positive integers, but different integers and the area we don't know for sure are just left as zero. For this we use cv2.connected Components (). It labels background of the image with 0, then other objects are labelled with integers starting from 1.

Step 6: Now our marker is ready. It is time for final step, apply watershed. Then marker image will be modified. The boundary region will be marked with -1.Watershed transform gives the region where they touch are segmented properly and for some, they are not.

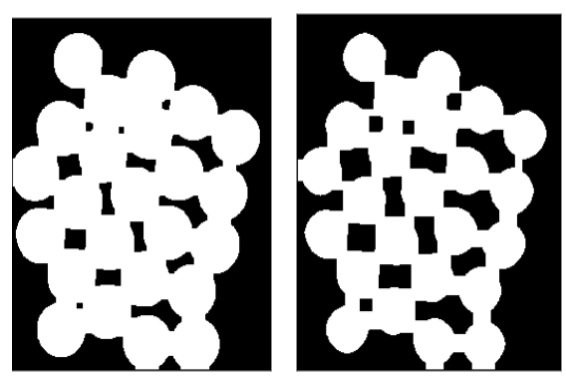
V. EXPERIMENTAL RESULTS



(a) (b)

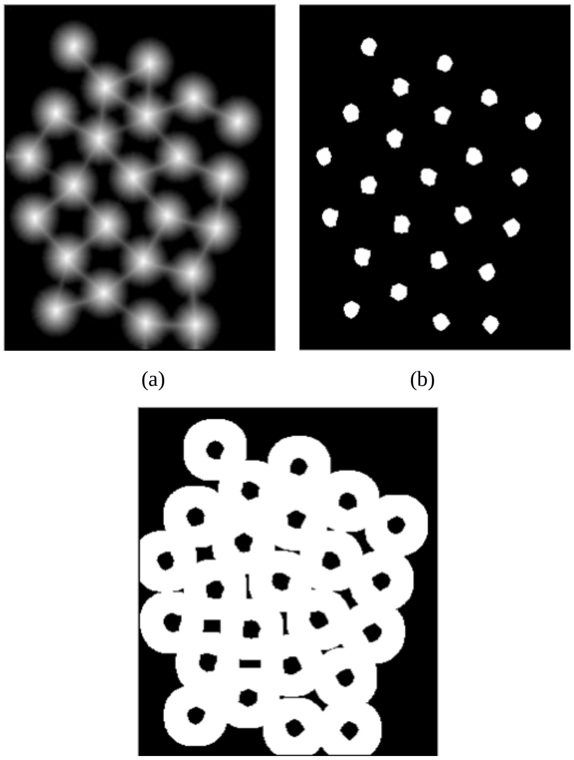
Fig. 3: (a) Original image and (b) Otsu's Binarization image

Now we know for sure that region near to center of objects are foreground and region much away from the object are background. Only region we are not sure is the boundary region of coins. So we need to extract the area which we are sure they are coins. Erosion removes the boundary pixels. So whatever remaining, we can be sure it is coin. That would work if objects were not touching each other. But since they are touching each other, another good option would be to find the distance transform and apply a proper threshold. Next weneed to find the area which we are sure they are not coins. For that, we dilate the result. Dilation increases object boundary to background. This way, we can make sure whatever region in background in result is really abackground, since boundary region is removed. See the image as shown in Fig. 4



(a) (b)

Fig. 4: (a) White Region shows Sure Foreground and (b) Black Region shows Sure Background



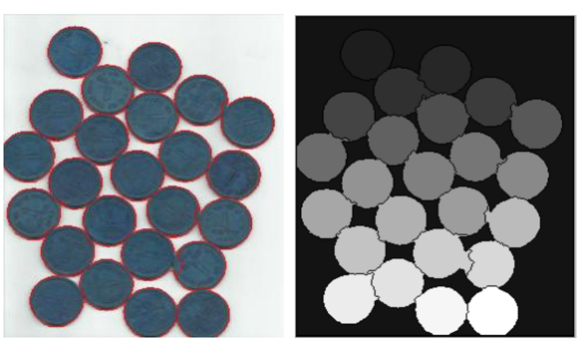
(a) (b)

(c)

Fig. 5: (a) Distance Transform (b) Thresholding (c) Unknown

As shown in Fig. 5, we get some regions of coins, which we are sure of coins and they are detached now. In some cases, we may be interested in only foreground segmentation, not in separating the mutually touching objects. In that case, we need not use distance transform, just erosion is sufficient. Erosion is just another method to extract sure foreground area, that's all**.** But we know that if background is marked with 0, watershed will consider it as unknown area. So we want to mark it with different integer. Instead, wewill mark unknown region, defined by unknown, with 0 as shown in Fig. 5 (c).

It is time for final step, now our marker is ready, apply watershed. Then marker image will be modified. The boundary region will be marked with -1 as shown in Fig. 6.



(a) (b)

Fig. 6: (a) Marker image after segmentation and (b) Final Result

VI. CONCLUSION

In this paper we used morphological gradient approach and the watershed transformation. A watershed algorithm based on connected components is selected for the implementation. A pre-processing step is required to overcome the problem of over-segmentation by watershed based image segmentation. Morphological gradient provides a global analysis of the image then the almost unwanted contours due to the noise added to a given image can be significantly reduced by our approach.

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