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# An Effective Segmentation of Hyperspectral Cancer Images using Watershed Transform

Arun Gopi
Mohandas College of Engineering & Technology
Thiruvananthapuram, India
arunvgopii@gmail.com

Reshmi C S
Mohandas College of Engineering &Technology
Thiruvananthapuram, India
csreshmi@gmail.com

*Abstract*—**Cancer margin detection is a challenging task in cancer treatment. Once the proper removal of the malignant tissue is not done effectively, there may be chances for the further intermittence of the disease. Here an effective segmentation strategy for hyperspectral cancer images is proposed using watershed transform. Hyperspectral Images (HSI) is the emerging medical imaging trend, it could radiate many characteristic features of a tissue which is not possible in normal images. The watershed transform is popular and having interesting properties that make it useful for many image segmentation applications especially for the medical applications. One of the important drawbacks associated to the watershed transform is the over segmentation which can be solved by incorporating certain morphological operator with it. Here this refined strategy is introduced in HSI to effectively extract the malignant tissue boundary.**

**Keywords— Cancer, Hyperspecral images, Watershed transform, Morphological operations, Feature Extraction**

## I. INTRODUCTION

In 2014, around 1.7 million people may be diagnosed with cancer and 585,720 will die from the disease in the United States. Cancer is a continual multiplying of cells abnormally. The cells divide uncontrollably and will grow into adjacent tissue or unfold to distant parts of the body. Cancers are a large family of diseases that involve abnormal cell growth with the potential to invade or spread to other parts of the body. They form a subset of neoplasm. A neoplasm or tumor is a group of cells that have undergone unregulated growth and will often form a mass or lump, but may be distributed diffusely. Tobacco use is the cause of about 22% of cancer deaths. Another 10% is due to obesity, poor diet, lack of physical activity and drinking alcohol. Other factors include certain infections, exposure to ionizing radiation and environmental pollutants. In the developing world nearly 20% of cancers are due to infections such as hepatitis B, hepatitis C and Human Papilloma Virus (HPV). These factors act, at least partly, by changing the genes of a cell. Typically many genetic changes are required before cancer develops. Approximately 5–10% of cancers are due to inherited genetic defects from a person's parents. Survival and life quality of the patients correlate directly to the primary tumor size at initial diagnosis; therefore, early detection of malignant lesions could improve both the incidence and survive. Suspicious lesions found through standard screening technique should be biopsied for histopathological assessment to make a definitive diagnosis [7]. Screening and detection could be vastly improved by optical technologies that are now self sufficient and which will provide improvement in accuracy and speed of diagnosis while decreasing the cost of finding and confirming lesions in the curable, pre-cancerous phase. In cancer treatment, the accurate determination of cancer margin of surgical resection is challenging. Noninvasive alternatives have been sought using a number of imaging modalities including computed tomography, ultrasound, and magnetic resonance imaging. Optical imaging may provide a potential solution to the global need for affordable imaging tools to aid in early detection and management of cancer [8].

Hyperspectral imaging (HSI) has the potential to improve cancer verification, decrease the use of invasive biopsies, and reduce patient discomfort associated with traditional procedures. The basic principle of a wavelength-scanning system consists of illuminating a subject area, spectrally discriminating the reflected light by a dispersive device, and detecting the light reflected from the sample surface onto a two-dimensional (2-D) detector array [9]. By measuring the changes in the reflectance spectrum, structural and biochemical information of tissue can be obtained. The major advantage of HSI is that it is a non-invasive technology that does not require any contrast agent, and it combines spectroscopy and wide-field imaging to simultaneously attain

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both spectral and spatial information from an object. HSI is preferred it does not need any detailed preprocessing as in MRI and can directly move on to the analysis of the input data without having a prior idea about the input taken.

A watershedis a transformationdefined on a grayscale image. The name refersmetaphorically to a geological watershed, or drainage divide,which separates adjacent drainage basins. The watershedtransformation treats the image it operates uponlike a topographic map, with the brightness of each pointrepresenting its height, and finds the lines that run alongthe tops of ridges.Watershed algorithm is used inimage processing primarily for segmentationpurposes.The watershed method in its original form produces a severeover segmentation of the image, i.e., many small basins are produced due to many local minimain the input image. It is evident in biomedical images, which can be resolved by incorporating morphological operations, making it as modified watershed algorithm.

## II. METHODOLOGY

The proposed technique for the extraction of brain tumor consists of the following processes, as shown in Fig.1. Pre-processing, improved watershed transform, morphological operations and feature extraction. Here the HSI images of animal tissues are used and are taken from [3]. All the steps associated are explained below:

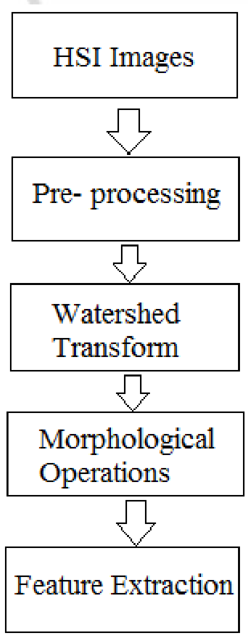


Fig 1. Block Diagram

### A. *Pre-processing*

The pre-processing has not much relevance in the HSI, it is the major advantage of the images. The only preprocessing required are simple rgb-to-gray conversation. The various bands associated with the HSI may be converted to intensity variation in the gray scale version.

### *B. Watershed Transform*

Watershed transform [2] is a most efficient segmentation technique coming from the field of mathematical morphology. The intuitive idea of this transform is quite simple: if we consider the image as a landscape or topographic relief, where the height of each point is directly related to its gray level, and consider rain gradually falling on the terrain, then the watersheds are the lines that separate the "lakes" actually called catchment basins that form. The watershed transform is computed on the gradient of the original image, so that the catchment basin boundaries are located at high gradient points. This transform has been widely used in many fields of image processing, including medical MR image segmentation, due to the number of advantages that it possesses: it is quite simple, intuitive, fast, parallelized technique and produces a complete division of the image in separated regions even if the contrast is poor, thus avoiding the need for any kind of contour joining. Some important drawbacks associated to the watershed transform are the over segmentation and poor detection of significant areas with low contrast boundaries that commonly results in MR brain images.

In medical images, the markers selection and extraction are not so easy. Some images may be very noisy and image processing becomes more and more complex. In some cases, the objects to be detected may be so complex and so varied in shape and size that it is very hard to find improved algorithm enabling their extraction. For that reason, we need to go a step further in the segmentation approach. We know that the initial watershed transformation of the gradient image provides very unsatisfactory results many apparently homogeneous regions are fragmented in small pieces. Fortunately, the watershed transform itself, applied on another level, will help us to merge the fragmented regions. Indeed, if we look at the boundaries produced by the segmentation, they do not have the same weight. Those which are inside the almost homogeneous regions are weaker. In order to compare these boundaries, we need to introduce neighborhood relations between them. The improved watershed transform presents some advantages: The watershed lines always correspond to the most significant edges between the markers and it always detects a contour in the area; where there are no strong edges between the Markers. This contour will be located on the

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pixels with higher contrast. In this work we first remove the noise from the image and pixel values are adjusted so that they will help to obtain the well segmented image.

*C. Morphological Operations*

Mathematical morphology commonly refers to a broad set of image processing operations that process images based on shapes. Morphological operations selects appropriate structuring element of the processed image and makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and the operations of them to get clear HSI edge. In the process, the synthesized modes of the operations and the feature of structuring element decide the result of the processed image. Detailed saying, the synthesized mode of the operation reflects the relation between the processed image and original image, and the selection of structuring element decides the effect and precision and the result. Therefore, the keys of morphological operations can be generalized for the design of morphological filter structure and the selection of structuring element. In brain tumor extraction, we select disc shaped structuring element by texture features of the image and the size, shape and direction of structuring element must been considered roundly. By the operation features of morphology, erosion and dilation operations satisfy: $\mathbf{F \ominus B \subseteq F \subseteq F \oplus} B$,Where, F denote a gray scale brain image, B denote structuring element.
Opening and closing operations satisfy: $\mathbf{F \circ B \subseteq F \subseteq F \cdot B}$. In this work morphological operations are applied on the converted binary image. The purpose of the morphological operators is to extract the tumor part of the HSI. [11] proposed a system, in which a predicate is defined for measuring the evidence for a boundary between two regions using Geodesic Graph-based representation of the image. The algorithm is applied to image segmentation using two different kinds of local neighborhoods in constructing the graph. Liver and hepatic tumor segmentation can be automatically processed by the Geodesic graph-cut based method.

III. RESULTS AND DISCUSSION

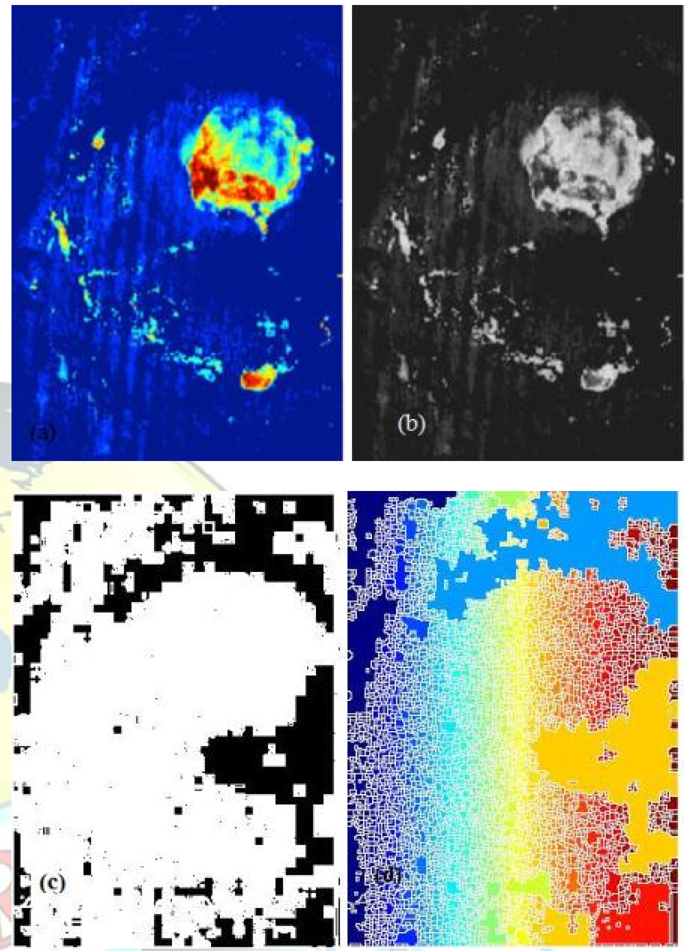


Fig 2. (a) Input image (HSI) (b) Gray scaled Image of input (c) Gradient Magnitude (d) Watershed Transform of gradient magnitude.

The preprocessing involves the rbg-to-gray conversion. Then perform the gradient magnitude of the input image. The preprocessed is then filtered with a Sobel kernel in both horizontal and vertical direction to get first derivative in horizontal direction (Gx) and vertical direction (Gy). From these two images, we can find edge gradient and direction. Aftergetting gradient magnitude and direction, a full scan of imageis done to remove any unwanted pixels which may not constitute the edge. For this, at every pixel, pixel is checked if it is a local maximum in its neighborhood in the direction of gradient. It is respectively shown in Fig 2. (a) and (b). And the watershed transform is performed on the gradient magnitude and is shown in Fig 2. (d).

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The steps involved in watershed segmentation are :

- Gradient magnitude of image is detected and watershedtransform is applied.
- Opening-closing by reconstruction of the image is determined.
- Regional maxima of opening and closing by reconstruction.
- Thresholding is done.
- Object boundaries are marked. Colored watershed labelmatrix is obtained through which the tumor is segmentedfrom the input image.

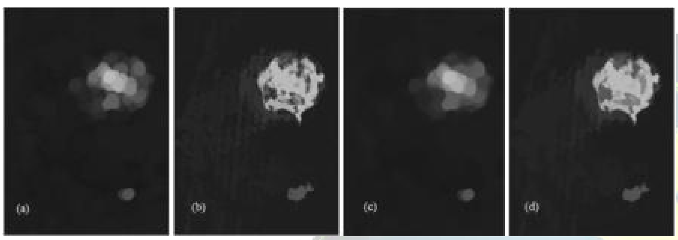


Fig 3. (a) Opening (b) Opening by reconstruction (c) Opening-closing(d) Opening-closing by reconstruction.

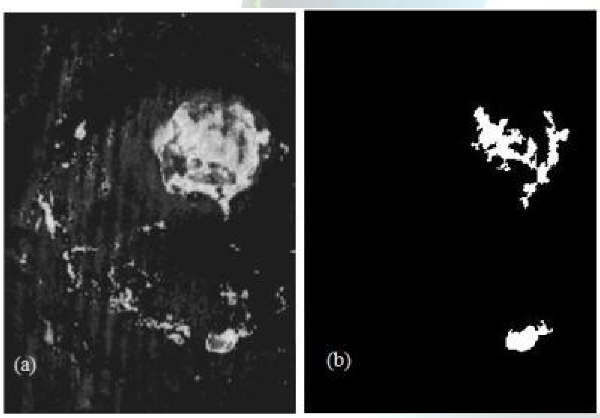


Fig 4. (a) Gray scaled input image (b) Region maxima of opening- closing of reconstruction.

| METHOD | ACCURACY (%) |
| --- | --- |
| Proposed Method | 98.8 |
| Tumor Detection in MRI Using Watershed[1] | 97.5 |
| Tumor Detection Using Watershed & Thresholding [4] | 91.6 |

Table 1. Comparison on Proposed Method

## IV. CONCLUSION

The proposed watershed based feature extraction can be applied as an efficient method for cancer boundary detection in HSI . The watershed algorithm was modified with certain morphological operations, in order to correct the over segmentation problem occurring in medical images. The medical HSI is proven to give a better result than the normal images and it proven to be a promising imaging tool for cancer research. And it analyzed that the watershed algorithmapplied in the HSI shows better efficiency than the other methods. The errors found in these classification attempts were from large gradients and shaded regions of the images. Despite these errors, the method is able to accurately segment the cancerous tissue in the hyperspectral images. The future work is devoted to extracting more features like depth feature with more accuracy.

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