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Image Restoration Segmentation Using Watershed Method for Basic Medical Applications

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Abstract

In this research, the knowledge of the geography of Thailand and mathematics by applying the knowledge of image processing and image segmentation to apply to basic medical such as photos of different parts of cancer, x-ray images, ultrasound images, or other images. To be used for accurate medical imaging analysis and reducing the initial error diagnosis of doctors which in this research we have applied the knowledge of the watershed method and image segmentation using mathematical morphology the methodology used depends on the watershed dynamics. To avoid over-segmentation, the watershed change is combined with a fast algorithm using the contour configuration method. Thresholding active contours and differential operators do well in the segmentation of isolated regions, while regional growth has a greater advantage, yielding good results. and there are numerical tests that have demonstrated the effectiveness of our method for segmenting images.

Keywords: Image restoration, Image segmentation, Watershed method

1. Introduction

In the medical field, we often hear it in our daily news that doctors misdiagnose them, which is a problem in the patient safety gap. That is, when a diagnosis error occurs, doctors may prescribe the wrong type of medication to a patient, for example, when a doctor diagnosed a patient in Thailand with HIV (15), which caused this patient to be infected for more than 5. Years later (18), it was found that the patient did not have HIV at all. (12) Which has a serious impact on the lives of patients who have to live as infected patients. This means that the error of the diagnosis is not correct. Which, in addition to being dangerous, the patient also causes excessive medical costs. In this research, we reduce the error of diagnosis by applying the geographic knowledge of Thailand and mathematics and apply it to image processing knowledge for basic medical use. Such as cancer photographs, X-rays, ultrasound images (4) of children with physical abnormalities or other images to be used for accurate medical imaging analysis and reducing the initial error diagnosis of doctors.

The geography or topography of Thailand has a distinctive structure and boundaries. Such as mountains or rivers, bays, lakes, deserts, forests, and swamps, so mountains are widely used as international boundaries in clear demarcation. (3) Because the mountains often cover a fairly wide area. And most commonly used is the watershed or water dividing line, which is an imaginary line connecting points on a ridge that divides water on each side of the ridge to flow in the opposite direction of the river. If there are many of the most continuous ridges, the ridge will be considered. The ridge is the highest, not necessarily the ridge. But the ridge is high and has the greatest continuity, often thought of as a watershed That is, puddle pattern is a popular segmentation method derived from mathematical morphology. (1) To solve the problem of excess in medical images, we convert the original image into a gradation image using the method. Morphology and transformed with an on-off filter to get a reference image with less noise. Then we looked for a reference image using the water table format. Experiments with doctors, image segmentation using a water grid pattern, showed that pre-and post segmentation image processing would help. Effectively prevent grouping. In this research, we studied the primary medical treatment of patients for each disease such as bladder stones, ovarian cysts, and brain cancer. (5) Patients who go to the doctor will have different diseases because they have different symptoms. Therefore, the doctor must ask the patient about the symptoms of the underlying disease. The doctor will then make an initial diagnosis or give medication to alleviate or cure the disease. (9) But if the patient has received the drug and the patient has not recovered from the symptoms, the doctor will need to diagnose the disease again whether the patient has

the correct initial diagnosis or not. The doctor will then use medical tools to help make an accurate and accurate diagnosis. To cure the disease by having Basic medical equipment in advanced disease examination Such as an X-ray, ultrasound, CT Scan or MRI procedure, Nose cancer and Gallstones as figure 1.

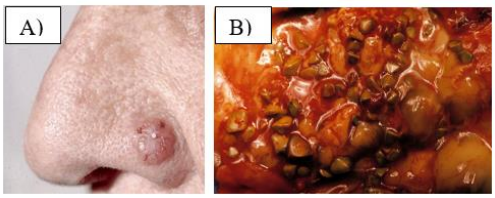

Figure 1 A) Nose cancer (24), B) Gallstones (25)

Hence from the above problems, we will use mathematics to help solve the visual problem. And find abnormalities in the body using the watershed method

2. Materials and Experiment

Basin segmentation is another region-based approach that originates in mathematical morphology (Serra, 1982). The general concept was presented by (Digabel and Lantuejoul,1978). (Vincent and Soille,1991) which presented an algorithm of magnitude orders that were faster and more accurate than ever before. Which since then it has been widely applied to a wide variety of medical imaging applications. In a watershed classification, the image is considered a topographic landscape with ridges and valleys. Landscape elevation values are typically determined by the corresponding pixel grayscale or slope size. By displaying the 3D image, the watershed changes decompose the image into the reservoir. (2) For each local minimum, the reservoir contains all the points where the steepest path of descent ends at this minimum. Basin separate water basin. Watershed transformations completely disintegrate the image and assign each pixel to a region or region of the watershed. With noisy medical imaging data creating a very small area, this is known as a "watershed segmentation" problem.

A watershed is a nature-inspired algorithm that mimics the phenomenon of water flowing through terrain mitigation. In a watershed segmentation, the image is considered to be a topographic relief, where gradient magnitude is interpreted as elevation data. Watershed algorithms have been enhanced with marker flood control techniques. In this operation, the automatic selection of markers with separate blobs is used in the processing of data extraction. It can be used to calculate elements such as area, eccentricity, centroid by adjusting the binary image by using appropriate criteria. This research will present the segmented restoration of images using the watershed method, which will address the steps as follows.

Step 1: Distance Transform is the distance from every pixel to the nearest non-zero pixel.

Step 2: The gradient magnitude method is to preprocess grayscale images before applying watershed transformation for segmentation. Gradient images have higher pixel values along the edges and lower pixel values. Upstream conversion creates a watershed ridge along the edge of the object.

Step 3: The Marker Controlled Method is a direct application of a watershed deformation as a gradient effect in the subdivision due to noise. A large division refers to a region that is divided into large numbers. The method used to control segmentation is based on the concept of the marker. The mark is the connecting element belonging to the picture. Gradation modifier mark Marks are of two types, internal and external, internal for objects and external for boundaries. The segmentation of the marked watershed is a robust and flexible method for the segmentation of closed-shaped objects. The mark is placed on the object of interest. An internal marker is associated with an object of interest, and an external marker is associated with a background. (8) After segmentation, the boundaries of the watershed are arranged on the desired ridge, thus separating each object from its neighbor. Segmentation using the upstream transformation is great if you can identify or mark the foreground object and the background-position. The gradient size of the main segmentation was obtained using the Sobel operator, the Canny edge detector, but it was found that the results obtained from the two methods were compared. Therefore, we decided to use the sobel filter as the canny edge detectors are more complex. Also, Sobel filters have the advantage of providing both contrast and softness. To segment the watershed that controls the mark, follow these basic steps:

3.1 Calculate the segmentation function This is an image where dark areas are the objects we are trying to segment

3.2 Calculate the prefix These are linked as drops of pixels within each object

3.3 Calculate background marks These are pixels that are not part of any object

3.4 Modify the segmentation function so that there is only a minimum at the foreground and background positions of the marker

3.5 Calculate the conversion of a watershed modified segmentation function

In the next step, we present the Watershed method algorithm diagram as figure 2.

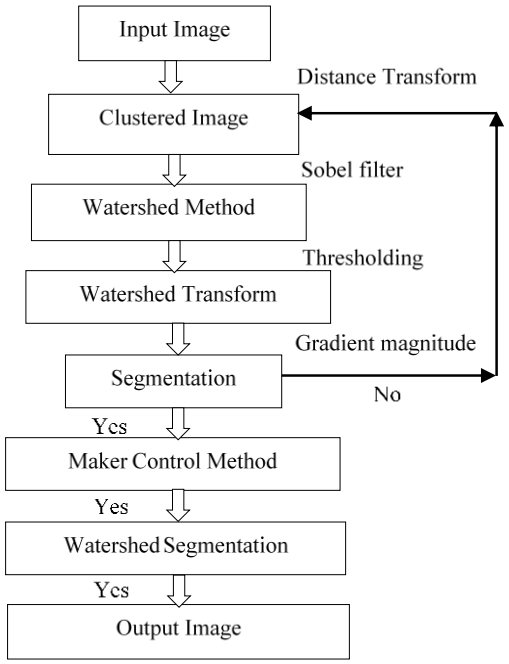

Figure 2 Algorithm watershed Segmentation

2.1 Research Processes

Image processing is the enhancement of image data to reduce unwanted image distortion or by adding certain image properties for further processing, which is essential to reduce the effects of image distortion found in devices. Take pictures such as fluctuations in light to remove blueness and at the same time. Processing is necessary to remove unwanted areas from the image, and sometimes it is used to enhance image properties such as the boundaries and texture of the image so that we can divide the image's content into two desired content and not. To easily remove noise from images, many researchers use different filtering techniques depending on the type of noise. In medical imaging, all types of filtering techniques may be used depending on the image noise. (2)

Image restoration is a technique in which we improve the data (raw images) obtained from sensors placed in various artifacts of life for a variety of applications. The results are of better quality because the subject is visible compared to the original tactile image. There are various basic steps involved in image representation processing, image preprocessing, enhancement, restoration, analysis, image reconstruction, and image compression. Image Recovery: The concern of image restoration is to remove or reduce the degradation that is included during image exposure such as noise, pixel value errors, focus blurring, or motion blur. Apply previous knowledge of deterioration phenomena. This means that it involves the modeling of degradation and the use of (inverse) processes to create new images. Image restoration has a wide scope of use. And images tend to degrade during the data collection process. (11) Degradation may involve blurring, loss of information due to various sampling, quantifying, and sound sources. The purpose of image recall is to approximate the original image from the degraded data. Applications range from medical imaging, astrophotography to forensic photography, and more. Often the benefits of improving image quality to the highest possible level outweigh the costs. And the complexity of regeneration algorithms. And the purpose of image restoration is to compensate or cancel the effect.

2.1.1 Materials and Methods

Image restoration the concerns of the image restoration are the removal or reduction of degradations which are included during the acquisition of images e.g.; Noise, pixel value errors, out of focus blurring or camera motion blurring using prior knowledge of the degradation phenomenon. This means it deals with the modelling of the degradation and applying the process (inverse) to reconstruct the image. The image restoration has got a wide scope of usage (19). The purpose of image restoration is to compensate for or undo effects. the orientation of the image restoration techniques is towards modelling the degradations such as blur and noise which involves the applications of various filters to obtain the original scene approximation. segmentation is often an important step in the analysis of images. The point that we move from each pixel consideration is a unit of observation working with the object. If the segmentation is good, other steps in the analysis of the image are easier. But, as we can see, success is often only partial when using automatic segmentation algorithms. However, manual intervention can often fix these problems and at this stage, the computer should do most of the work. The process of dividing an image into two parts is the desired part. and other parts that are not wanted. The required part is called ROI: Region-Of-Interest. In the case of brain cancer, the goal is to identify tumors present in brain cancer images. So the tumor is a return on our investment and one is an unwanted area. It is an important task for machines to automatically detect tumors due to the different surface properties of brain tissue in abnormal regions. Such as tumor return or cancer level for visual segments, there are two strategies found in different literature, such as marginal and regional segmentation:

Edge is the result of a change in the pixel color value between two areas of the image, which is a fundamental aspect of the image. The Grayscale image has a color value of each pixel between 0-255 and is stored as $m \times n$ matrix, where m,n are the number of rows and digits of the image.

Image smoothing is the color value of each pixel of an image is adjusted using a Gaussian filter. Which creates a sub-matrix mask (mask) for filtering. Using the Gaussian equation as follows:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{x^2+y^2}{2\sigma^2}} \quad (2.1)$$

Where (x,y) is the position of the member in a submatrix and σ is the parameter.and calculate the size and the direction of the color change as follows. (20)

$$GM(i,j) = \sqrt{g_x{}^2(i,j) + g_y{}^2(i,j)}$$
$$\text{and} \quad GD(i,j) = \arctan\left(\frac{g_y(i,j)}{g_x(i,j)}\right) \quad (2.2)$$

Where (i,j) is the position of the pixel g_x and g_y is the magnitude of the change in color values in x and y respectively. The values of g_x and g_y can be obtained in several ways, such as by using the mask of the robert operator. Use the mask of the pewit operator or the mask of the Sobel operator. In Algorithm Watershed Segmentation, we took equation (2.1), (2.2) and (2.3) in Watershed method and Watershed transform.

The determination of the possible edge (non-maximal suppression) is to determine the possible shell that will be the edge. And eliminate non-edge cells So that check the pixels the highest between positive and negative gradient pixels as figure 3.:

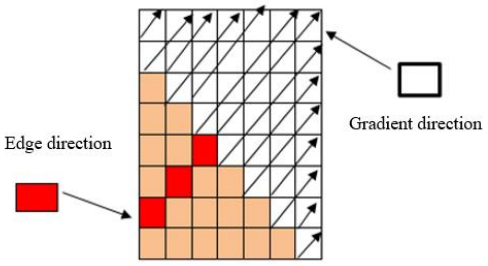

Figure 3 Images of determining possible edges

And determine the direction of the color change for each pixel from the m values divided into partitions 0, 45, 90, and 135 degrees by comparing the size. To the extent possible only if the size of the change in pixel color value is greater than or equal to the size of the change in the color value of two neighboring pixels. (23)

Thresholding is a very easy and common method of segmentation. and it is a value that can segment the ROI, called a threshold value. In the case of shell images and the brain cancer image, we convert our image to a grayscale image and then decide the threshold based on tumor properties. For example, we find that the tumor has intensity values 115-255, and then we can convert all values less than 115 to 0 and all other values between 115-255 equal to 1 in the binary image. Black and the desired area becomes white.

Where t is a pixel at the (i,j) position with the value greyscale $f(i,j)$ as follows:

$$\text{if } t(i,j) = \begin{cases} f(i,j) \le t, \\ Otherwise \end{cases} \quad (2.3)$$

The brain cancer image application with Thresholding as figure 4.

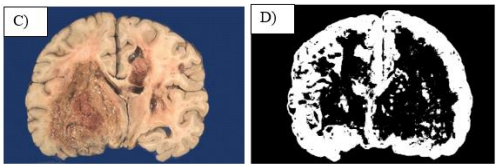

Figure 4 C) Brain cancer, D) Thresholding

The objective of this research was to study image processing by using watershed method, which is mathematical science. It is applied to medical analysis and diagnosis of medical diseases to be accurate in the diagnosis of patients to have the prescription of drugs or guidelines for the treatment of the disease completely.

3. Results and Discussion

For the results of this research, we have applied segmental image restoration using a watershed approach to its primary medical application. There are main components: Distance transform, Gradient magnitude and Marker Controlled Method were tested with 3 test images: Nose cancer, Skin cancer, and Cell cancer, with the comparison with canny edge operator method as follows:

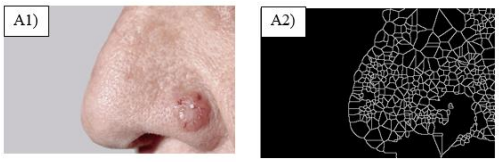

Figure 5 A1) Nose cancer, A2) Watershed Method

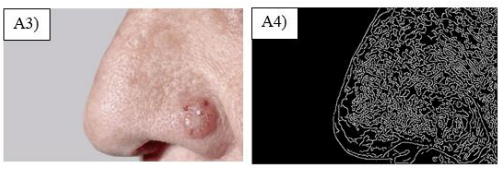

Figure 6 A3) Nose cancer, A4) Canny Edge Operator Method

Figure 5 and Figure 6 show the image division efficiency between the Watershed Method and the Canny Edge Operator.

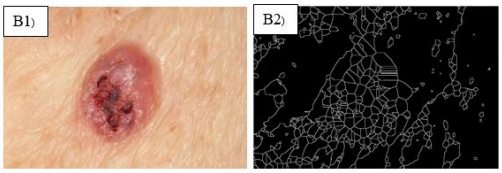

Figure 7 B1) Skin cancer, B2) Watershed Method

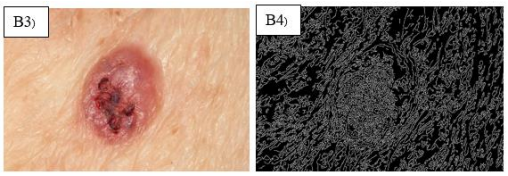

Figure 8 B3) Skin cancer, B4) Canny Edge Operator Method

Figure 7 and Figure 8 show the image division efficiency between the Watershed Method and the Canny Edge Operator

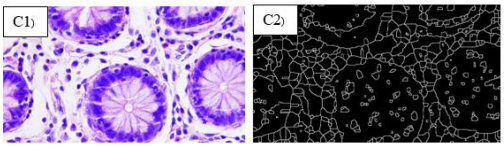

Figure 9 C1) Cell cancer, C2) Watershed Method

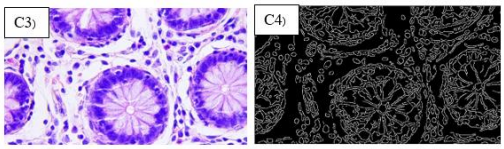

Figure 10 C3) Cell cancer, C4) Canny Edge Operator Method

Figure 9 and Figure 10 show the image division efficiency between the Watershed Method and the Canny Edge Operator.

From figure 5 – 10 a that the watershed method was more effective in the medical division than the candy method, which resulted in more accurate image division.

The aforementioned methods, we can apply to basic medical imaging to diagnose a medical disease and find out the disorder and treat it in the next step

Table 1 Performance Measures of Watershed Segmentation and Canny Edge Operator Method

Image Test	Watershed Method	Canny Edge Operator Method
Nose cancer	85.44	79.89
Skin cancer	84.39	78.55
Cell cancer	85.03	79.42

From Table 1, we tested the nose cancer, skin cancer, and cell cancer with two methods, the first method we tested with watershed method and the second with caddy. From the table, it was found that the watershed method was more accurate than the caddy edge operator method.

4. Conclusions

This research presents a segmented image restoration using a watershed approach for its primary medical application. The test was performed with 3 test images: Nose cancer, Skin cancer, and Cell cancer etc. along with the comparison with the Canny edge operator method. Clearly when compared with the canny edge operator method for initial medical diagnosis. And as a guideline for treating patients to make a cure for the existing disease

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Declaration of conflicting interests

The authors declared that they have no conflicts of interest in the research, authorship, and this article's publication.

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