Morphological Segmentation and Gradient of Multispectral Image of Bareilly Region

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ABSTRACT
Segmentation is the process of partitioning a digital image into multiple segments. The segmentation task consists of extracting the particles from the image under study. Morphology is a technique for the analysis and processing of the geometrical structures based on set theory and random functions. Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. In this paper we have performed morphological segmentation on Multispectral image of Bareilly region. A multispectral image is one that captures image data at specific frequencies across the electromagnetic spectrum. The four basic morphological operations used in the segmentation of multispectral images are (a) dilation, (b) erosion, (c)opening, (d)closing. After performing all the basic operations of morphological segmentation, we obtained the direction gradient of the multispectral image of bareilly region on Matlab software of version R2010b.

Keywords
Structuring element, erosion, dilation, opening, closing and gradient.

1. INTRODUCTION
The word segmentation in the image processing community means the decomposition of image under study into its different area of interest. In texture segmentation, an image is partitioned into regions, each of which is defined by some set of features characteristic to the smaller structure within it. The segmentation task consists of extracting the particles from the image under study. Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels).

Morphology is a technique for the analysis and processing of the geometrical structures based on set theory and random functions. It is most commonly applied to the digital images as well to the graphs, solid, geometrical structures. Morphological segmentation removes the random noise as well disturbances introduced during segmentation process. The basic tools used to perform morphological segmentation are Dilation and Erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. These two are duals of each others. With the help of these two operations we can perform some other complicated operations such as closing, opening etc in order to remove imperfections introduced during segmentation process.

1.1 Mathematical Definition of Erosion:
The erosion of the binary image A by the structuring element B is defined by:

$$A \ominus B = \{z \in E | B_z \subseteq A\}$$

where B_z is the translation of B by the vector z, i.e.,

$$B_z = \{b + z | b \in B\}, \forall z \in E.$$

The erosion of A by B is also given by the expression:

$$A \ominus B = \bigcap_{b \in B} A_{-b}.$$

1.1.1 Mathematical Definition Of Dilation
The dilation of A by the structuring element B is defined by:

$$A \oplus B = \bigcup_{b \in B} A_b$$

The dilation is commutative, also given by:

$$A \oplus B = B \oplus A = \bigcup_{a \in A} B_a.$$

The dilation can also be obtained by:

$$A \oplus B = \{z \in E | (B^s)_z \cap A \neq \varnothing\}$$

where B^s denotes the symmetric of B, that is,

$$B^s = \{x \in E | -x \in B\}.$$

1.2 Rules of dilation and erosion:
1.2.1 Dilation:
The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

1.2.2 Erosion:
The value of the output pixel is the *minimum* value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0.[3][4]

The above two definitions are defined in terms of binary images. Whereas in terms of set theory we can define it as: The **dilation** of an image f by a structuring element s (denoted $f \oplus s$) produces a new binary image $g = f \oplus s$ with ones in all locations (x,y) of a structuring element's origin at which that structuring element s hits the input image f, i.e. $g(x,y) = 1$ if s hits f and 0 otherwise,

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repeating for all pixel coordinates (*x*,*y*). Dilation makes the objects larger, and can merge multiple objects into one.

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2. ORIGIN OF STRUCTURING ELEMENT

A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. It is one of the most essential part of the segmentation. The structuring element has both shape and origin. Some of its properties are:

The matrix dimensions specify the *size* of the structuring element.

- The pattern of ones and zeros specifies the *shape* of the structuring element.
- An *origin* of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.[5]

2.1 Opening and Closing operation:

The opening of *A* by *B* is obtained by the erosion of *A* by *B*, followed by dilation of the resulting image by *B*:

$$A \circ B = (A \ominus B) \oplus B$$

On the other side closing is the just opposite operation to the opening in which dilation is followed by erosion. The closing of *A* by *B* is obtained by the dilation of *A* by *B*, followed by erosion of the resulting structure by *B*:

$$A \bullet B = (A \oplus B) \ominus B$$

The closing can also be obtained by $A \bullet B = (A^c \circ B^s)^c$, where X^c denotes the complement of *X* relative to *E*

$X^c = \{x \in E | x \notin X\}$. Hence we can conclude that they are dual of each other.

Basic operations performed by them on the images are as:

- Function of Opening:
- Smoothes the contour of the object.
- Breaks narrow isthmuses (bridges).
- Eliminates thin protrusion.
- Function of Closing:
- Smoothes sections of contours.
- Gaps of contour are filled.
- Eliminates small holes in contour.
- Fuses narrow breaks and long thin gulfs.
- In context to the matlab concern, we define the program function which are performed step by step to get the result.

2.2 Morphological opening:

Step1: Read the image into the matlab workshop by using 'imread' function.

Step2: Define structuring element as per your requirement by using 'strel' function. The structuring element must be large enough so that it is capable of to remove the lines when we erode the image.

Step3: Erode the image by using structuring element, with the help of 'imerode' function. It mainly accepts two primarily arguments:

- The input image to be operated. It can be any binary, gray scale image etc.
- A structuring element object, returned by the `strel` function, or a binary matrix defining the neighborhood of a structuring element.

Step4: Dilate the image by using same structuring elements, with the help of 'imdilate' function. Similarly it also accepts two arguments:

- The input image to be operated. It can be any binary, gray scale image etc.
- A structuring element object, returned by the `strel` function, or a binary matrix defining the neighborhood of a structuring element.

Step5: Lastly 'imshow' function is used to show the result on the figure window.

The complete steps perform the opening operation, the same steps are followed for the closing operation only the difference is that the erosion is followed after dilation.

2.3 Morphological closing

Step1: Read the image into the matlab workshop by using 'imread' command.

Step2: Define structuring as per your requirement by using 'strel' command. The structuring element must be large enough so that it is capable of to remove the lines when we erode the image.

Step3: Dilate the image by using structuring element, with the help of 'imdilate' function. It mainly accepts two primarily arguments:

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- The input image to be operated. It can be any binary, gray scale image etc.
- A structuring element object, returned by the `strel` function, or a binary matrix defining the neighborhood of a structuring element.

Step5: Lastly 'imshow' function is used to show the result on the figure window.

However we can also use the single functions i.e.’ imopen’ and ‘imclose’ to perform the opening and closing operation of the image.

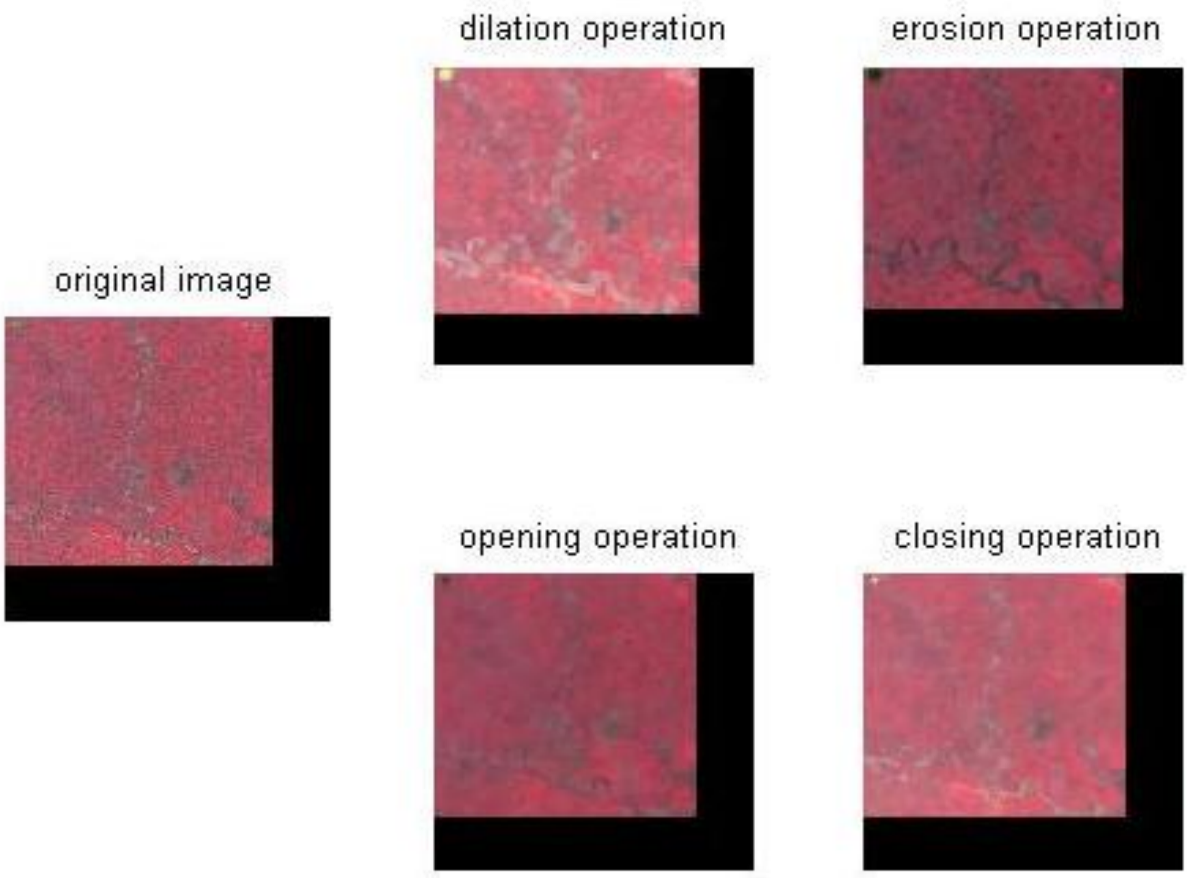

Fig 1: Morphological Segmentation of Multispectral image of Bareilly Region.

3. MORPHOLOGICAL GRADIENT OF AN IMAGE

Gradient operators are used in segmentation because they enhance intensity variations in an image. These variations are assumed to be edges of the object. Hence gradients are also called “edge detectors”.

The morphological operator dilation acts like a local maximum operator. Erosion acts like a local minimum operator. Dilation and erosion are often used in combination to produce a desired image processing effect.

In mathematical morphology and digital image processing, a morphological gradient is the difference between the dilation and the erosion of a given image. It is an image where each pixel value (typically non-negative) indicates the contrast intensity in close neighborhood of that pixel.[1][7]

3.1 3.1Mathematical definition of morphological gradient

Let $f : E \mapsto R$ be a grayscale image, mapping points from a Euclidean space or discrete grid E (such as R^2 or Z^2) into the real line. Let$b(x)$ be a grayscale structuring element**.**

$$b(x) = \begin{cases} 0, & |x| \leq 1, \\ -\infty, & \text{otherwise} \end{cases}$$

Then, the morphological gradient of f is given by

$$G(f) = f \oplus b - f \ominus b,$$

where $\oplus$ and $\ominus$ denote the dilation and the erosion, respectively.

An **internal gradient** is given by:

$$G_i(f) = f - f \ominus b,$$

and an **external gradient** is given by:

$$G_e(f) = f \oplus b - f$$

Three basic kinds of morphological gradients are:

- dilated_image - eroded_image
- original_image - eroded_image
- dilated_image - original_image

In this paper, we have obtained the direction gradient of multispectral image of Bareilly region [This image is obtained from IRSA website] on Matlab Software R2010b version. By using line segments as structuring elements, we can compute directional gradients.

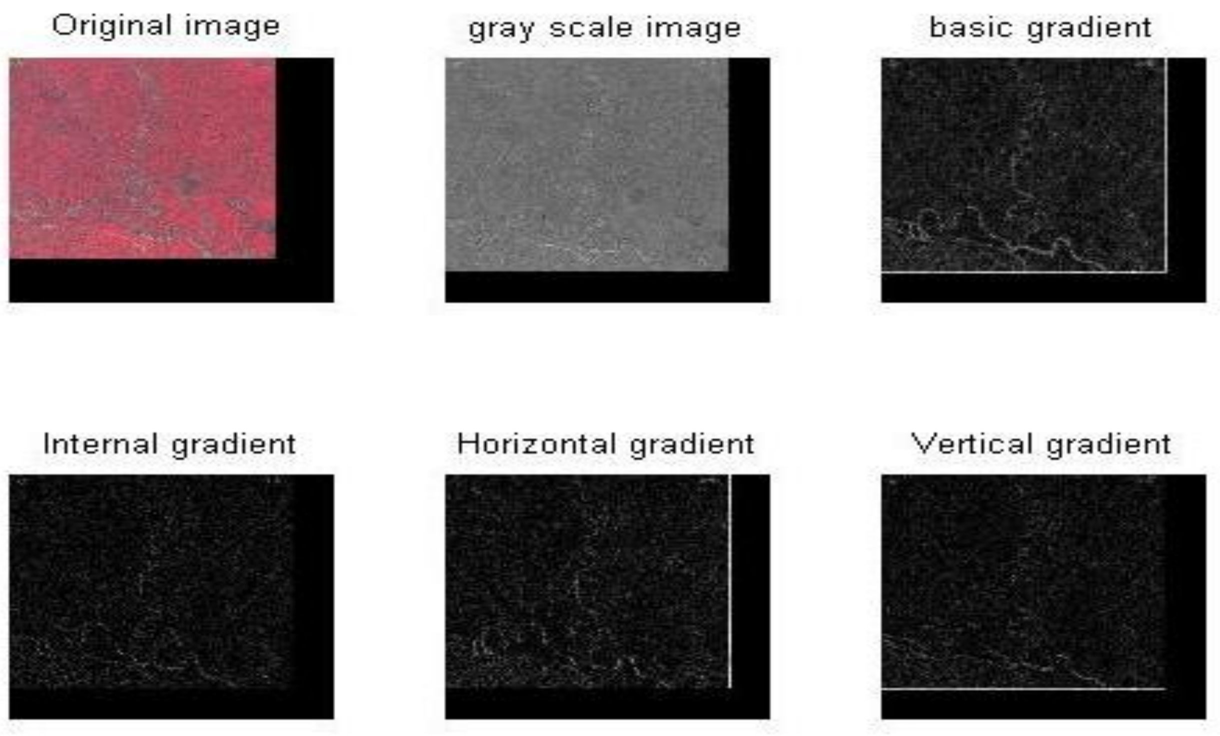

Fig 2: Directional gradient of multispectral image of Bareilly region.

4. CONCLUSIONS

The morphological segmentation is used to remove the random noise as well disturbances introduced during segmentation process. Dark spots are eliminated during opening process. Binarization of the image is very necessary before performing morphological segmentation. operations such as closing, opening etc in order to remove imperfections introduced during segmentation process. The magnitude of the gradient tells us how quickly the image is changing, while the direction of the gradient tells us the direction in which the image is changing most rapidly.

5. REFERENCES

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