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RESEARCH ARTICLE

EFFECT OF MORPHOLOGICAL OPERATORS ON DIGITALCOLOUR IMAGE.

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Abstract

Digital Colour Image processing techniques are used in wide varieties of applications. Our aim is to study the effect of morphological operator on colour images, which is a modern approach to the generalize morphology concept of grayscale or binary image to colour images. This work is mainly focused on effect of transformation of digital image using mathematical morphology. Using this, we are able to extract the information form the image.
Mathematical morphology has been chosen to explain how transform images are used to illustrate mathematical set of theoretic operations, such as union, intersection by means of morphological operations like dilation, erosion, opening, closing, thinning, thickening, hit and miss transform and boundary extraction on colour images.
These techniques are implemented in MATLAB using image processing algorithms. MATLAB is an excellent tool to accomplish these tasks.

Introduction:-

The field of Digital Image Processing (DIP) refers to processing digital images by means of a digital computer. An image may be defined as a two-dimensional function, $f(x, y)$, where x and y are spatial coordinates, and the amplitude at any pair of coordinates (x, y) is called the intensity or grey level of the image at that point. When x, y and the amplitude values of f are all finite, discrete quantities, we call the image a digital image.

Colour perception plays an important role in object recognition and scene understanding for humans and intelligent vision systems. Recent advances in digital colour imaging and computer hardware technology have led to an explosion in the use of colour images in a variety of applications including medical imaging, content-based image retrieval, biometrics, digital in-painting, remote sensing, digital multimedia, and visual quality inspection [1,2,3].

Colour image processing is divided into two major areas: full-colour and pseudo-colour processing. Digital colour image processing is done at the pseudo-colour level. The field of colour digital image processing refers to processing colour digital images by means of a digital computer. In image processing operations both the input and the output are images [1,2,3].

Mathematical Morphology:-

Mathematical Morphology (MM)is the analysis of signals in terms of shape. This simply means that morphology works by changing the shape of objects contained within the signal. For the processing and analysis of images, it is

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important to capable to extract features, describe shapes and recognize patterns. Such tasks refer to geometrical concepts such as size, shape, and orientation. It uses the concepts from set theory, geometry and topology to analyse geometrical structures in an image. Also the fact that an image may contain a lot of disturbances therefore, most of the images need to be clean up. Hence another important role of mathematical morphology is to remove this disturbances [4 -7].

Morphological Operators: -

Serra have shown that morphological operations can be formulated on any complete lattice. A set $\mathcal{L}$ with a partial ordering " $\leq$ " is called a complete lattice if every subset $\mathcal{H} \subseteq \mathcal{L}$ has supremum $\vee \mathcal{H} \in \mathcal{L}$ (least upper bound) and infimum (greatest lower bound) $\wedge \mathcal{H} \in \mathcal{L}$.

An operator $\emptyset: \mathcal{L} \rightarrow \mathcal{M}$, where $\mathcal{L}$ and $\mathcal{M}$ are two complete lattices, is called dilation if it distributes over arbitrary suprema: $\emptyset(\vee_{i\in I} X_i) = \vee_{i\in I} \emptyset(X_i)$, and erosion if it distributes over arbitrary infima. Erosions and dilations are increasing operations. An operator $\psi: \mathcal{L} \rightarrow \mathcal{L}$ is called a closing if it is increasing, idempotent $(\psi^2 = \psi)$ and extensive $(\psi(X) \geq X)$. An operator ψ is called an opening if it is increasing, idempotent and anti-extensive $(\psi(X) \leq X)$. A pair of operators $(\varepsilon, \delta)\delta: \mathcal{L} \rightarrow \mathcal{M}$ and $\varepsilon: \mathcal{M} \rightarrow \mathcal{L}$, is called an adjunction, if for every two elements $X \in \mathcal{L}, Y \in \mathcal{M}$ it follows that $\delta(X) \leq U$and $X \leq \varepsilon(Y)$.It is proved that if (ε, δ) is an adjunction then ε is erosion and δ is dilation. (ε, δ) is an adjunction, then the composition $\varepsilon\delta$ is a closing in L , and $\delta\varepsilon$ is an opening in the lattice$\mathcal{M}$. As an example, let us consider the lattice $\mathcal{L}$ with elements is the subsets of a linear space E. Then every translation-invariant dilation is represented by theMinkowski addition: $\delta_A(X) = A \oplus X = X \oplus A$, and its adjoint erosion is given by Minkowski subtraction: $\varepsilon_A(X) = X \ominus A$. Then closing and opening of A by B are defined as $A \cdot B = (A \oplus B) \ominus B$,$A \circ B = (A \ominus B) \oplus B$,: These operations are referred to as classical or binary morphological operations[8, 9]. Openings and closings are generally used as filters for denoising of binary images. Morphological transformation $\emptyset$ is given by the relation of the image (point set A) with another small point set B called a structuring element. B is expressed with respect to a local origin O called the characteristic point [7].The structuring element B is a$3X3$ flat square element.

Dilation: -

Dilation is one of the two basic operators in the area of mathematical morphology. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels (*i.e.* white pixels, typically). Thus areas of foreground pixels grow in size while holes within those regions become smaller. With A and B as sets in Z^2, the dilation of A by B, denoted$A \oplus B = \{z/(\hat{B})_z \cap A \neq \emptyset\}$.As colour image is assembled by three channel namely red, green and blue colour so we can apply the dilation operator on all the three channels separately and get the combine effect of all three channel to the original image.

Algorithm:-

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3Dilation of A by B
- Step:4 Get Dilated image in R, G and B
- Step:5 Get Dilated colour image

(a) **(b)** **(c)** **(d)** **(e)**

Figure – 1:- Dilation Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Erosion:-

For sets A and B in z^2 the erosion of A by B, denoted $A \ominus B$ is defined as $A \ominus B = \{z / (\hat{B})_z \subseteq A\}$. In contradistinction erosion is an operation that increases the size of background objects and shrinks the foreground objects in binary images. But here we apply erosion operator on colour image. As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm:-

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Erosion of A by B
- Step:4 Get Eroded image in R, G and B
- Step:5 Get Eroded colour image

(a) **(b)** **(c)** **(d)** **(e)**

Figure – 2:- Erosion Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Opening:-

The opening of set A by structuring element B, denoted by $A \circ B$, is defined as $A \circ B = (A \ominus B) \oplus B$.Opening is defined as erosion followed by dilation *using the same structuring element for both operations.* The erosion part of it removes some foreground (bright) pixels from the edges of regions of foreground pixels, while the dilation part adds foreground pixels. As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm:-

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Opening of A by B
- Step:4 Get Opening image in R, G and B
- Step:5 Get opening colour image

(a) **(b)** **(c)** **(d)** **(e)**

Figure – 3:- Opening Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Closing:-

The closing of set A by structuring element B, denoted $A \cdot B$, is defined as $A \cdot B = (A \oplus B) \ominus B$. Closing is defined as dilation followed by erosion *using the same structuring element for both operations. Closing smoothes the contours of foreground objects but, in contradistinction to opening, it merges narrow breaks or gaps and eliminates* *small holes.* As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm:-

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Closing of A by B
- Step:4 Get closing image in R, G and B
- Step:5 Get closing colour image

(a) **(b)** **(c)** **(d)** **(e)**

Figure – 4:- Closing Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Hit-or-Miss Transform:-

The hit-or-miss transform is a basic tool for shape detection or pattern recognition. So it is not useful in colour image processing, but this operator is used in many operators for colour image processing.

Algorithm:-

- Step:1 Image $A = X \cup Y \cup Z$
- Step:2 A small window W
- step:3 $[W - X]$
- Step:4 A^c
- Step:5 $(A \ominus X)$
- Step:6 $[A^c \ominus (W - X)]$
- Step:7 $(A \ominus X) \cap [A^c \ominus (W - X)]$
- Step:8 Detect a shape from Hit and Miss Transform $A \circledast B$

Thinning:-

The thinning of a set A by a structuring element B, denoted $A \otimes B$, can be defined in terms of the hit-or-miss transform:

$$A \otimes B = A - (A \circledast B)$$
$$= A \cap (A \circledast B)^c$$

Thinning is a morphological operation that successively erodes away foreground pixels from the boundary of binary images while preserving the end points of line segments. Thinning is a morphological operation that is used to remove selected foreground pixels from binary images. Here we apply thinning operator on colour image processing. As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm:-

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Thinning of A by B until it no longer changes the image
- Step:4 Get thinning image in R, G and B
- Step:5 Get thinning colour image

Figure – 5:- Thinning Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

(a) **(b)** **(c)** **(d)** **(e)**

Skeleton:-

The skeleton of A can be expressed in terms of erosions and openings. That is, it can be shown that

$$S(A) = \bigcup_{k=0}^{K} S_k\,(A)$$

With $S_k(A) = (A \ominus kB) - (A \ominus kB) \circ B$

Where B is a structuring element, and

$$(A \ominus kB) = (\ldots((A \ominus B) \ominus B) \ldots) \ominus B$$

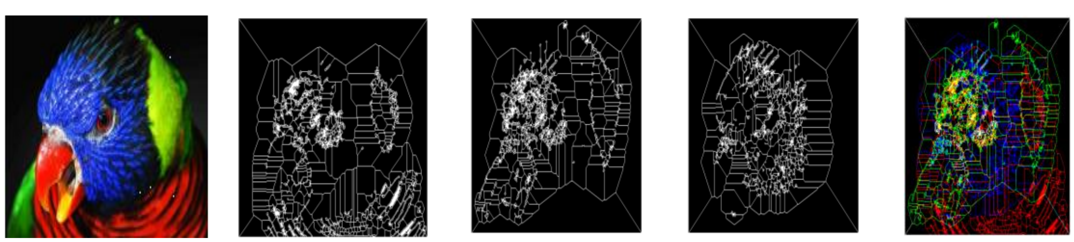
K times, and K is the last iterative step before A erodes to an empty set. In other words,

$$K = \max\left\{\frac{k}{A \ominus kB} \neq \emptyset\right\}$$

Skeletonization is a process for reducing foreground regions in a binary image to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels. As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm: -

- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Convert A in a binary image
- Step:4 Apply thinning operation using B until it no longer changes the image
- Step:5 Get thinning colour image and also thining image in R, G and B
- Step:6 Apply skeleton operation using B until it no longer changes the image
- Step:7 Get skeletonize image in R, G and B
- Step:8 Get skeletonize colour image



(a) **(b)** **(c)** **(d)** **(e)**

Figure – 6:- Dilation Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Thickening:-

Thickening is the morphological dual of thinning and is defined by the expression $A \odot B = A \cup (A \circledast B)$. Thickening is normally only applied to binary images, and it produces another binary image as output. In fact, the operator is normally applied repeatedly until it causes no further changes to the image (*i.e.* until *convergence*). Alternatively, in some applications, the operations may only be applied for a limited number of iterations. As colour image is assembled by three channel namely red, green and blue colour so we can apply the operator on all the three channels separately.

Algorithm:-
- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Convert A into a binary image
- Step:3 Thickening of A by B
- Step:4 Get thickening image in R, G and B
- Step:5 Get thickening colour image

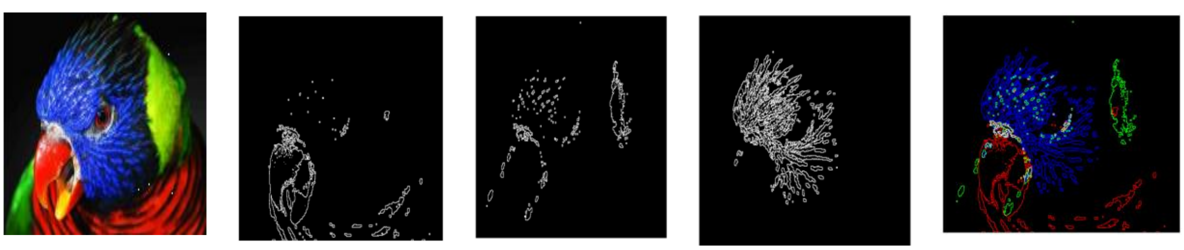
(a) **(b)** **(c)** **(d)** **(e)**

Figure – 7:- Thickening Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Boundary Extraction::-

The boundary of a set A, denoted by $\beta(A) = A - (A \ominus B)$, Where B is a suitable structuring element.*Image Boundary Extraction* can be considered a method of Image Edge Detection. In contrast to more commonly implemented gradient based edge detection methods, Image Boundary Extraction originates from *Morphological Image Filters*. Here we use this operator on colour image.

Algorithm:-
- Step:1 Image A in z^2
- Step:2 A structuring element B in R^2
- Step:3 Boundary extracted of A by B
- Step:4 Get boundary extracted image in R, G and B
- Step:5 Get colour boundary extracted image



(a) **(b)** **(c)** **(d)** **(e)**

Figure –8:- Boundary extraction Operator (a) Original Image (b) Red Colour (c) Green Colour (d) Blue Colour (e) Combine Effect of all colour

Conclusion:-

The morphological image processing is generally deal with the grey image or binary image but our attempt is to apply morphological operator on colour image. In this work, we are successfully applying the all non-linear morphological operators on colour image. In colour image processing, mathematical colour morphology is used to investigate the interaction between an image and chosen structuring element using the basic operations. It is mostly used in edge detection, image filtering, image segmentation, image compression. Some of the areas in which the morphologically extracted image features can be used and analysis of components of the images

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