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MATHEMATICAL MORPHOLOGY BASED DIGITAL IMAGE ENHANCEMENT PROCESSING WITH CROSS SEPARATE BOUNDARY OBJECTS

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Abstract

In computer science, digital image processing is the use of computer algorithms to perform image processing on digital images. The Image processing as a subgroup or background of digital signal processing has many advantages over analog image processing. The Digital image processing allows the use of a wide range of algorithms for input data and avoids problems such as noise accumulation and signal distortion during the processing process. Because images are defined in two dimensions (perhaps more than two dimensions), image processing can be formatted into multi-dimensional systems. In this paper an effective Mathematical morphology model was proposed to enhance the quality of images. In this mode, the image is pre-processed and then the gradient is changed using a mathematical image system. Then, the edges are detected by the margin detection method based on the statistical data. This method removes the shadow contours caused by the lights, directly separates the boundaries of the objects and has an impact on the background noise suppression.

Keywords:

Digital Image Processing, Computer Algorithms, Digital Images, Mathematical Morphology

1. INTRODUCTION

Nowadays, “image processing” is widely used in a wide range of applications and in various types of electronics such as computers, digital cameras, and mobile phones. Image attributes can be changed with minimal investment, such as contrasting properties, border detection. Measuring intensity and using different mathematical functions to enhance images [10]. Although these methods are very influential, consumers often control images by dump, but it is rare to understand the basic values behind the practice of image processing without difficulty. While this is ideal for some people, it often leads to a distorted image. In this paper, an efficient improvement of image attributes is proposed.

The Mathematical morphology is a non-linear image processing method using two-dimensional transformation functions including binary morphology, grayscale morphology and color morphology. Erosion, expansion, opening and closing processes of exploitation are at the center of mathematical morphology. Mathematical morphology can be used for margin detection, image segmentation, noise, deletion, feature extraction and other image processing [11]. It is widely used in the field of image processing. Based on the current progress, this thesis provides a detailed description of the mathematical morphological classification and its use in diagnosis. Consequently, the discovery of the problem and further study of mathematical morphology are relevant.

The basic idea of mathematical morphology and its methods can be applied to any aspect of the field of image processing. With the development of computers, image processing, format recognition, and machine vision, mathematical morphology is rapidly evolving and expanding in scope [12]. There are many implementations of mathematical morphology in existing software systems. Mathematical morphology is used in many areas such as margin detection, image segmentation, distortion, and feature extraction. The term morphology refers to the description of the properties of the shape and structure of any object [13]. In the context of machine vision, this term refers to the description of the shape properties of the parts in an image. It soon became clear that the functions of mathematical morphology were initially defined as the functions of sets, but they were also useful in the problems of executing a set of points at two-dimensional intervals. Collections in a mathematical figurative system refer to objects in an image. You can easily see that the set of all background pixels in the binary image is one of the options for its complete description.

First, mathematical morphology is used to extract certain properties that are useful for representing and describing an image. For example, definitions, skeletons, convex hulls. The imaging methods used in the stages of preliminary and final image processing are also of interest. For example, morphological filtration, thickening or thinning.

2. LITERATURE REVIEW

The Mathematical morphology is a new theory and method used in the field of digital imaging and authentication. Its mathematical basis and language are the set of theory. With the commercial applications of the grain analyzer and the publication of a random and intuitive set, the development of mathematical morphology focused on the gray matter aspects [1].

In mathematical morphology, an independent mathematical theory was discovered and its ideas and methods have a great influence on the theory of images and technologies, and are also used in the process of image analysis in many fields. In addition, the use of mathematical morphology led to significant advances in agriculture [2].

Mathematical morphology is used in binary imagery, although initially the morphology only applied to grayscale images. But rapid progress in theory and already mathematical morphology can be applied in other studies. Recently, mathematical geometry research has been betting on color pictures and there are currently some achievements [3].

The morphological changes of the binary image in mathematical morphology are a set of formulas describing these changes. The contacts between the object, its shape and the structure describing the structure may contain information about the object of the morphology operator, the shape of the structural element, the waveform, and the function performed. Morphological image processing is the set of functions for moving a structural element in an image and then changing or merging the structure of the element and the binary image. The main morphological functions are erosion and expansion (expansion) [4].

Due to the possibility of parallel processing and hardware processing, a binary image can be processed in a number of ways, such as margin extraction, image segmentation, thinning, feature extraction, and format analysis. However, under other conditions, the choice of structural element and the associated algorithm is different. The choice of the size and shape of the structural elements will affect the outcome of the morphological process of the image [5].

Morphology of Huang et al. Round, triangular, square and other basic geometric shapes have been accepted in some cases as part of the binary structure, which is extracted by the image fractional system of the hexagon. The section showed that the algorithm could get a better result and set the initial location for the diagnosis in the image [6]-[9].

3. PROPOSED MODEL

Digital image processing makes it possible to use the most sophisticated algorithms, and therefore can provide both the most complex performance in simple tasks and the implementation of methods that are not possible with analog tools. In particular, the proposed digital image processing is the only practical technology for the following:

- Classification
- Feature Extraction
- Multi-level signal analysis
- Sample type identification
- Prediction

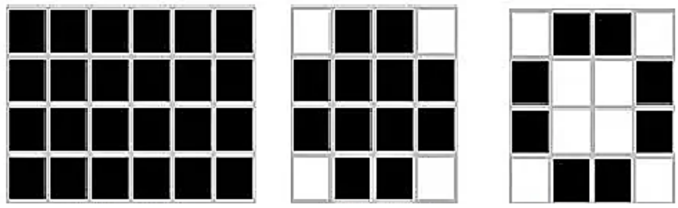
3.1 FILTRATION

Digital filters are used to blur and sharpen digital images. Filtering in the location sphere can be done by rotating in the frequency field (Fourier) by covering specially designed cores (filter array) or certain frequency bands. The following examples show both methods:

3.2 IMAGE STACKING IN THE FILTER

Images are usually stacked before being transferred to the Fourier location. The following overlay filter images show the results of different layering techniques: The high-pass filter shows additional edges when zoomed in, compared with repeated edge layering.

Mathematical morphology (MM) is a theory and technique used primarily in digital image processing, but can also be applied to graphs, polygonal meshes, stereometry and many spatial structures. In the binary image system, a binary image is represented by a set of black and white dots (pixels) or 0 and 1 (sorted set). Image area is generally understood as some subset of image points.



(a) (b) (c)

Fig.2. (a) BOX - given size rectangle, (b) DISK [R] - given size disk, (c) RING [R] - given size ring

Each binary morphology function is a modification of this set. A binary image *B* and some structural element *S* are taken as initial data. The end of the process is a binary image. Some binary image (geometric shape) is a structural element. It can be arbitrary size and arbitrary configuration. Often, symmetric elements such as a fixed size (BOX(l,*w*)) or a rectangle with a certain diameter (DISK(*d*)) are used. In each element, a special point is assigned, which is called the initial (origin). It can be located anywhere in the element, although in symmetry it is usually the central pixel.

Initially, the resulting surface is filled with 0, forming a completely white film. Then the inspection or scanning of the original image is carried out pixel by pixel by frame structure. To examine each pixel, a structural element is "crusted" over the image, thus merging the study and starting points. A specific condition is checked for the correspondence between the pixels of the structural element and the pixels of the image "below". If the condition is met, 1 will be set to the corresponding location in the resulting image (in some cases, not a single pixel will be added, but all from the configuration elements). The basic functions are performed according to the scheme discussed above. These functions are expansion and contraction. The derived functions are a combination of some of the basic functions performed continuously. Opening and closing is the key.

3.3 RELOCATION

Change the example to $a = (2,1)$. The transfer function for a set of pixels *S* to the vector t is given as,

$$S(a) = (s+a|s\in S) \qquad (1)$$

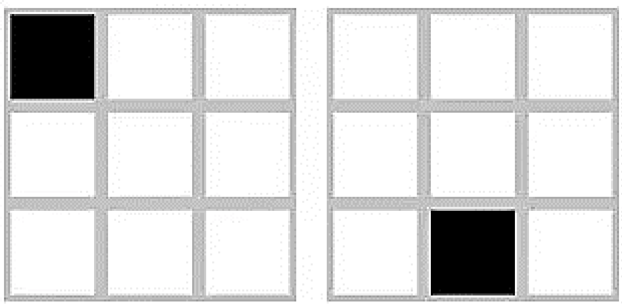


Fig.3. Relocation

Therefore, the transfer of a set of single pixels in a binary image change all the pixels of the set by a given distance. The translation vector t can be given as an arranged pair $(\Delta r, \Delta c)$ where Δr is the component of the translation vector in the direction of the row and Δc is the component of the translation vector in the column direction of the image. An increase in a binary image *A* is denoted by a structuring element *B*:

In this expression, the union operator can be thought of as the operator applied to the surroundings of the pixels. Element *B* is used to structure all the pixels in the binary image. Each time the appearance of the structural element is aligned with a single binary pixel, a translation is applied to the entire structural element and the subsequent logical addition (logical OR) with the corresponding pixels of the binary image. The results of the logical addition are written to the output binary image, which is initially initialized to zero values.

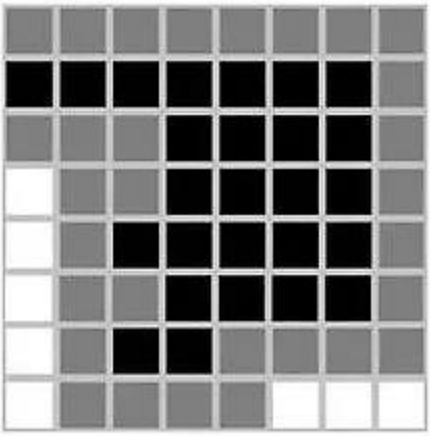


Fig.4. Image extension with square structure element

The erosion of a binary image A by a structuring element B is denoted and expressed by: During the erosion process, the structural element passes through all the pixels of the image. In some cases, if each unit pixel of the frame element is combined with one unit pixel of the binary image, the center pixel of the frame element will logically be added to the corresponding pixel of the output image. As a result of the use of the corrosion process, all materials smaller than the structural elements are destroyed, the material connected by thin lines is cut off, and the size of all materials is reduced. The snap function “closes” small internal “holes” in the image and removes indentations at the edges of the area. If we first apply the growth process to the image, small holes and cracks can be removed, but at the same time, the margin of the material will increase. This increase can be avoided by the erosion process that takes place as soon as the structure is structured with the same structural element. The erosion process is useful for removing small objects and various noises, but there is one drawback to this process - all the remaining material is reduced in size. This effect can be avoided by using the built-up function with the same structural element after the erosion process. The opening filters out all the material that is smaller than the structural elements, but this helps to avoid a strong reduction in the size of the material. Also, the opening is better for removing lines that are thinner than the diameter of a structural element. It is also important to remember that after this process, the contours of the material will become smoother.

This type of morphology is a natural development of binary grayscale images that have no set of expressions, but the function of images. For such an image system, the cross-section and union used in the binary image system are replaced by the maximum and minimum functions. The input data for the mathematical morphology tool are two images: processed and specialized, depending on the type of function and the problem being solved. Such a special image is commonly referred to as the primitive or structural element. As a rule, the structural element is much smaller than the processed image. A structural element can be thought of as a description of an area with certain shapes. It is clear that the form can be anything; the main thing is that it can be referred to as a binary image of a given size. In many images processing packages, the most common configuration components have special names:

- BOX - rectangle of a given size,
- DISK [R] - disk of a given size,
- RING [R] - ring of a given size.

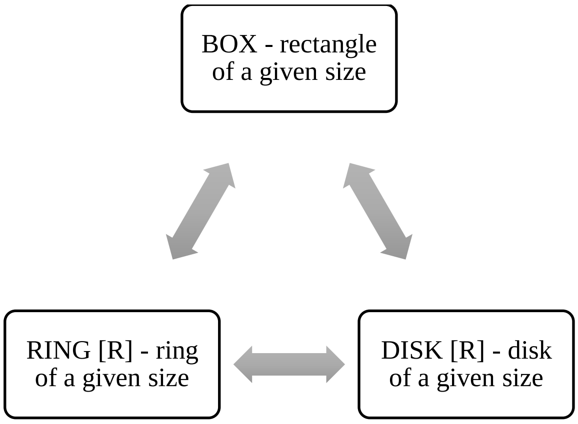


Fig.5. Most common configuration components

The result of the morphological processing depends on both the size of the original image and the configuration and structure of the arch. The size of a structural element is usually 3×3, 4×4 or 5×5 pixels. This is due to the main idea of the morphological processing, during which the characteristic details of the image are found. The desired detail is described by an antique, and as a result of the morphological processing such details can be emphasized or removed from the whole picture. One of the main advantages of morphological processing is its simplicity: at the input and output of the processing process, we obtain a binary image. Other methods, as a rule, first obtain a grayscale image from the original image and then convert it to binary using a gateway function.

4. RESULTS AND DISCUSSION

The proposed Mathematical morphology model (MMM) was compared with the existing geometry and training algorithms (GTA), morphological and fuzzy algebraic systems (MFAS), segmentation based visual processing algorithm (SVPA) and fast Fourier algorithm (FFA)

4.1 MORPHOLOGY OF COLOR IMAGES

There is not much research on morphology in the field of color processing. Some scholars have introduced some morphological techniques used for color imaging. Most of them consider each image vector individually and ignore the relationship between the vectors. An efficient and reasonable research approach is to process the colors of the pixel using vector methods that describe the relationship between each vector. The study of color space morphological transformations can point to its relationship with the morphology of grayscale images shown in Table.1.

Table.1. Comparison of Morphology of Color Images

Images	GTA	MFAS	SVPA	FFA	MMM
100	60.22	72.09	74.75	83.76	87.59
200	61.71	74.06	77.17	85.96	89.58
300	63.20	76.03	79.59	88.16	91.57
400	64.69	78.00	82.01	90.36	93.56
500	66.18	79.97	84.43	92.56	95.55
600	67.67	81.94	86.85	94.76	97.54
700	69.16	83.91	89.27	96.96	99.53

4.2 BOUNDARY SELECTION

Mathematical morphology depicts and analyzes the image based on the angles of the set, making geometric changes to the target objects using the "test" set (structural element) to reject the required information. With the continuous development and development of the theory of mathematical mathematics, mathematical morphology has been studied and widely used in image margin detection shown in Table.2.

Table.2. Comparison of Boundary Selection

Images	GTA	MFAS	SVPA	FFA	MMM
100	62.51	75.19	77.58	86.76	90.78
200	64.84	76.40	79.18	87.43	91.26
300	67.17	77.61	80.78	88.10	91.74
400	69.50	78.82	82.38	88.77	92.22
500	71.83	80.03	83.98	89.44	92.70
600	74.16	81.24	85.58	90.11	93.18
700	76.49	82.45	87.18	90.78	93.66

4.3 MARGIN DETECTION

Compared to traditional image margin detection algorithms, morphology has a unique advantage over margin detection and achieves better results. The morphological image margin detection system can preserve the detailed properties of the image and solve the problem of integrating margin detection accuracy and noise resistance performance shown in Table.3.

Table.3. Comparison of Margin Detection

Images	GTA	MFAS	SVPA	FFA	MMM
100	65.85	76.77	81.50	88.86	92.69
200	66.49	78.30	82.75	89.95	93.85
300	67.15	78.80	85.48	90.43	94.62
400	67.80	79.99	87.22	91.32	95.65
500	68.45	81.00	89.21	92.10	96.62
600	69.10	82.02	91.20	92.89	97.58
700	69.75	83.03	93.19	93.67	98.55

4.4 FEATURE EXTRACTION

In general, feature extraction is a modification that converts high-dimensional space events into maps or lower-dimensional spaces in order to reduce the size of the dimension. In the application of agricultural disease recognition, plant features such as color, texture, and shape are widely used. Using mathematical morphology, IC can isolate not only disease structure characteristics such as energy, entropy, and moment of recession, but also pathological features such as circumference, area, circularity, length-width ratio shown in Table.4.

Table.4. Comparison of Feature Extraction

Images	GTA	MFAS	SVPA	FFA	MMM
100	69.72	70.95	80.45	89.60	94.43
200	68.23	68.98	78.03	87.40	92.44
300	66.74	67.01	75.61	85.20	90.45
400	65.25	65.04	73.19	83.00	88.46
500	63.76	63.07	70.77	80.80	86.47
600	62.27	61.10	68.35	78.60	84.48
700	60.78	59.13	65.93	76.40	82.49

5. CONCLUSION

The main functions of mathematical morphology are growth, erosion, closing and opening. These names reflect the essence of the process: the increase increases the surface area of the film, and the erosion makes it smaller, the closing function allows you to close the inner holes of the area and remove the bays at the border of the area, helping to eliminate the opening function. The small pieces extend beyond the area closest to its boundary. The mathematical definitions of morphological functions are very useful to accurately identify the boundaries of the specific images. The proposed MMM was compared with the existing GTA, MFAS, SVPA and FFA. In a saturation point the proposed models achieved 93.56% of morphology of color images, 92.22% of boundary selection, 95.65 % of margin detection and 88.46% feature extraction. So, the proposed model getting higher efficiency while compared with the other existing methods.

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