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A Survey Report on Hit-or-Miss Transformation

Wala Riddhi Ashokbhai[1]

Department of Computer Engineering, Darshan Institute of Engineering and Technology, Rajkot, Gujarat, India
riddhi.wala205@gmail.com

Abstract- *Hit or miss is a field of morphological digital image processing which is basically used to detect shape of regular as well as irregular objects. Initially, it was defined for binary images, as a morphological approach to the problem of template matching, but can be extended for gray scale images. For gray-scale it has been debatable, leading to multiple definitions that have been only recently unified by means of a similar theoretical foundation. Various structuring elements are used which are disjoint by nature in order to determine the output. Many authors have proposed newer versions of the original binary HMT so that it can be applied to gray-scale data. Hit or miss transformation operation takes a binary image as input and a kernel (also known as structuring element), and the result is another binary image as output. Main motive of this survey is to use Hit-or-miss transformation in order to detect various features in a given image.*

Keywords*-Hit-and-Miss transform, Hit-or-miss transformation, Morphological image technology, digital image processing, HMT*

I. INTRODUCTION

The hit-or-miss transform (HMT) is a powerful morphological technique that was among the initial morphological transforms developed by Serra (1982) and Matheron (1975). It constitutes the morphological approach to pattern matching. Its initial definition for binary images has been widely used since then, with the purpose of shape recognition[1][2]. Shape recognition using mathematical morphology is one of the fundamental image analysis methods. HMT is an important tool to locate known objects. In this situation the problem of shape recognition is equated to that of detecting occurrences of an object shape within an image. In the case of binary images, the domain of shape recognition is easy since the image function f(x, y) describing the image defined on a 2 dimensional domain takes on only binary values (1 or 0) that are specifically defined on Z^2[7][8].

II. HIT OR MISS TRANSFORMATION

The shape recognition (or, shape matching) process can be generally described by an operation called the hit-or-miss transformation. The hit-or-miss operation is defined upon image I as $[I \ominus A] \cap [I_c \ominus B]$, where $(A, B) \subseteq G$ and G is a general structuring element. I_c is the complement of the given image. Here $\ominus$ is the notation for erosion, where $X \ominus Y = \{z: Y + z \subseteq X\} = \cap_{y \in Y} X_{-y}$. The symbol X_p is the transformation of X by p, that is, $X_p = \{z = a + p: a \in X\}$. The image I is eroded by a structuring element (SE) A, and the complement of the image, I_c, is eroded by an SE B. The results of the two erosion operations are then ANDed producing an output set. Given that A represents a shape to be recognized within I, and B is a windowed complement of A, then the resulting point set of a hit-or-miss transformation consists of points where each point indicates one occurrence of A within I. Specifically, it attempts to match A (foreground SE) within the image (i. e. “a hit”) while also matching B (background SE) in its background $Xc = \varepsilon \setminus X$ (i. e. “a miss”) [6].

In this paper, various uses of Hit-or-Miss Transformation are demonstrated. The structuring element used in the hit-and-miss is a slight modification to the type that has been introduced for erosion and dilation, in that it can have both foreground and background pixels. The simpler type of structuring element used with erosion and dilation is often depicted containing both 1’s and 0’s as well, but in that case the 0’s really stand for ‘don't care's’, and are just used to fill out the structuring element to a convenient shaped kernel, usually a square. Here, these ‘don't care's’ are shown as blanks in the kernel in order to avoid confusion. Foreground pixels are denoted using 1’s, and background pixels are 0’s. In general, for hit or miss, ‘don’t care’ pixels in structuring elements are given as -1.

III. VARIOUS FORMS OF HIT OR MISS TRANSFORMATION

The hit-and-miss operation is performed in much the same way as other morphological operators, by rendering the origin of the structuring element to all points in the image, and then comparing the kernel with the underlying pixels of the image[3]. If the foreground and background pixels in the structuring element exactly match foreground and background pixels in the image, then the pixel below the origin of the structuring element is set to the foreground color. If it is a mismatch, then that pixel is set to the background color.

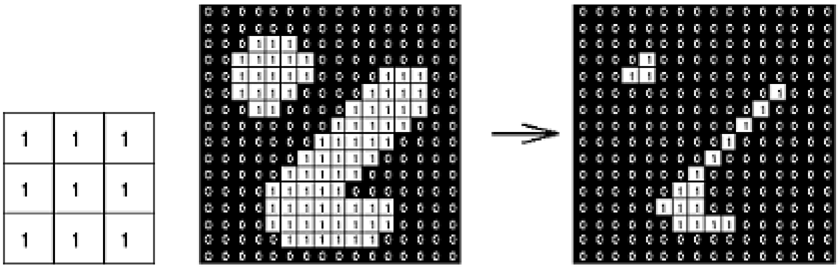
The hit-and-miss transform is used to look for possibilities of particular binary patterns in fixed directions. It can be used to look for several patterns simply by running successive transforms using different structuring elements, and adding (also called ORing) the results together[4].

The operations of opening, closing, erosion, dilation, thickening and thinning can all bederived from the hit-and-miss transform in conjunction with simple set operations. Generally white pixels in binary image are considered as foreground pixels and black pixels are considered as background pixels [5].

Following shows the ways in which hit or miss transformation can be used as the above given operations:

A. Erosion:

The basic effect of erosion on a binary image is to erode away the boundaries of regions of foreground pixels (i.e. white pixels, typically). Thus areas of foreground pixels get smaller in size, and holes within those areas become larger.



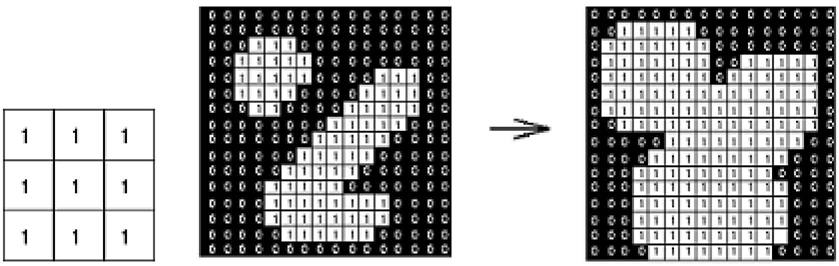
(a)(b) (c)

Figure 1.(a) Structuring element for Erosion (b) Image before Erosion (c) Image after applying Erosion

To obtain the erosion of a binary input image by this structuring element, each of the foreground pixels in the input image is considered in turn. For each foreground pixel (which we will call the input pixel) we superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel coordinates. If for every pixel in the structuring element, the corresponding pixel in the image underneath is a foreground pixel, then the input pixel is kept as it is. If any of the corresponding pixels in the image are background, the input pixel is also given the background value.

B. Dilation:

The basic effect of dilation 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.



(a) (b) (c)

Figure 2.(a) Structuring element for Dilation (b) Image before Dilation (c) Image after applying Dilation

To compute the dilation of a binary input image by this structuring element, we consider each of the background pixels in the input image in turn. For each background pixel (which we will call the input pixel) we superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position. If minimum one pixel in the structuring element coincides with a foreground pixel in the image below, then the input pixel is set to the foreground value. If all the remaining pixels in the image are background, however, the input pixel is left at the background value.

There are other standard operations which are derived from Hit-or-Miss Transformation.

C. Thinning:

Thinning is a morphological operation that is used to remove selected foreground pixels from binary images, similar to erosion or opening. It can be used for several applications, but is particularly useful for skeletonization. In this method it is commonly used to remove the output of edge detectors by decreasing all lines to single pixel thickness. Thinning is normally only applied to binary images, and results into another binary image as output.

D. Thickening:

Thickening is a morphological operation that is used to grow selected regions of foreground pixels in binary images. It has several applications, including determining the skeleton by zone of influence and determining the approximate convex hull of a shape. Thickening is normally only applied to binary images, and it results in another binary image as output.

E. Opening:

The basic effect of an opening is somewhat like erosion in that it tends to remove some of the foreground (bright) pixels from the edges of regions of foreground pixels. But the positive is side is that it is less destructive than erosion in general.

F. Closing:

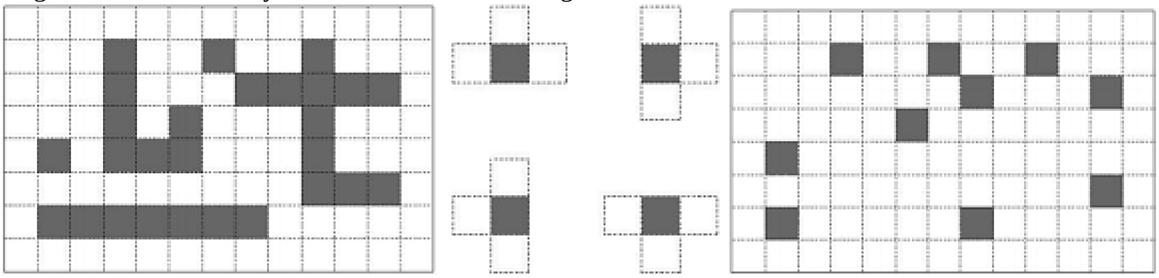
Closing is similar in some ways to dilation in that it tends to enlarge the boundaries of foreground (bright) regions in an image (and shrink background color holes in such regions), but it is less destructive of the original boundary shape.

These are some of the standard basic operations. Other non-standard operations can also be using different structuring elements. Sometimes structuring elements need to be used from 4 or 8 dimensions to get output from all the directions. Below given are few examples of using different structuring elements.

IV. OTHER NON-STANDARD HIT-OR-MISS TRANSFORMATION

A. Locating 4-connected endpoints

The given image depicts hit or miss transformation applied to find the pixels which are 4-connected. The structuring element is rotated by 90° four times in order to get the results from all the four directions.



(a) *(b)* *(c)*

Figure 3. (a) The image before transformation (b) The four connected structuring elements (c) The four connected components left after hit or miss

B. Detecting the Corners of an Object

Given below are the four structuring elements in all the four directions to detect the corners. The result is obtained by ORing all the images which are produced by passing the single image through all the structuring elements.

(a)

	1	
0	1	1
0	0	

(b)

	1	
1	1	0
	0	0

(c)

	0	0
1	1	0
	1	

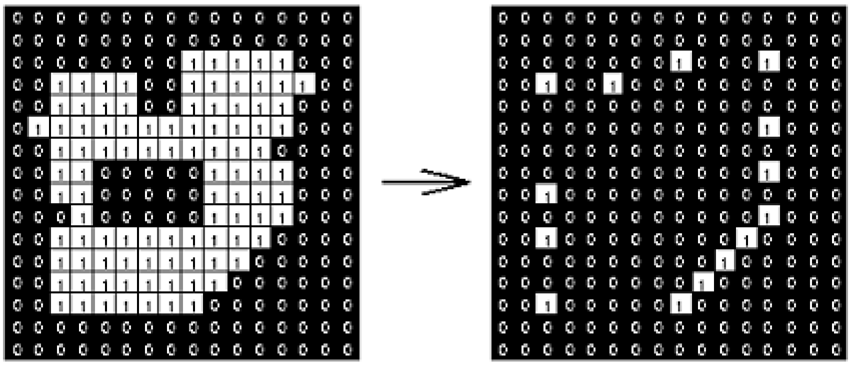
(d)

0	0	
0	1	1
	1	

Figure 4. (a) through (e) shows the structuring elements to detect corners in all the four directions

The blank spaces are don't care conditions. It doesn't matter that whether it is a black pixel or a white pixel. If the pixel of the structuring element fits point to point in the image then it's a hit or else it's a miss.

The result obtained is shown below:

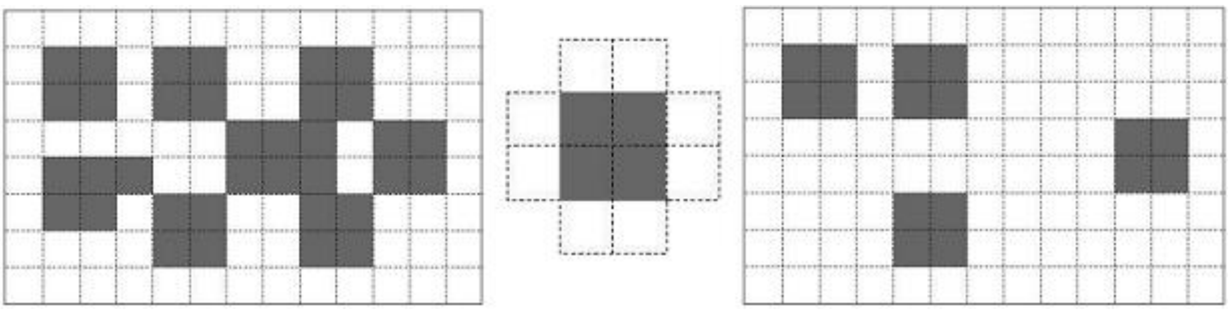


(a) *(b)*

Figure 5. (a) shows the image before transformation (b) shows the edges left after ORing the results obtained after transformation from all the four SEs

C. Hit-or-Miss Opening

Another example of hit or miss transformation is shown in opening. It isolates the pixels on the basis of the structuring element and leaves only the pixels which are underlying the structuring element.



(a) (b) (c)

Figure 6. (a) Image before applying opening operation (b) Structuring element (c) The image after opening

V. CONCLUSION

Shape recognitionusing morphological operations open the new horizons in the area of object detection. Generally morphological hit or miss transformation is used to extract information from the irregular objects. Its applications are extraction of vehicle number from the number plate whose image is obtained from CCTV cameras, recognition of handwriting, extract letters from videos, differentiating various shapes and so on. These morphological operations come into picture when the input from which the result is to be extracted is not very clear. Hence it has to be passed through various filtering operations. It is used in investigating department, medical field, etc. The only requirement is to choose the structuring elements wisely in order to get the relevant result. Various other operations are performed in conjunction of hit-or-miss transformation in order to get the desired result.

REFERENCES

[1] Murray, Paul and Marshall, Stephen (2012) A review of recent advances in the hit-or-miss transform. Advances in Imaging and Electron Physics, 175. pp. 221-282.
[2] J. Serra, Image Analysis and Mathematical Morphology, Academic Press, New York, 1982..
[3] T. R. Crimmins and W. R. Brown, Image algebra and automatic shape recognition, IEEE Trans. Aerospace Electron. Systems, AES-21, Jan. 1985, 60-69.
[4] C. R. Giardina and E. R. Dougherty, Morphological Methods in Image and Signal Processing, Prentice-Hall, Englewood Cliffs, NJ, 1987.
[5] P. Maragos, A Unified Theory of Translation-Invariant Systems with Applications to Morphological Analysis and Coding of Images, Ph.D. thesis, Georgia Tech., Atlanta, GA, 1985.
[6] R. M. Haralick, S. R. Sternberg, and X. Zhuang, Image analysis using mathematical morphology, IEEE Trans. Pattern Anal. Mach. Intell. PAMI-9, July 1987, 532-550.
[7] P. Maragos, Pattern spectrum and multiscale shape recognition, IEEE Trans. Pattern Anal. Much. Intell. PAMI-11, July 1989, 701- 716.
[8] D. Sinha and C. R. Giardina, Discrete black and white object recognition via morphological functions, IEEE Trans. Pattern Anal. Mach. Intell. PAMI-U, Mar. 1990, 275-293.

