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An Automated Method for Segmentation of the Hand In Sign Language

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Abstract: *This paper presents an automated method for hand segmentation in images that make use of signs language. For this, used an images bank that was captured by a webcam to which were applied spatial domain methods for hand segmentation.*

Keywords: *Digital images processing, spatial domain methods, images segmentation*.

I. Introducción

Around of 70 million deaf people in the world use the signs language as their maternal language or main language [1]. The difficulties faced the people deaf-mute in the daily life are quite due to the difficult understanding or total ignorance of signs language meaning that use. The signs language is a communication mean for the people with deficiency hearing, where the words and sentences are represented for hand gestures, and have grammatical structures perfectly defined. Due to the difficult communication that be between a deaf people that use the signs language for take charge of the translation process with the finality of study to deeply the deaf culture with psychotherapeutic purpose[2]. A system capable of carry out the automatic recognition of sign language without the need of an individual translator can eventually provide an excellent tool for deaf people to communicate with people that disown the language, and this way we can achieve a better way to live [3]. This paper proposes a methodology for carry out the automatic segmentation of hand in images that show the Mexican sign language (figure 1). For this, images were captured by a people webcam doing some Mexican sign language, later with digital treatment techniques of images basing in the spatial domain was obtained the sign segmentation doing by the individual.

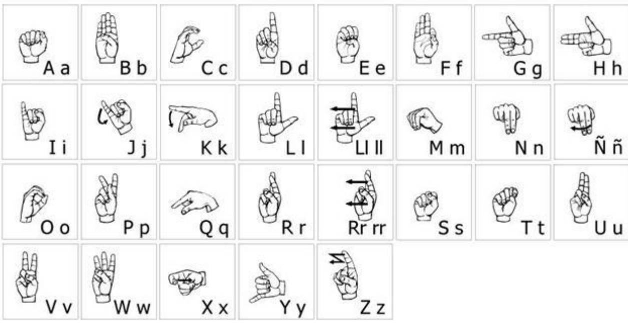

Figure 1: Mexican sign language

II. Basic concepts

In the section three will be shown the proposed method, however for that, make use of the mathematical morphology, and for that reason, in the following lines we show the concerning concepts for the mathematical morphology.

The mathematical morphology is a framework based exclusively in the set theory. The original theory developed by Georges Matheron and Jean Serra, has been used with huge success in the digital processing of binary images. There are two fundamental operations in the mathematical morphology: dilatation and the erosion. The dilatation is a term referred to increase, expand, rise, among other actions, of any object. On the other hand, the erosion is referred to the contraction, reduction, decrease, among other actions, of any object. In the following lines are the accuracy definitions of the fundamental operations of the mathematical morphology.

2.1 Dilation

Started the short dilation operation study. For this, consider in all that follow, discrete sets 2-dimensional, that is, subsets of $\mathbb{Z}^2$.

Definition 2.1.1:Be$A \subseteq \mathbb{Z}^2$. The set A is denoted byA^-, is defined by:

$$A^- = \{-x | x \in A\} (1)$$

Definition 2.1.2:Be$A \subseteq \mathbb{Z}^2$and$x \in \mathbb{Z}^2$. The translation of A by x denoted by $(A)_x$is defined as:

$$(A)_x = \{a + x | a \in A\} (2)$$

The following definition shows the formal concept of what is dilation operation.

Definition 2.1.3: Be$A, B \subseteq \mathbb{Z}^2$, the dilation of A by B, denoted by$A \oplus B$, is the sum of Minkowskiof A and B; this is:

$$A \oplus B = \{a + b | a \in A \text{ and } b \in B\} (3)$$

The set B of the previous definition will be called structuring element.

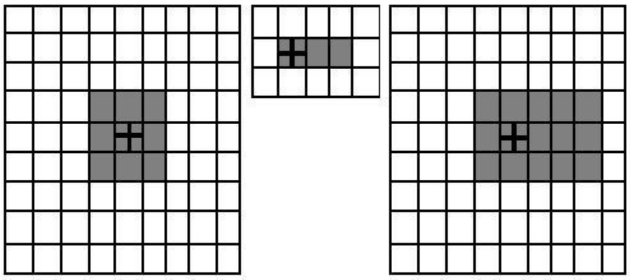

Figure 2: Representing the set A, the structuring element $B = \{(0,0), (1,0), (2,0)\}$ and the dilation$A \oplus B$

Theorem 2.1.1:Be $A, B \subseteq \mathbb{Z}^2$. It holds that:

$$A \oplus B = \{x | (B^-)_x \cap A \neq \emptyset\} (4)$$

Demonstration:

$x \in A \oplus B$Ifx$= a + b$ for some$a \in A$ and $b \in B$ if $x - b = a$ for some $a \in A$ and $b \in B$ if $x - b = a$ for some $a \in A$ and $-b \in B^-$ if $a - x = -b$ for some $a \in A$ and $-b \in B^-$ if $a \in (B^-)_x$ and $a \in A$ if $a \in (B^-)_x \cap A$ for some a if $(B_x^- \cap A) \neq \emptyset$.■

The previous theorem allows us to define an alternative form, which is the dilation of a set A by the structuring element B.

2.2 Erosion

Then be show the formal concept of what is erosion.

Definition 2.2.1: Be $A, B \subseteq \mathbb{Z}^2$. The erosion of A by B, denoted by $A \ominus B$, the subtraction of Minkowski of Aby B; this is:

$$A \ominus B = \{x \in \mathbb{Z}^2 | x + b \in A \text{ for each } b \in B\} (5)$$

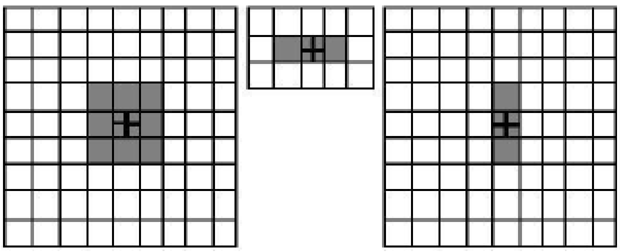

Figure 3: Representación the set A, the structuring element $B = \{(-1, 0), (0,0), (1,0)\}$ and the erosion $A \ominus B$

Theorem 2.2.1: be $A, B \subseteq \mathbb{Z}^2$, it holds that:

$$A \ominus B = \{x | (B)_x \subseteq A\} \quad (6)$$

Demonstration:

$x \in A \ominus B$ If $x + b \in A$ for each $b \in B$ by the definition 2.2.1 if $(B)_x \subseteq A$ by the definition 2.1.2 ■

The previous theorem allows us to define an alternative form, which is the erosion of a setA by the structuring element B.

III. Proposed method

Before to arrive on detail with proposed method, it's necessary give the definition about a digital image. A digital image is a Two-dimensional function $f(x, y)$, of the light intensity (Sheen/brightness) on a space point, so (x, y), the coordinates for that point [9]. Inasmuch as a digital image is a function $f(x, y)$ discretised on the space coordinates so in the sheen, sometimes could be representative like a two-dimensional matrix $F_{ij} = (f_{ij})_{mxn}$, where m and n are the size of the image and $f_{ij} = f(x_i, x_j)$.

The proposed method is dived in two parts: 1) image acquisition and 2) signal segmentation of the individual done.

1) *Image acquisition*: With webcam help, to get images of persons doing a signal of LSM set. Like in figure 4.

Figure 4: Imageacquisition.

2) *Signal segmentation*: For this part it could be considerate the next stages:

Step 1. The image need to be separate in three components red, green and blue (RGB) and it was considerate the red component because of the human skin is more sharp for this component (figure 5).
Step 2. It was considerate to grayscale from red component, this is, the value of the red component is copied to the green and blue component, thereby obtaining the image in grayscale.

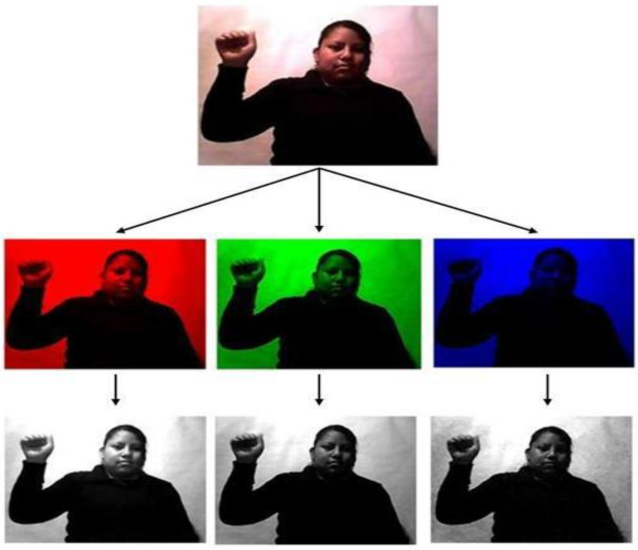

Figure 5: Decomposing an image into its three RGB components, and grayscale.

Step 3. The histogram was obtained of the image with gray levels in the range [0, 255], where the histogram is a discrete function H[k]represents the number of colors of each gray level (k = 0, …, 255) [9].

Step 4. Given an image $f(x, y)$and two variables u and v, the binarization by thresholding is used defined as follows:

$$bin_{ij} = \begin{cases} 0 & \text{if } u \leq f_{ij} \leq v \\ 255 & \text{if } f_{ij} < u \text{ or } f_{ij} > v \end{cases}$$

Shown in Figure 6, that the histogram shows two maximum peaks at 0 and 255, to eliminate these peaks, were considered as thresholds u = 20 and v = 185.

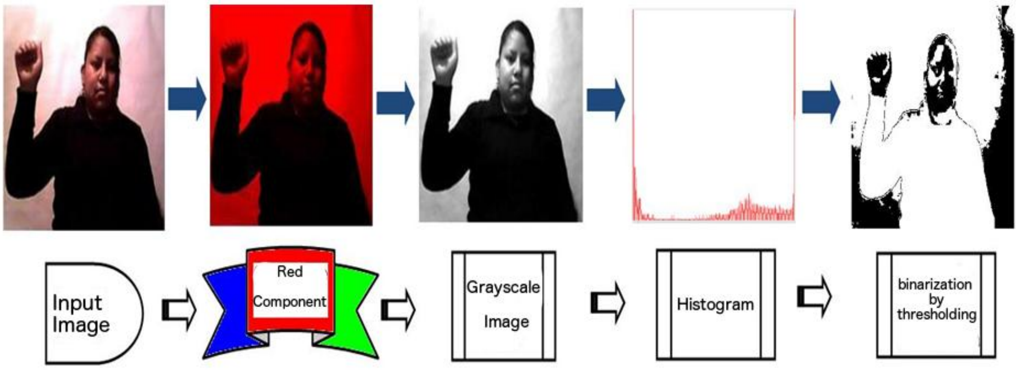

Figure 6: Show the first 4 steps applied to a color image.

Once obtained, the binarized image, we proceeded to locate the corresponding part of the hand, for it is considered that:

Step 5. Consider a mask size x within a mask size y as shown in Figure 7. Variablesu and v be two to locate the area corresponding to the hand image, the following function is implemented for each point (i, j) on the image, it is M_y^{ij} mask size and centered at (i, j), the function $T_{ij}$is defined at each point (i, j)as:

$$T_{ij}: M_y^{ij} \rightarrow [0, 255]$$

Where

$$T_{ij}(r, s) = \begin{cases} f_{rs} & if\ A_x \geq u\ and\ A_y - A_x \leq v \\ 255 & if\ A_x < u\ or\ A_y - A_x > v \end{cases}$$

WithA_x and A_y the areas enclosed by the masks of size x and y respectively.

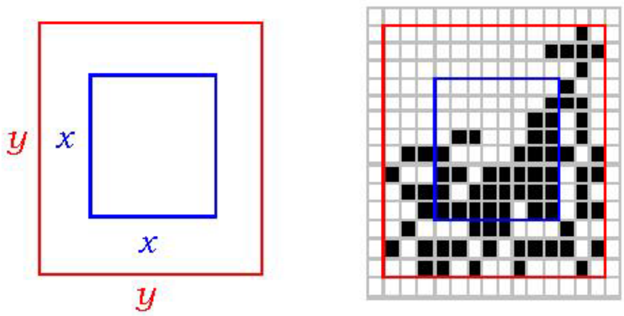

Figure 7: Masks of size x and y.

Step 6.Once located the section of image binary corresponding of the hand, morphological erosion operator was applied.

Step 7. Morphological dilation operator was applied.
The figure 8 shows the process of applying erosion to the image hand segmented with a Moore neighborhood, and subsequently applying dilation 6 times with the same vicinity. Finally, shows the image of the hand segmented to color.

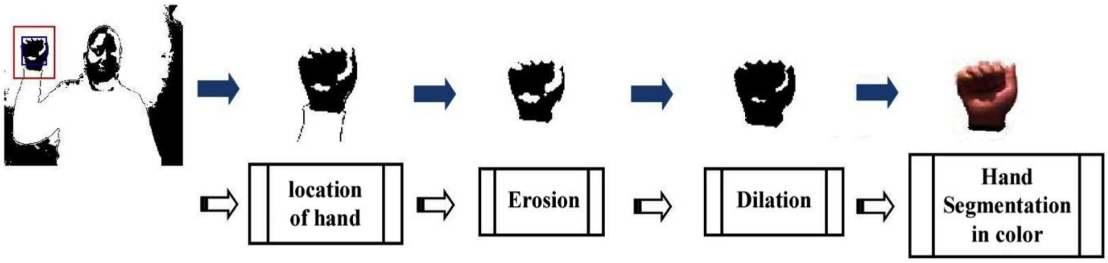

Figure 8: Process segmentation of the hand to locate the sign on.

IV. Conclusión

This paper is presented an automated method for segmentation of abnormalities in digital mammography images. The method was applied an images bank that was captured by a webcam The proposed segmentation method can be a useful to the development of computational systems that address the problem of patterns classification focused on the problem of sign language.

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