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Extraction skeleton of human body using fuzzy intuitionistic method

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ABSTRACT

Skeletonization is basically reducing binary image objects to a set of thin strokes which retain important information about the shapes. Different linear and nonlinear algorithms are there for finding skeletons. Most of the algorithms cannot find thin objects for low contrast images. In this paper we purpose a method for skeletonization of a binary image in which we use morphological gradient and fuzzy intuitionistic method.

KEYWORDS

Skeletonization;
Morphology;
Intuitionistic fuzzy.

INTRODUCTION

An important approach for representing the structural shape of a plane region is a graph which reduction may be accomplished by thinning algorithm. Thinning is an image processing operation in which binary valued image regions are reduced The skeleton of an object is a line connecting points midway between the thin boundaries[1]. The skeleton generated by thinning algorithms has not good accuracy and smoothness, so it might be need further processing[2]. Tao Ju[3] computed skeletons of volumetric models by alternating thinning. Ding[4] presented a novel method utilizing the distance transform. One important feature of mathematical morphology is the fact that it unifies the realization of many linear and nonlinear translation-invariant systems. Mathematical morphology provide some very powerful tools for feature extraction. Mathematical morphology is totally based on mathematical concept. It can be used for analyze the images[5-7]. It provides an approach to image analysis using set theory[8]. In the mathematical morphology theory, images are treated as sets, and morphological transformations which derived from Minkowski addition and subtraction are defined to extract features in images. In the case of binary-valued images, an efficient way to represent objects within the images is to use primitives such as geometrical patterns. One such geometric representation is the skeleton. Skeleton using morphology produces over segmentation for low contrast images. So in this paper fuzzy mathematical morphology with of intuitionistic fuzzy set applied to getting better results.

Intuitionistic fuzzy set considers more (two) uncertainties – membership and the nonmembership degree. Membership function is user defined and it may be Gaussian, triangular, Gamma membership function or any other. So there is some hesitation while defining the membership function. Attanassov's intuitionistic[9] fuzzy set define two values, one is membership values μ and another is non-membership values V of the elements of a set.

An intuitionistic fuzzy set in x is given by $A_{IFS=}$

$\{x, \mu_A(x), V_A(x) / x \in X\}$

Where, $\mu_A(x) \to [0,1]$, $V_A(x)) \to [0,1]$

with the condition $0 \le \mu_A(x) + V_A(x) \le 1$

where, $\mu_A(x)$ and $V_A(x)$ are the membership and non-membership degrees of an element x to the set A. For all intuitionistic fuzzy sets, Attanassov[9] also indicated an hesitation degree $\pi_A(x)$ which arises due to lack of knowledge about the membership degree, of each element x in A and is given by:

$\pi_A(x) = 1 - \mu_A(x) - V_A(x)$ Obviously, $0 \le \pi_A(x) \le 1$

Due to the hesitation in the membership function, membership values lie in the interval range:$[\mu_A(x) - \pi_A(x), \mu_A(x) + \pi_A(x)]$.

This paper presents a novel approach to find skeleton of human image using intuitionistic fuzzy set theory. A fuzzy smooth image constructed using fuzzy membership function and morphological operation. An intuitionistic fuzzy image is constructed using Sugeno type intuitionistic fuzzy generator. Then fuzzy hedge is applied to the intuitionistic fuzzy image. Finally using skeleton operator, a thinned image is obtained.

The organization of the paper is as follows. Mathematical morphological image processing methods are described in Section 2. Section 3 will present in detail the proposed algorithm. Then, this method is tested in section 4 using human body image, and its performance is compared with that of traditional method. Finally, Section 5 contains some concluding remarks.

MORPHOLOGICAL IMAGE PROCESSING

The advantage of mathematical morphology is it directly applied to image using spatial domain. Mathematical morphology is a tool for extracting image components which are useful in representing boundaries, skeletons and convex hull..

The basic idea above is to apply a structuring element to detect an image. The important morphological operations are basically dilation, erosion, open and close operations. Morphological operations make use of a structuring element *M*; which can be either a set or a function that corresponds to a neighborhood-function related to the image function *g*(*x*)[10]. In general, a dilation (denoted by ⊕) is a mathematical operator that commutes with the supremum operation. On the other hand, erosion (denoted by ⊖) is a mathematical operator that commutes with the infimum operation. There is a homomorphism between the image function *g* and the set *B* of all pixels with image function value 1. The structuring element *M*(*x*) is a function that assigns a subset of $N \times N$ to every pixel of the image function.[11] Then dilation, an increasing transformation, is defined as

$$B \oplus M = \cup_{x \in B} M(x)$$

Whereas, erosion, a decreasing transformation, is defined as

$$B \ominus M = \{x | M(x) \subseteq B\}$$

In the same manner, opening and closing of set *B* by structuring element *M* are respectively defined as

$$B \circ M = ((B \ominus M) \oplus M),$$

And $B \bullet M = ((B \oplus M) \ominus M)$.

PROPOSED METHOD

1. Read original image A
2. Initially fuzzified using the formula:

$$f\ \mu_A^{win}(g) = \frac{g - g_{min}}{g_{max} - g_{min}}$$

Where g=double (image), g_{min}=min (min (image)), g_{max}=max (max (image))

3. Define 3x3 square structuring elements [M] with set of fuzzy logic conditions.
4. Then smoothed fuzzified image $f\mu_A^{win}(g)$ using open and close operation with 3x3 square structuring elements [M] to get μ_A^{win}(g)=imclose(imopen((g),M).
5. Sugeno type intuitionistic fuzzy generator[12] applied in smooth image is follows as: N $(\mu(g)) = (1 - \mu(g)) / (1 + \lambda\mu(g))$, $\lambda > 0$ where $N(1) = 0$, $N(0) = 1$

This Sugeno type intuitionistic fuzzy generator is used for finding the non-membership function which is written as $v_{A_\lambda}^{win}(g(i,j)) = \dfrac{1 - \mu_A^{win}(g(i,j))}{1 + \lambda\mu_A^{win}(g(i,j))}$. Thus, with the help of Sugeno type intuitionistic fuzzy generator, I F S becomes: A_λ^{IFS}={x, Regular Paper

$$\mu_A g(i,j) = \frac{1-\mu_A g(i,j)}{1+\lambda\mu_A g(i,j)} \quad |g(i,j) \in A$$

with hesitation degree of the window is written as

$$\pi_A^{win} g(i,j) = 1 - \mu_A^{win} g(i,j) - \frac{1-\mu_A^{win}(g(i,j))}{1+\lambda\mu_A^{win}(g(i,j))}.$$

In the experiment, λ, = 1 is used. Because, as, λ increases, the fuzzy complement or the Sugeno generator will decrease thereby the non-membership value will decrease and the hesitation degree will increase

6. Due to the hesitation degree, membership values lie in an interval range, so, using[13] the modified membership value is written as:
   $\mu_A^{winmod} g(i,j) = \mu_A^{win} g(i,j) - mean * \pi_A^{win} g(i,j)$
   where mean =mean(mean($f\ \mu_A^{win}$(g)))
7. Finally the skeleton of the image is obtained by sequential application of erosion and opening operators to the modified membershipg μ_A^{winmod}(i,j)

RESULTS AND DISCUSSION

Experiments are performed on human body image. The proposed method is compared with non fuzzy method and a fuzzy method.

Figure 1 is an image of a human body. Figure 2 and Figure 3 are the result using non-fuzzy and fuzzy method. It is observed that image is brighter but not thin. Proposed Intuitionistic fuzzy method in Figure 4 shows that the skeleton is thin and smooth. The proposed Intuitionistic fuzzy method performs better than the other two methods.

Figure 1 : Original image

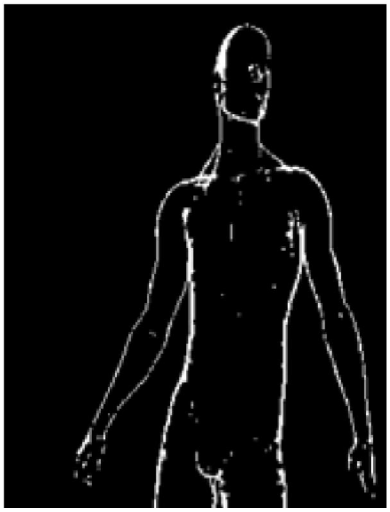

Figure 2 : Non-fuzzy image

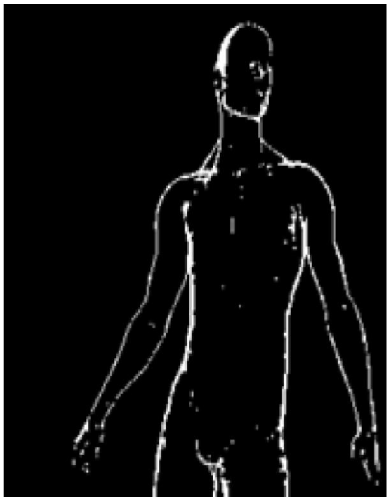

Figure 3 : Fuzzified image

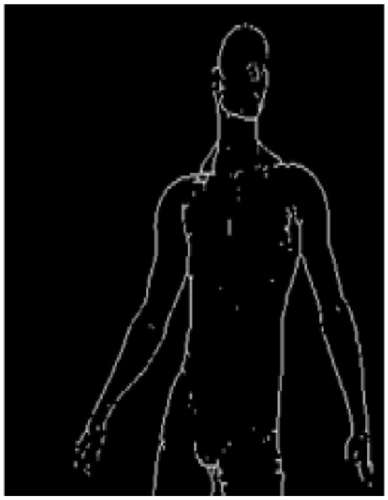

Figure 4 : Proposed intuitionistic fuzzy image

CONCLUSION

This paper suggests a novel approach using intuitionistic fuzzy set theory to find skeleton of human body which are poorly illuminated. It uses Sugeno type intuitionistic fuzzy generator to create an intuitionistic fuzzy image. Proposed method the result of image is thin and smooth than the existing fuzzy and non fuzzy methods.

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