

New Method of Image Smoothing and Edge Detection Based on Nonlinear Ambiguity Function

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Abstract—With the continuous development of the national economy and science and technology, the scope of the application of images is constantly expanding. The image has many uncertainties, and the improvement of this feature is often blurred and can not be accurately calibrated, which results in complex and diverse processing techniques. Image smoothing and edge detection are very important feature technologies in image processing, and they also the research focus in the field of image processing. This paper studies the method of image smoothing and edge detection based on nonlinear ambiguity function, and discusses the method.

Keywords- Image; Ambiguity function

I. INTRODUCTION

Image is the link between human and information, and it is the visual foundation of the world. The image is affected by many factors in the formation and transfer process which brings a lot of uncertainty on the recognition[1], similar to the fuzzy logic inference of human knowledge on the algorithm that can discover the interference factors in the image data from the image characteristics. From point of view, process information detection image is uncertainty, however, treatment of the uncertainty problem of fuzzy logic shows the effectiveness to a certain extent.

II. OVERVIEW OF IMAGE PROCESSING TECHNIQUES

The image is seemed as a digital signal on the computer, and its forming process will be accompanied by many disturbing factors, image smoothing and image edge processing technique is very important that contains the image and separability of most of the information. The main purpose of image smoothing is to reduce the noise of the image, and the first step is image processing, because most of the image in forms have some noise factors in the process of transmission, so the technology is bound properly to the edge detection of direct impact [2]. Image edge detection refers to the detection algorithm through the collection of gray image edge pixel step change certain, and the image pixels' direction of the shape and edge step of object contour information can be displayed which is an important feature extraction in image recognition[3,4].

Image smoothing and edge detection technology has become the basis for the study of image processing from the image, since the scholars began to study image

smoothing and edge detection technology. However, the key technology in initial studies have focused on how to establish the mathematical model, and the image processing technology based on the mathematical model of some targeted with a wide range that was not be covered. In 80s, Pal and King put forward the fuzzy edge algorithm for image processing technology, the image processing method based on fuzzy technology can effectively separate the object from the background, and applied in the field of medicine and computer pattern recognition, so scholars began to pay attention to application of fuzzy techniques in image processing, and gradually to the the research and development[5].

III. FUZZY TECHNOLOGY

A. Development of Fuzzy Technology

In 1960s, American scholar Professor L.A.Zadeh proposed the theory of fuzzy sets, and in the mathematical basis, fuzzy theory mainly includes the fuzzy set theory, fuzzy logic, fuzzy reasoning and fuzzy control which breaks through the end of nineteenth Century the German mathematician G. Cantor founded the classical set theory limitation_[4].

The membership function can be expressed as a fuzzy transition process, and the quantitative representation of the concept is established. The mathematical basis of the fuzzy theory is established. P.N.Marinos published a research report on fuzzy logic, which really marks the birth of fuzzy logic. Fuzzy logic is different from classical two valued logic. Fuzzy logic is a continuous logic, and a fuzzy proposition is a sentence that can determine the degree of membership. Its truth value is in any $[0, 1]$ interval_[1]. Then, the fuzzy technology for automatic control of the steam engine by a British scholar E.H.Mamdani, and achieved good control effect, it successfully created the people of industrial control direction of fuzzy control, so as to construct the fuzzy control system, the fuzzy control has become a kind of new technology that has been applied in various fields.

Comparatively speaking, fuzzy theory has many advantages. Firstly, fuzzy theory has some theories and methods to show the natural semantic and makes it into a substance capable of accepting and understanding, in order to improve the cognition and recognition ability of the computer; secondly, the theory of fuzzy reasoning method has fuzzy logic and it is similar to the human brain, thus it

makes the computer become more intelligent, such as fuzzy control and industrial products system can reflect these advantages; furthermore, the theory of fuzzy mathematics theory is more widely than general application, but in various application areas of science and technology and economic development in recent years, fuzzy theory and some optimization algorithms such as neural network, genetic algorithm group a computational intelligence technique. With the development and cross continuously, this theory will promote the human society towards more intelligent society by one step forward.

B. Overview of Fuzzy Technology

1) Concept of fuzzy technology

Based on the fuzzy set theory, the set of elements is set up by [0, 1], and real interval representation are used, and “1” means logical truth, and “0” means logical false. However, when fuzzy logic is used to establish the set of set elements, the value of the proposition is true except that it is “1” and false is “0”, so that any value between 0~1 can be taken, such as 0.6, which means the proposition is true or false to a certain extent. The fuzzy concept can be described by fuzzy set, and the function expressed by the set is the membership function:

$$\mu : X \rightarrow [0, 1]$$

The collection described by the membership function μ called fuzzy set to a fuzzy subset A conclusion on field X, $\mu_A(x)$ means the membership of set A, and it is also expressed as a mapping on the domain:

$$\mu_A : X \rightarrow [0, 1]$$

$$X \mapsto \mu_A(X)$$

As shown in Fig. 1, the general collection can define a clear boundary, such as under the age of 30 is young, however in the fuzzy set, it cannot define a clear boundary for young people under 30 years of age or 40 years old, which means 40 years old also belongs to the youth. But they belong to different levels of youth.

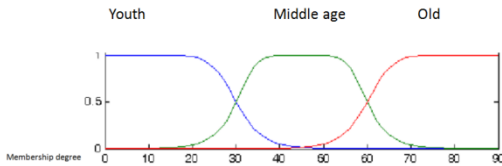


Figure 1. Typical subordinate functions of language values “Youth”, “middle age” and “old”

2) Operation of fuzzy sets

The three fuzzy sets A, B and C on the domain X:

a) If for $\forall x \in X$, then $A(x) = B(x)$ which means $A = B$:

$$A = B \Leftrightarrow A(x) = B(x) (\forall x \in X)$$

b) If for $\forall x \in X$, then $A(x) \leq B(x)$:

$$B \Leftrightarrow A(x) \leq B(x) (\forall x \in X)$$

c) If for $\forall x \in X$, then $B(x) = 1 - A(x)$, which means B is the remainder of A.

d) If for $\forall x \in X$, then

$$C(x) = \max\{A(x), B(x)\} \quad \text{or}$$

$$C(x) = A(x) \cup B(x) \quad \text{which means C is union set of A and B.}$$

$$C = A \cup B \Leftrightarrow C(x) = A(x) \cup B(x)$$

$$5) \text{ If for } \forall x \in X, \text{ then } C(x) = \min\{A(x), B(x)\} \quad \text{or}$$

$$C(x) = A(x) \cap B(x) \quad \text{which means C is intersection of A and B:}$$

$$C = A \cap B \Leftrightarrow C(x) = A(x) \cap B(x)$$

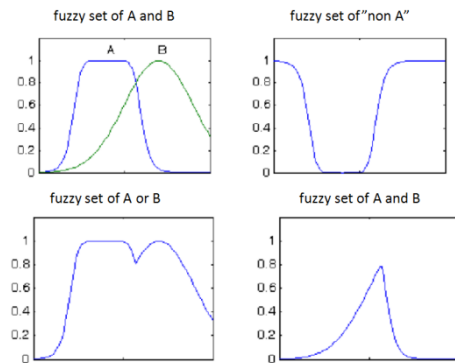


Figure 2. Fuzzy set operation

3) Fuzzy logic and fuzzy language

About quadratic element logical values are usually in {0 and 1}, which are not true or false. However, in many practical problems, it is difficult to make such a true and false judgment. Based on the fuzzy logic value function, no exact value proposition for dividing the determination which is defined to a certain extent, the ambiguity function of the proposition is judged only on closed interval [0,1], when determining the extent of the closer to 1, that proposition is true to the ratio that is higher, and vice versa proposition for the higher percentage is false.

Vague language is usually the simplest “If... Then” rule, such as “if x belongs to A, and Y belongs to B”. The compound means “if m is A and X is B, then y is C, or Z is D”; in which, A, B, C, D respectively on domain M, X, Y, Z including semantic fuzzy set values, “If” is part condition, and “then” is the condition.

For the image processing technology in the edge detection, when using the step edge detection edge slope, the parameters in the model are difficult to determine, in this situation, the human knowledge application of edge detection algorithm shows a flexibility based on fuzzy theory which is applied to the fuzzy logic expert system thought with using “If... Then” rules to represent human knowledge.

IV. APPLICATION OF FUZZY TECHNOLOGY IN IMAGE PROCESSING TECHNOLOGY

In the actual application process, the fuzzy function has certain steps of image smoothing and edge detection based on image technology: firstly, linear and nonlinear fuzzy membership function can replace the traditional definition of correlation based on fuzzy membership function correlation, improved traditional image smoothing algorithm making the noise out of processed images, and it is more clear; secondly, the mode conversion of the input image, which means the image is converted into gray image, its purpose is to reduce the amount of calculation and speed up the computation time for feature extraction; then, the image data began fuzzy processing, and image data is transformed into fuzzy domain data; fuzzy image’s pre-processing domain means fuzzy enhancement of image that reduces the image fuzzy uncertainty in the decision; and then determine of the

bandwidth and fuzzy threshold with the use of “If... Then” fuzzy language rule determines the degree of its collection, detects the edge data in the fuzzy domain, and finally outputs the edge image in the spatial domain.

Image processing technology is a kind of digital processing method, these methods are to improve the appearance of the image, because of the equipment, channel and objective condition limit, it causes the conversion between the actual scene and image information of the deviation, affecting the image quality of output. In a word, the ambiguity function of the image processing technology can make the image observation and judgment which is more suitable for human eyes based on analysis and machine processing that has important significance to improve the image quality and improve the visual effect.

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