

# Image Segmentation Adaptive Distance Preserving Level Set Evolution Analysis Based on Depth Learning

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**Keywords:** Image segmentation; Self-adaptation; Distance maintenance

**Abstract:** Image segmentation is an important and low-level processing task in computer vision. The quality of segmentation has a great impact on the completion of subsequent tasks. From the perspective of visual perception, image segmentation seems to be a very easy problem to solve. In actual image processing, it is a very difficult task. Compared with image classification and target detection, distance-preserving level set method involves two cross-cutting fields of image recognition and natural language processing, thus it is extremely challenging. In the research and application of computer vision, image segmentation is often the first step and plays a very important role in the whole process. The zero level set curve can adaptively decide whether to move inward or outward according to the characteristics of the image, and the curve can continue to evolve to the boundary of the target object in the region where the gray values of the pixels are equal. Adaptive distance keeping level set evolution model introduces variable weight coefficient on the basis of no need to initialize the model, so as to get rid of the dependence of evolution curve on initial position.

## 1. Introduction

In the digital information age, people have to accept massive amounts of information every day, most of which are image information obtained by human vision, so image is an important information carrier for human perception of the world. In the research and application of computer vision, image segmentation is often the first step and plays a very important role in the whole process [1]. The automatic generation of image description by computer is a hot and difficult point in the field of computer research. Its fundamental task is to let the computer correctly describe the perceived image scene and its contents. Image segmentation is an important and low-level processing task in computer vision. The quality of segmentation has a great impact on the completion of subsequent tasks [2]. In recent years, the image segmentation method based on partial differential equation proposed by people has become an important image segmentation method. Its basic concept is to first construct the corresponding partial differential model according to the requirements of image segmentation, and then solve the partial differential equation. The solution of the equation is the desired result [3]. Computer processing image description tasks not only focus on the object recognition in the image, but also pay attention to the interconnection between the objects in the image. The level set function is always maintained as a function on a fixed grid point during the evolution process, which can automatically and flexibly handle the change of the topology of the zero level set [4].

Handling the information interaction between the machine and the real world is the first step in studying artificial intelligence, and the goal of computer vision research is to give computers the ability to perceive and understand image information similar to humans. The adaptive distance-preserving level set evolution model is an improved model that does not need to re-initialize the model. It replaces the constant weight coefficients of the original model with variable weight coefficients, which is a good way to get rid of the dependence of the evolution curve on the initial position [5]. Compared with image classification and target detection, the distance-preserving level set method involves two intersecting fields of image recognition and natural language processing,

which is extremely challenging [6]. Introduce the weight coefficients related to the image information, which can adjust the size adaptively according to the image information. Thus, the speed of curve evolution is accelerated, and the segmentation effect of the algorithm is improved. The adaptive distance-preserving level set method can automatically detect the inner and outer contours of the target object from a randomly selected initial curve, detect the edges of the multi-target object and the deep depression area, and can better extract the weak boundary of the target object [7]. Using the gray mean difference between the inner and outer small neighborhoods of the evolution curve contour as independent variables, the establishment of an adaptive weight function model can improve the efficiency and accuracy of the model for segmenting uneven gray images.

## **2. Image Segmentation Based on Deep Learning**

### **2.1. Structure Analysis of Deep Neural Network**

In the traditional geometric active contour model, the level set function must always keep close to the symbolic distance function in the evolution process, so as to ensure the stability of the level set evolution and the effectiveness of the results. The distance preserving level set method adds an internal energy functional to the energy functional of the traditional method, which is mainly used to correct the deviation between the level set function and the symbolic distance function [8]. Neurons in each network layer of the neural network are all connected to each other. Although it is feasible to use this fully connected network to deal with handwritten numeral recognition, the recognition effect is poor. The main reason is that for image data, there is a correlation between adjacent pixels of the image. Vector representation is performed on the image, and the decoding end adopts a cyclic neural network language model to generate a language description. When there are a large number of input and output mapping samples, a machine can be used to find a way to simulate this mapping mode. In the traditional geometric active contour model, the level set function must always keep close to the symbolic distance function in the evolution process, so as to ensure the stability of the level set evolution and the effectiveness of the results.

### **2.2. Image Target Category Perception**

The simplest and most common method to reduce the over-fitting of image data is to artificially enlarge the training data set by using the transformation method of preserving labels. At the noise, the edge stop function may reach a local minimum, making the model more sensitive to noise. The network is pre-trained without supervision, the weights are initialized with the pre-training results, and then the parameters are fine-tuned through the supervised training team network model. From the perspective of visual perception, image segmentation seems to be a very easy problem to solve. In actual image processing, it is a very difficult task. For image data, one way to expand the data set is to translate and flip the image horizontally without changing the image label. The weight coefficient not only determines the evolution direction of the zero level set, but also changes the amplitude of the stop velocity function. For some non edge parts of the image due to the uneven gray level, there will be a large gradient value, and the edge stop function will approach zero here, which makes the model inaccurate for such image segmentation. The distance keeping level set method lacks the adaptability of direction and size.

## **3. Evolution of Distance-Preserving level set**

The initialization curve must surround the target object or be inside the target object, otherwise an erroneous boundary will be generated or no boundary can be extracted at all. The model based on distance regularization and gradient information solves the problem that the traditional geometric contour model needs to be reinitialized continuously. Referring to the spatial characteristics of pixel points in the image, each pixel point is only closely related to pixels in a certain range around it. Convolution neural network is designed as a sparse network, i.e. each neuron is only connected to the neighboring neurons. The model may reach a local minimum at the image noise and the non-boundary gradient, thus making the model less noise resistant and inaccurate in segmentation of

uneven gray scale images. Weight coefficient also plays an important role in distance preserving level set method. On the one hand, its sign determines the evolution direction of the zero level set, making the zero level set converge to the correct target boundary. If the initial curve surrounds the target object, the zero level set needs to shrink inward. The new weight coefficient is approximately inversely proportional to the image gradient and has a larger value in the non-boundary region. It can guide the zero level set to pass through the deep depression region and improve the capture capability of the zero level set to the boundary of the deep depression region.

The adaptive distance preserving level set evolution model is obtained by introducing a variable weight coefficient  $v(I)$  on the basis of no need to reinitialize the model, and its energy functional is:

$$\varepsilon(\phi) = \mu \int_{\Omega} p(|\nabla \phi|) dx dy + \lambda \int_{\Omega} g(I) \delta(\phi) |\nabla \phi| dx dy + \int_{\Omega} v(I) g(I) H(-\phi) dx dy \quad (1)$$

According to the variational principle and the steepest descent method, the partial differential equations that control the evolution of the set function  $\phi$  are:

$$\frac{\partial \phi}{\partial t} = \mu \operatorname{div} \left( d_p(|\nabla \phi|) \nabla \phi \right) + \lambda \delta(\phi) \operatorname{div} \left( h(I) \frac{\nabla \phi}{|\nabla \phi|} \right) + v(I) g(I) \delta(\phi) \quad (2)$$

Where,  $\mu > 0$ ,  $\lambda > 0$ .  $H(z)$  and  $\delta(z)$  are regularized Heaviside function and regularized Dirac

function, respectively,  $p(s) = \frac{1}{2}(s-1)^2$ .

For some images, some parts of the target object exceed the boundaries of the image. No matter how the initial curve is placed, it cannot meet the requirements of surrounding the target object or being located inside or outside the target object. The performance parameters of image segmentation before and after optimization are shown in Table 1. After wavelet transform and filtering optimization, the topology of image segmentation is greatly optimized, with fewer nodes and better monitoring area. The simulation comparison of topology reliability optimization for image segmentation is shown in Figure 1.

Table 1 Performance parameters of image segmentation image structure before and after optimization

	Before optimization	After optimization
Row number	132	181
Column number	96	117
Monitoring points	12672	21177

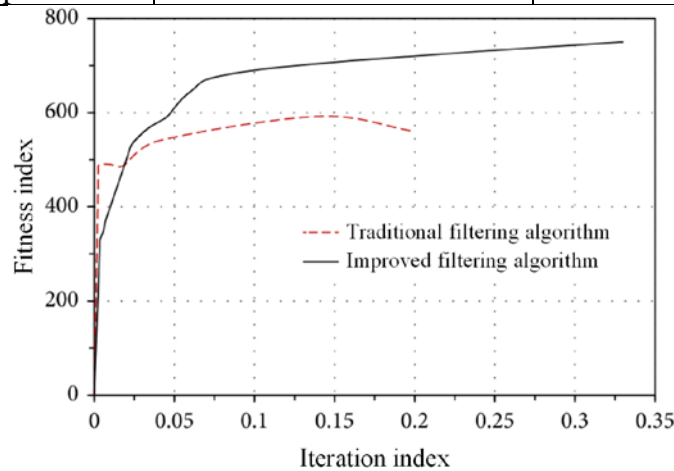


Figure 1 Comparison of simulation optimization of image segmentation filtering

For the extraction of target candidate regions, the initial method is to use a sliding window to traverse the image, crop different regions of the image and extract the features to identify whether there is a target in the region. The initialization curve must surround the target object or be inside

the target object, otherwise it will produce wrong boundaries or no boundaries can be extracted at all. An input does not only affect the corresponding output, but also affects all subsequent outputs. The output result of image segmentation is an end-to-end pixel-level classification label, which requires that the output and input have the same size. For some images, some parts of the target object exceed the boundary of the image, no matter how the initial curve is placed, it cannot meet the requirements of surrounding the target object or being located inside or outside the target object. After multiple convolution and pooling operations in the encoding stage, the output size is getting smaller and smaller [9]. Most of the input images are adapted to a fixed size by cropping or scaling, but the cropped area may not contain the target. The adaptive distance-preserving level set evolution model replaces the constant weight coefficients of the original model with variable weight coefficients, which can well get rid of the dependence of the evolution curve on the initial position. It is necessary to find a reasonable method for extracting target candidate regions, simplify the number of target candidate regions, and thus reduce the calculation amount of the entire target position sensing system.

#### **4. Conclusion**

The partial differential equation computer image segmentation method, as a hot research topic at present, has received much attention at home and abroad. The algorithm based on depth learning has become the mainstream method in the field of image segmentation, and various novel and efficient network models have been proposed continuously. The distance preserving level set method is a major breakthrough of the traditional level set method. It does not need to initialize the level set function periodically, and can adopt a simple difference scheme and allow a larger time step when numerically calculating the evolution equation. Distance preserving level set method is a great breakthrough of traditional level set method. It does not need to initialize the level set function periodically, and can use a simple difference scheme and allow a large time step in the numerical calculation of evolution equation. Deep learning technology can be used in the situation factor detection task in the situation awareness system, and its perception accuracy and efficiency have reached a high level. It effectively solves the problem that the evolution curve is sensitive to the initial position, and can define the initial curve in any direction. In the future, we will focus on improving the generalization ability of the model so that the model can perform well in various tasks.

#### **Acknowledgements**

Anhui University Natural Science Research Project "Research and Application of Face Image Recognition Technology" (KJ2017A472); Tongling university talent research start-up fund project "research on photoelectric detection technology of circuit board surface defects based on image registration" (2015tlxyrc02).

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