An Algorithm of Image Calculus

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Abstract: the differential equations of different classification, and image registration as the application object, the differential equations of different types of modeling finally, in different images in different differential equations in the simulation experiments, the simulation results show that the partial differential equation model of this paper in the extraction and recognition of image information in the debate.

Keywords: Algorithms; Calculus; Images; Equations

1. Introduction

In recent ten years, the image processing method based on partial differential equation theory has been greatly developed [1-3]. The theory of partial differential equations has penetrated into every field of image processing, and has achieved great success and development. Partial differential equations are widely used in image processing, such as segmentation, enhancement, registration, fusion, denoising and so on, because of their local adaptability, normalization, flexibility and so on. At present, there are two main methods to establish the model of partial differential equations: the first method is to establish a 0 energy functional, a Lagrange equation, the Lagrange equation is a partial differential equation, so that you can put the modeling problem into a variational problem; the second method is a physical process is expected to achieve the image evolution and the reality of analogy, according to the physical model of reality, through mathematical modeling, the establishment of the corresponding partial differential equation model [4-5].

This paper is based on the error of the existing optical flow image processing of moving in the pull, the image is not clear, more fuzzy defects, the proposed adaptive anisotropic image standard model research based on partial differential, first of all to the theory of partial differential equations based on partial differential equations are classified, and then the partial differential equations from the specific graphics model was introduced and applied to different functions, the partial differential equation model for image registration was simulated, the simulation results show that the adaptive image using partial differential equation, the resolution of the image is improved obviously, read the image information is enough fast enough, diffusion the effective protection of the tangent direction and the direction of the inhibition, successfully protecting the image edge and edge angle.

2. Partial Differential Equation

The heat diffusion equation is first introduced into image processing to solve the problem of image denoising, and gradually forms a class of image processing methods based on diffusion partial differential equation theory. The heat equation has a very important position in the field of partial differential equations. It mainly describes the law of temperature changing with time in a certain region. "Heat conduction is assumed to propagate in the homogeneous medium with three directions, and the heat conduction equation is":

Is first introduced into image processing of thermal diffusion equation, is used to solve the problem of image denoising, and gradually formed a kind of image processing method based on partial differential equations of diffusion theory. The heat equation plays a very important role in the field of partial differential equations, mainly described in a particular area, the law of temperature change with time that heat conduction in the three-dimensional direction of homogeneous medium propagation, then the heat conduction equation:

$$\Delta^2 = \frac{\partial^2}{\partial l^2} + \frac{\partial^2}{\partial j^2} \quad (1)$$

The surface $\frac{\partial^2}{\partial l^2} + \frac{\partial^2}{\partial j^2}$ temperature, which is a function of the T variable time and space variables, as the coefficient of heat conduction, F function is known, if the medium is not considered the whole space, in order to get the equation only solution, you must specify the U boundary conditions, if the medium is the whole space, in order to obtain the uniqueness of the solution must be assumed, upper bound the growth rate is exponential.

The heat equation is equivalent to the Gauss function of the initial image of Gauss low-pass filter, so the thermal diffusion retain low frequency components of initial image, filter the high frequency components and high frequency components, including details and noise "because of the heat equation is an isotropic diffusion equation, so the heat equation can remove noise but preserve the edge is not very good the.

2.1. Partial differential wave equation

The wave equation is a partial differential equation is common and important, it has appeared many times in different fields, such as fluid mechanics, electromagnetics and acoustics, we used the wave equation expressed all kinds of waves, such as light, sound or water waves such as wave, the general form of the wave equation is:

$$\begin{cases} l\Delta^2 a - w_j\left(w_j a + w_l b + w_r\right) = 0 \\ l\Delta^2 v - w_j\left(w_j a + w_l v + w_r\right) = 0 \end{cases} \quad (2)$$

3. PDE-based Self-adaption Anisotropy Registration Model

3.1. Partial differential parameter active contour model

Parametric active contour model is the most representative I30] snake model proposed by Kass et al, the model in the region of interest is defined with an energy near the spline curve to fit the image data by minimizing the energy function, the minimum energy is the energy weighted curve inside and outside and reaches the minimum, the internal energy describe the curve of tension and sliding force, the external energy is determined by the image information, achieve the object boundary curve of minimum energy, model definition, spline curve.

$$V(s) = \left(x(s), y(s)\right), s \in [0,1]$$
$$E_{snake} = \int \left(E_{\text{int}} + E_{ext}\right) ds \quad (3)$$

Among them, the internal energy to maintain spline elastic and smooth, the external energy is determined by the image information, the evolution of constraint curve, make it stop at the object boundary, two energy are defined as follows:

$$E_{\text{int}} = a\left\|V'(s)\right\|^2 + b\left\|V''(s)\right\|^2,$$
$$E_{ext} = -\left|\nabla\left[G_s * I(V)\right]\right|^2 \quad (4)$$

Among them, a and weight coefficient, is that the Gauss variance function, gradient operator, and one order and two order derivative respectively, minimizing the energy functional can adopt difference, finite element, optimization methods to achieve. The Snake model has been proved to be an efficient method for contour detection, but the model for image segmentation has the following problems: (L) needs to be placed in the initial contour near the boundary of the interested region, and the segmentation results are general and the position and shape of the initial contour is closely related; (2) with topological variability that is difficult to segment image in the region depression; Experimental simulation and analysis

3.2. Optical Flow Experimental of Rubik Chart

Rubik Chart is one of the most representative test charts of the optical flow field; first, choose this chart to validate the registration result of the model in this paper. Use Rubik Chart placed at an angle 2 (a) to be chart waiting registration. Rubik Chart rotates in certain angle 2 (b) as a benchmark figure, three models were used 100 times iterations. The results can be seen from Hom model 2 (c), Hom model results in blurred images quickly , as well as the edges of the image is difficult to distinguish; Registration result in Figure 2 (d) of Weickert model shows that the diffusion model defined by Weickert has enhanced ability to maintain the edge of the model, it is better than Hom method, but on the top of Rubik whose working speed is fast (fierce change of the performance of the image), image characteristics can not be effectively maintained and edges severely blurred; registration results of this model (Figure 2 (e)) shows that this model can maintain image features and applies to all forms of image motion, and has better adaptability on fast motion, and the registration accuracy is significantly better than the other two models. In table 4.1 and Table 2, the mean and variance of registration results in our model is minimum, which further explains the registration result of our model is the closest to reference image.

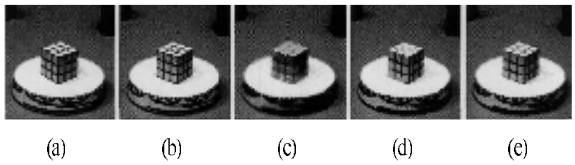

Figure 1. The diffusion model defined by Weickert has enhanced ability to maintain the edge

3.3. Registration of Human Face Images

To validate our model is suitable for image with illumination changes, this experiment choose two face images for registration. Observe from figure 1 , in Figure 2 illumination changed significantly, all three models were used 20 iterations, the obtained vector of optical flow field is shown in Figure 6. Experimental results show that both the whole or partial view, Horn model seriously obscure the image, so that we can not recognize (see Figure 2 (c)), once again validate the limitation of the Horn model; the registration result of Lucas-Kanade model obviously loss the moving edges; our model has better retention ability to image detail, and the illumination image can be changed to achieve more satisfactory results, the data in Table 4 further illustrate the registration result of this is the closest to the reference chart.

Figure 2. Registration of face image

Figure 3 Result: The division result comparison of four methods on artificial image, line 1: the original image and the initialization curve; Line 2: segmentation of Contrast constraint LBF model; line 3: division result of the original LBF model: Line 4: segmentation result of PS model

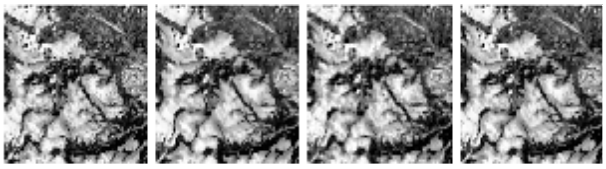

Figure 3. Optical flow vector field of face image

Table 1. Evaluation for registration results of face image

model	*PSNR*	*Mean*	*Var*
Horn model	34.03	-4.17	35.25
Lucas-Kanade model	32.36	10.62	38.68
Proposed model	38.89	1.24	9.25

Table 1 shows the comparison of the running time from our algorithm and other algorithms in the experiment of face image. The above results show this improvement is valid.

Table 2. Computation time compared with our algorithm and other algorithms

model	Image Size	Iterations	Computation time/s
Horn model	200×200	30	1.50031
Lucas-Kanade model	200×200	Size of window is 5.6 layer iteration	7.80624
Proposed model	200×200	30	2.86041

4. Conclusion

With the development of the theory and application of partial differential equations, the distribution of partial differential equations has become a hot topic. This paper is based on the error of the existing optical flow image processing of moving in the pull, the image is not clear, more fuzzy defects, the proposed adaptive anisotropic image standard model research based on partial differential model, through the classification of partial differential equations, and the application of equation theory, the image of different models the experimental simulation, the simulation results show that the adaptive image using partial differential equation, the resolution of the image is improved obviously, read the image information is enough fast enough, effectively protect the diffusion direction and the tangent direction of inhibition, successfully protecting the image edge and edge angle.

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