Research and Application of Multiscale Representation and Regularization Method in Image Recognition

Wang Heng¹, Zheng Bi-Geng²*

1School of Electronics and Information Engineering, Jingchu University of Technology, Jingmen 448000, China
2Periodical Press of Jingchu University of Technology, Jingmen 48000, China
*Begin@Jcut.Edu.Cn

*Corresponding Author

Abstract. Image Recognition is the Use of Computers to Process, Analyze and Understand Images to Identify Different Patterns of Objects and Images. In This Paper, We Introduce the Idea of Nonlocal Processing on the Basis of Regularization $\text{TV}$. The Process of Image Recognition System is Divided into Five Parts: Image Input, Preprocessing, Feature Extraction, Classification and Matching, In Which Preprocessing Can Be Divided into Image Segmentation, Image Enhancement, Two Value Reduction and Refinement and So on. The Paper Presents Research and Application of Multiscale Representation and Regularization Method in Image Recognition. At the Same Time, through Programming in the Matlab Programming Environment to Achieve the Relevant Algorithm, through the Actual Image Recognition Experiments, the Use of These Conclusions, and Finally to Accurately Identify the Results.

1. Introduction
The variational multiscale (VMS) method has great potential in dealing with important issues in science and engineering. Image is the source of some important information, but in the process of image acquisition, transmission and storage, the image is usually polluted by noise, which makes the quality of the image decrease. The noisy image affects the acquisition of some useful information from the original image, and then the denoising process is the most basic problem before getting the correct information [2]. Its purpose is to estimate the desired image from noisy observations, which itself is an ill posed inverse problem.

Nature shows image in people's eyes is a continuous analog signal, in the computer before the treatment, must use the image sensor to convert light into electrical signals and brightness, a digital image is obtained by sampling and quantization. Sampling is the process of discretization of an image in coordinates, each of which is called a pixel. Quantization is the process of discretization of image gray
levels. After sampling, M*N pixels are obtained, and each pixel is quantized to obtain a gray value L, which represents the allowable range of gray values by L.

Image recognition is the use of computers to process, analyze and understand images in order to identify different patterns of objects and images. With the development of computer technology and information technology, image recognition technology has been more and more widely used. For example, a variety of the success of wavelet analysis.

The method of image registration has so far reported a considerable amount of image registration research in the field of image processing both at home and abroad, and has produced many image registration methods. Generally speaking, all kinds of methods are facing a certain range of application areas, but also have their own characteristics. For example, in computer vision scene matching and vehicle location system of map matching, according to the main functions of the completion of the known as the target detection and location, according to the adopted algorithm called image correlation and so on.

2. Variational Multiscale Geometric Analysis

Variational multiscale (VMS), in addition to providing an additional stability, is also a general framework of turbulence models and the derivation of computational fluid dynamics methods. Recently the variational method better deal with the anisotropic properties, a class of sparse representation methods with directionality -- multiscale geometric analysis has come into being. It accords with the requirement of human visual cortex to express image effectively, namely locality, directionality and multiscale. Its purpose is to find the optimal or sparse representation for high-dimensional functions with surface singularities or line singularities [4].

\[
p_{z|u}(z(x) | u(x)) = p_{u(x)}(z(x)) = \frac{e^{-u(x)}u(x)^{z(x)}}{z(x)!}, u(x) \geq 0
\]

Many papers have studied this problem, but most scholars research object is mainly additive white Gauss noise, however, such as astronomical imaging and X ray imaging, fluorescence and confocal microscopic imaging and image transmission in the photon counting imaging, usually with time or space change by quantum noise the pollution, the noise is not additive noise, but is subject to statistical laws, the Poisson distribution at the same time, between this kind of noise intensity and variance of signal dependence exists. Generally speaking, the pixels with higher brightness have more interference, so Poisson denoising is especially important and difficult to handle.

In RGB system, a color value consists of 3 components. Such an image is called a color image, and a RGB system is called a color space model. Common color space models are HSI, CMYK, and so on. If the color space of an image is one dimension (a color value has only one color component), the image is a grayscale image. In bitmap images, grayscale images are typically displayed in R=G=B.

Automatic image recognition system is divided into five parts: image input, preprocessing, feature extraction, classification and matching, the pretreatment can be divided into image segmentation, image enhancement, and two value and refined etc.

(1) Image input
The first step of image recognition is to collect the image and input it into the computer for processing.

(2) pretreatment
In order to reduce the complexity and efficiency of the subsequent algorithm, image preprocessing is essential. The bacplex system, physical constraint variational multiscale method introduces an independent N-S equation outside (such as turbulence, and macro stability conditions) Hughes variational multiscale method is the N-S equation as another expression of variable fractal like.
In the field of image processing, sparse representation of images has been widely used in the storage and transmission of image data. Since Yu Xianji and wavelet bases can achieve more accurate nonlinear approximation of images with fewer coefficients, they become important methods for sparse representation of images. Formula (2) is denoted as $L^3(x, y)$.

$$N_{p,q} : x \mapsto \{\phi_{p,q}(k, x_k)\}_{k \in \mathbb{N}}$$  

Feature extraction is responsible for expressing the features that uniquely represent the uniqueness of the image in numerical form. Try to retain the true features and filter out false features.

(4) Image classification

In the image system, the input image to be matched with dozens of hundreds or even thousands of images, in order to reduce the search time and reduce the computational complexity, need the image to assign an accurate method to consistent image database in different.

The method of image registration based on gray information generally does not need to preprocess the image in a complex way, but uses some statistical information of the gray image to measure the similarity of the image. The main feature is that the implementation is simple, but the range of application is narrow. It can not be used to correct the nonlinear deformation of the image directly. In the search of the optimal transform, huge computation is often required. After decades of development, the people proposed many image registration method based on the gray information, can be roughly divided into three categories: the cross-correlation method (also called template matching method), sequential similarity detection matching method, mutual information method.

Although there are some differences between their variational multiscale methods and our variational multiscale methods, there is still a lot of consensus about the importance and multiscale understanding of variational multiscale methods. Hughes's variational multiscale approach, a real breakthrough in the direction of turbulence models, was only made in the last two or three years. This is a research field full of challenges and opportunities.

In this paper, the infinitely derivable functions are smooth or not singular. If the function is discontinuous somewhere or the discontinuity of a certain order, it is said that the function is singular here. The singular or irregular structure of an image usually contains the essential information of an image. For example, the disco method, assuming the error detection probability in advance, and processing the threshold value at the same time. The algorithm is extended to biorthogonal wavelet, and the denoised ideal image is smoother.

3. Application of Regularization Parameter Determination Method in Image Recognition

Character segmentation consists of dividing the character region from the verification code image and dividing the character region into two parts of a single character. If you use statistical feature matching and neural network identification, you must first separate the individual characters. Simple segmentation methods include equidistant segmentation, integral projection segmentation, intersection segmentation, and connectivity. Among them, the segmentation of adhesive characters is a difficult problem, and it is difficult to segment in complex conglutination. It is a hard artificial intelligence problem.

Image matching based on ioblem if there is an obvious linear relationship between variables and response variables prediction, least squares regression will have very little bias, especially if the number of observations $n$ is far greater than the predicted variable $P$, the variance of least squares regression will be smaller. However, if $n$ and $P$ are relatively close, it is prone to overfitting; if $n<p$, the least squares regression fails to yield meaningful results [6].

$$dx(i, j) = \sum_{u=-1}^{1} \sum_{v=-1}^{1} S_x(u+1, v+1)f(i+u, j+v)$$  

(3)
The general method for solving ill posed problems is that the solution of the original problem is approximated by the solution of a set of suitable neighborhood problems of the ill posed problem, which is called regularization method. How to establish an efficient regularization method is an important issue in the research of ill posed problems in inverse problems. Regularization methods are usually based on the variational principle of Tikhonov regularization, various iterative methods and some other methods, these methods are effective methods for solving ill posed problems, has been widely used in the study of the inverse problem of all kinds of, and further study.

Another method is the Poisson denoising based on Bayesian theory. Compared with other methods, it has the advantage that it can combine the prior knowledge of the original image, and can be simplified by multi-scale analysis. Lit recognition. The purpose of preprocessing is to remove the noise in the image and put it into a clear point of line graph, image feature extraction in order to facilitate the correct calculation, 2.1 direction, direction Tuinig with authenticity in simplified form and can directly reflect the morphological characteristics of the image of the most basic, so it is widely used in image enhancement, image feature extraction, image classification, direction template matching image recognition and other key links [6].

\[
\sum_{i=1}^{n} \left( y_i - \beta_0 - \sum_{j=1}^{p} \beta_j x_{ij} \right)^2 + \lambda \sum_{j=1}^{p} |\beta_j| = \mathbb{R}\mathbb{S}\mathbb{S} + \lambda \sum_{j=1}^{p} |\beta_j| \tag{4}
\]

Gray level image registration algorithm plays a very important role in image processing technology, and it is an important foundation for the development of image processing technology. It can promote the application of image processing technology in medicine, biology, information processing and many other high-tech fields, it has gradually developed into a kind of technology can not be separated from social life, is of great significance for the development and application of image processing technology.

The model can explain the problem consists in a multivariate linear regression model in many variables and response varia in the difference image, combined with non local regularization, propose nonlocal Poisson noise suppression model based on TV regularization, is used to solve the multi step iteration, the model can not only achieve the basic denoising function, can improve the total variation which realize the function in non local TV, effectively maintain the edge texture images at the same time, reduce the influence of the step effect.

4. Research and Application of Multiscale Representation and Regularization Method in Image Recognition

The basic framework of ridgelet theory is established by E.J Cand s, and D.L.Donoho et al in the follow-up work and gradually expand and improve. Ridgelet transform is a non adaptive representation of high-dimensional functions. It can obtain the optimal approximation order for multivariable functions with linear singularities. The theory of ridgelet has a profound influence on the history of multiscale geometry analysis and is of inestimable value. The main part of ridgelet transform is to transform linear singularit segmentation method based on D-S evidence theory.

Registration procedures are as follows: first, the two image features are extracted feature points; similarity could be found by matching feature points; then match the feature points of the image space coordinate transformation parameters: by the coordinate transformation parameters of image registration. Feature extraction is the key to the registration technology, and accurate feature extraction provides the guarantee for the success of feature matching. Therefore, it is very important to find a feature extraction method with good invariance and accuracy for matching accuracy.
The 2 norm square of a vector, called the regular parameter, is used to control the relative size between the residual norm and the norm of the solution. $L$ is a regular operator and is related to the specific form of the system matrix [8].

\[
T = \begin{bmatrix} a_1 + a_2x + a_3y \\ a_4 + a_5x + a_6y \end{bmatrix} = Xa,
\]

The quality of the Tikhonov regularization is closely related to the regular parameter lambda, so the choice of lambda is critical. There are two main methods to determine regular parameters: generalized cross validation method and L-curve method.

1. Generalized cross validation (GCV, generalized, cross-validation)

The generalized cross validation method is proposed by Golub et al. The basic principle is that the optional canonical parameter should be able to predict the changes caused by the removal item when any of the measurements in the $Ax=b$ is removed. After a series of complex derivations, the final method of choosing the regular parameter lambda is to minimize the following GCV functions.

In practical applications, the discretization of ridgelet transform and its algorithm implementation is a challenging problem. Because of the radial nature of the ridgelet, the continuous formula is directly discretized and interpolated in polar coordinates. The results of such transformations are either redundant or not fully recoverable first. The so-called “three division” means that the first stage divides the background area; the second stage divides the fuzzy region from the foreground; the third stage divides from the fuzzy region: the non-recoverable part. After such processing, not only the computing time is saved, but also the reliability of segmentation is improved.

In view of the overall matching of image translation, rotation, scale transformation, a matching algorithm for image linear transformation [11] is proposed. Firstly the definition of the image to be matched, linear transformation model between points, corresponding to the pixel gray difference square as the image matching error function, then the parameters determine the iterative and incremental iteration method by minimizing the error function, the optimal linear transformation parameters. In order to reduce the computational complexity and increase the convergence speed, three improved strategies are proposed: adding weight function, sampling the image mesh point and increasing the acceleration. Experiments show that for small range translation, rotation and scale transform images can be accurate and fast overall matching, and the improved strategy can effectively improve the matching speed.

\[
G(\lambda) = \frac{\| (A + \lambda^2 L^T L)^{-1} A^T e \|^2}{\left( \text{trace} (I - A \cdot (A^T A + \lambda^2 L^T L)^{-1} A^T) \right)^2}
\]

Elastic net has an obvious effect on $P$ far greater than $N$, or severe multicollinearity. For elastic net, when alpha is close to 1, elastic net behaves very close to lasso, but removes the degeneration or odd expression caused by extrem.

5. Conclusion

According to the gray distribution of the image, the best threshold is the core of the two valued algorithm. The traditional two valued algorithms include static algorithm and dynamic algorithm. The dynamic algorithm is better than the static algorithm has good effect, the static algorithm produces a lot of pseudo feature points of the image region of poor quality, the dynamic algorithm can compensate for the static algorithm to a certain extent, but it will also introduce more noise. In the aspect of image two values, some new methods have appeared recently, for example, a dynamic threshold image two valued method based...
on direction map. The method directly obtains the dynamic threshold from the gray image of the image, and then the image is two valued. At one time, the process of separation, invalid region, filtering, enhancement and two value reductions in the general image preprocessing are completed.

If a given condition exists, there is a linear transformation between the two image contents, and the registration can be achieved by solving the transform coefficients. This is a reasonable assumption for many problems. Based on this idea, in order to solve the image matching problem based on image translation, rotation and scaling, overall, put forward a kind of image coordinates of linear transform with 6 parameters, the new model, the model matching error is defined as the overall image error parameters are determined by minimizing the error function of incremental iteration, by iterative method to obtain the optimal linear transform parameters. In addition, three strategies and implementation methods are proposed to increase the weight function, the mesh point sampling and the acceleration momentum.

In a word, image recognition is challenging, with only one existing method is difficult to obtain good recognition results, how to improve the recognition rate and recognition speed, reduce the amount of calculation, and how to improve the robustness of the utility are worth studying.

Acknowledgement
2019 Jingmen Guiding Scientific Research Project “Research of Medical Image Encryption on Scrambling and composite segmentation chaotic mapping based on dynamic update”, Number: 2019YDKY078.

References
[1] G. Peyre, S. Bougleux, and L. Cohen. Non-local regularization of inverse problems. In Proceedings of Proc. ECCV 2008, 14, 20, 2008.
[2] Efron, B., Johnstone, I., Hastie, T., and Tibshirani, R.: Least angle regression. Annals of Statistics, 32(2), 407–499, 2004,
[3] A. Buades, B. Coll, and J.M Morel. A review of image denoising algorithms, with a new one.SIAM Multiscale Modeling and Simulation (MMS), 4(2):490--530, 2005.
[4] Daubechies I, Defrise M and De Mol C An iterative thresholding algorithm for linear inverse problems with a sparsity constraint Commun. Pure Appl. Math., 57, 1413–57, 2015.
[5] J. Friedman, T. Hastie, H. Hoe ing, and R. Tibshirani.:Pathwise coordinate optimization. Annals of Applied Statistics, 2(1):302-332, 2014.
[6] G. Gilboa and S. Osher. Nonlocal Linear Image Regularization and Supervised Segmentation.SIAM Multiscale Modeling and Simulation (MMS), 6(2):595--630, 2012.
[7] Candes E J and Tao T 2015 Decoding by linear programming IEEE Trans. Inf. Theory, 51, 4203–15, 2015.
[8] Tibshirani, R.: Regression shrinkage and selection via the LASSO. Journal of the Royal Statistical Society: Series B, Vol. 58, No 1, 267–288, 2016
[9] T. Goldstein and S. Osher. The Split Bregman Method for L1-Regularized Problems. SIAM Journal on Imaging Sciences, 2(2):323--343, 2009.
[10] X. Zhang, M. Burger, X. Bresson, and S. Osher. Bregmanized Nonlocal Regularization for Deconvolution and Sparse Reconstruction. CAM Report, 09-03, 2013.