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A Vehicle Recognition New Approach with the Application of Graph Network Theory

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ABSTRACT

A vehicle recognition approach based on graph theory and neural networks is proposed in this paper. In this approach, image threshold method described in this paper based on spectral theory is used for image pre-processing. And after filter of undetermined regions with rules, regions left are unified. These values are input into neural network to recognize vehicle and vehicle types. The experiment proves that this method has high recognition rate and low false rate.

Keywords: Component, Neural Network, Vehicle Recognition, Graph Theory

1. INTRODUCTION

Along with the rapid development of industries, we have more and more approaches of capturing image. There have been a few of approaches of capturing topographical object information, such as Satellite Image, Remote Sensing Image in high altitude and SAR. Especially in recent years, many scholars and experts have given a lot of research of Vehicle Detection and Recognition from high-resolution images. Xiaoying Jin and Curt H. Davis propose a vector-guided vehicle detection approach from high-resolution Satellite Imagery [1], and Zu Whan Kim and Jitendra Malik propose fast vehicle detection with Probabilistic Feature Grouping [2].

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In domestic researches, Yuyong and Zhenghong, from Wuhan University, proposed vehicle detection from high resolution satellite imagery based on the morphological neural networks [3]. However, those approaches have their deficiencies, such as limiting the scope of the detection and identification of vehicles to the roadway, and morphological neural networks approach has deviations in locating vehicles.

At the same time, the capacity of detailed vehicle object information is low for an integrated image and modeled approaches can't be applied in vehicle detection, for the limitation to low-resolution ratio in Satellite Image, Remote Sensing Image in high altitude at present. For this reason, a new vehicle recognition approach based on graph spectral theory and neural networks is proposed in this paper. At first, undetermined regions are received by image pre-processing of graph spectral deviation. And after filter of undetermined regions with rules, regions left are unified. These values are input into neural network to recognize vehicle and vehicle types. In the experiment, the result shows that the method has high recognition rate and low false rate.

The relationships between artificial neural networks and graph theory are considered in detail. The applications of artificial neural networks to many difficult problems of graph theory, Especially NP-complete problems and the applications of graph theory to artificial neural networks are discussed. For example graph theory is used to study the pattern classification problem on the discrete type feed forward neural networks, and the stability analysis of feedback artificial neural networks etc.

2. IMAGE THRESHOLD VALUE DIVIDATION BASED ON GRAPH SPECTRAL THEORY

In recent years, Graph Spectral Theory has been applied to the domain of Image separation as a new approach. In essence, an image is regarded as a value-attributed graph, which is made up of a series of nodes, corresponding to an image element or a region. The value of a side which having two nodes denotes possibility of belonging to the same region. The value size correlates comparability, neighborhood and continuity of the two nodes. An energy function would be based on every special value separation. The minimal decision function of an energy function represents an optimal grouping of the image. In accordance with the above mentioned, some researchers proposed respective rules of graph spectral deviation, of which the best rules representative are maximal decision rule, minimal decision rule, average decision rule, unified and inverse proposition rule and so on. This paper adopts graph spectral degree as the rule of image threshold value deviation distinguishing objects from background, and introduces a matrix based on gray value replacing general matrixes based on image-element value to describe relations of image-elements.

3. BP NETWORKS

The application of ANN technology in engineering has become more and more popular in China and abroad recently. The back propagation (BP) neural network is the most popular model, which has good model identification and model classification [4]. This paper studies the method to locate the burst point by using a three-layer BP neural network based on experiment.

In graph theory, a threshold graph is a graph that can be constructed from a one-vertex graph by repeated applications of the following two operations:

1. Addition of a single isolated vertex to the graph.
2. Addition of a single dominating vertex to the graph, i.e. a single vertex that is connected to all other vertices.

A three-layer back propagation neural network is a typical multiple-layer network, which includes an input layer, a hidden layer, and an output layer. There are no connections between nodes that belong to the same layer. It supposes that the input layer has *m* nodes that correspond to the *m* inputs of the network, and the output layer consists of *n* nodes that correspond to the *n* output of the network. The node number in the hidden layer can be varied to fit the task. Suppose x_i, z_j, y_k is the input node, the hidden node and the output node separately. The connection value between input node and hidden node is w_{ij}, and the connection value between output node and hidden node is w_{jk}. In the experiment, the sigmoid function **[S(x) =1/1+e^-x^]** is selected as its activated function.

The three-layer back propagation neural networks use the BP learning method to learn knowledge. The BP learning method is a typical error-revised learning method. This method can overcome some shortcomings of traditional methods.

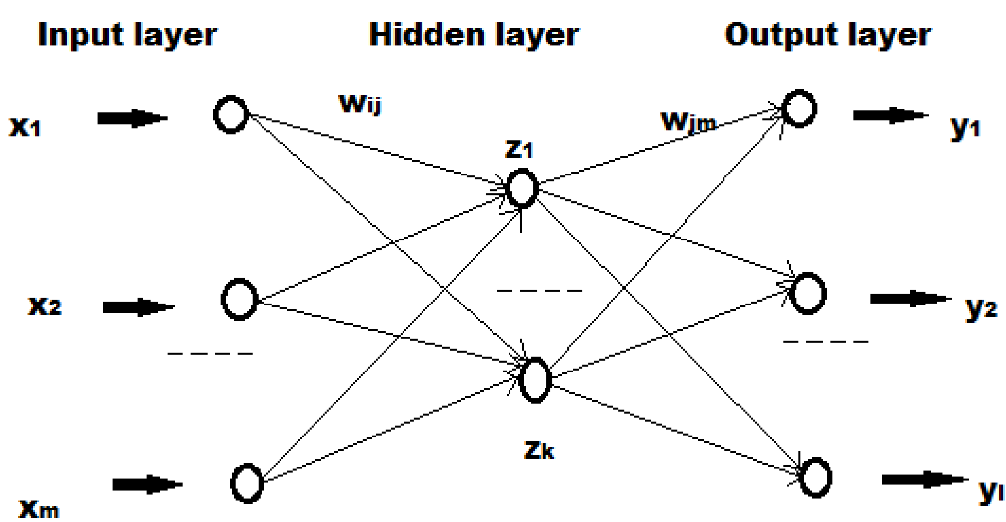

Figure 1. BPNN

4. VEHICLE OBJECT RECOGNITION ARITHMETIC PROCESS

Vehicle recognition identification (VRI) is a technology that employs cameras and surveillance systems to identify vehicles and analyze information. Using an array of input types including image and video, VRI systems can identify data such as vehicle make, model and driver.[1] VRI software has applications in targeted advertising, law enforcement, military, car buying and selling, and toll road invoicing.

VRI is also closely related to other technologies such as license plate recognition (LPR) and automatic number plate recognition (ANPR). However, vehicle recognition is a wider umbrella term: VRI analyzes an entire vehicle instead of seeking out the numbers on a license plate.

This term also encompasses recognition that does not require cameras; some VRI providers use RFID scanners to recognize vehicles at a distance and perform programmed actions automatically, such as lifting car barriers for approaching emergency vehicles.

Final results of this experiment have three classifications, namely tanks, vehicle and non-objects.

Step 1: dividing an image up according to the threshold value.

Step 2: obtaining all possible regions, after seed-supplement arithmetic process of the divided image.

Step 3: eliminating most of the impossible from all possible regions above, using magnitude rule and border length rule. The remained regions are uncertain regions.

Step 4: extracted centers of all uncertain regions, and then unified uncertain regions. In this experiment, taking unified of 25×25 regions.

Step 5: delivered the BP network of all uncertain 25×25 regions to vehicle recognition, which had been already trained.

Step 6: assembling information of regions recognized as vehicle objects to be expediently employed later.

The information of regions recognized as vehicle objects was mainly including of the size, the positions of centers of so-called objects in the image.

5. EXPERIMENT RESULTS

It concludes five groups in the experiment of this arithmetic，here is the experiment results.

Table 1. Original Image Data

Image Name	Tank Number	Vehicle Number
1	11	10
2	3	2
3	7	5
4	5	6

Table 2. BPNN Parameter Setting

	Test 1	Test 2	Test 3	Test 4	Test 5
Output tanks	27	26	27	26	25
Output vehicle	23	23	25	26	25
Judging right tanks	25	26	25	25	22
Judging right vehicle	21	21	23	23	23
Taking tanks as vehicle	1	0	1	1	1
Taking vehicle as tanks	0	0	0	0	0
Taking tanks and vehicle as non-object	2	2	0	0	3
Taking non-object as tanks and vehicle	3	2	3	3	3

Table 3. Experiment results

	Test 1	Test 2	Test3	Test 4	Test 5
Sample number	178	178	178	178	178
Input node number	625	625	625	625	625
Hidden node number	55	58	62	50	70
Learning ratio	0.4	0.4	0.4	0.4	0.4
Momentum parameter	0.2	0.2	0.2	0.2	0.2
Expectation error	0.001	0.001	0.001	0.001	0.001
Repeat time	791	796	753	779	763

The key assumption in the convex optimization formulation is that the capacities of the communication links are concave in the communications resource variables. This assumption is true for many classical wireless channel models, such as the Shannon capacities for Gaussian broadcast channel with TDMA and FDMA; CDMA channels with interference cancellation can be readily converted into a convex formulation. For SRRA problems with interference-limited channels, we gave a concave approximation of the capacity function at relatively high SINRs, and developed a link-removal procedure to further improve the system performance. It is important to notice that we assume fixed technology and find the system parameters that attain the optimal performance within the specified infrastructure. Although the SRRA formulation often gives significant performance improvements over classical approaches, it does not address the information-theoretic question about the ultimate capacity of a wireless network. In addition, this chapter does not directly address some important practical issues in wireless networks, such as quality of service. An extension of the SRRA formulation in this direction seems very attractive and needs further investigation.

Most recently, the SRRA framework has been extended to study joint routing, link scheduling and power allocation in CDMA wireless systems with very low SINRs. The cross-layer joint optimization approach and vertical decomposition method have also appeared in the work on joint optimal design of decentralized control systems and their supporting communication systems

6. CONCLUSIONS

This paper proposes a new vehicle recognition approach based on graph spectral and neural network theory to vehicle recognition of high-resolution satellite image. The experiment result proves that this approach has an excellent capability of vehicle recognition. The further work is including of increasing to training samples, better pre-treatment means (especially fast pre-treatment means), as well as elevating vehicle recognition ratio using other character information.

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