Data transmission pattern recognition method for communication network with terminal band constraint

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Abstract: In view of the problem of large recognition error and low accuracy of traditional pattern recognition methods, a new method of data transmission pattern recognition based on terminal band constraint is proposed. The transmission mode is analyzed, the coupling mechanism mutual inductance model is used to extract the characteristic parameters, and the Spark-KNN fast pattern recognition algorithm is used to realize the communication network data transmission pattern recognition with terminal number band constraints. Design a control experiment, compared with the traditional method analysis, the experimental results confirmed that the proposed method identification is more accurate.

Keywords: communication network; data transmission; pattern recognition; support tree

1 Introduction

A large number of studies have shown that the support tree is the most basic and optimal topological structure of the communication network, the edge on the support tree represents the connection line between the communication devices. Generally, this connection can be represented by the amount of information in communication, but it can also be defined by the communication cost or time. Thus, the optimal communication line connection among the various alternative connections is equivalent to finding the minimum support tree topology of the communication network. Prim algorithm, Kruskal algorithm is an effective algorithm to solve these problems [1].

However, in the actual communication network design, there are often some additional design requirements, because each node represents different communication devices. their role in the network is different. Obviously, it represents the hub, the middle node of the multiplexer, because of the connection with multiple nodes, both the sufficient hardware and software are more complex and much higher equipment cost than the terminal equipment of a single node. Therefore, before the design, the number of terminals is often clearly fixed, the design of the communication network topology can be attributed to the terminal node band

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constraints of the minimum tree problem, is a difficult combination optimization problem. At present, there is no very effective algorithm to solve this problem, although when the problem is proposed, a heuristic algorithm is designed, obviously, it is very meaningful to further study the effective algorithm to talk about the problem. As a new modern heuristic algorithm, genetic algorithm has been widely and successfully applied in many fields of science and technology [2]. This paper will use the new technology of genetic algorithm to realize the pattern recognition of communication network data transmission.

2 Data Transfer Pattern Recognition for Terminal Band Constraint Communication Network

The frequency variation of the communication network data signal cannot be obtained by Fourier transforming the signal directly. This is mainly due to the time domain information of the signal is eliminated after the fourier change maps the signal to the frequency domain. the signal spectrum reaction obtained by the transformation is the statistics of the energy of the signal at different frequencies without the time combination information of the signal. For a disturbance signal, the information of the signal mainly exists in the combination of a certain energy of the signal and its time of occurrence. Therefore, a signal processing method is needed to show the signal frequency and time information in order to facilitate pattern recognition.

2.1 Transport Mode Analysis

Radio energy transmission technologies are classified according to the energy transmission mechanism and can be divided into the following three categories: First, electromagnetic radiation type of wireless power transmission technology. At present, this kind of technology usually uses laser energy transmission technology and microwave energy transmission technology to realize the long-distance transmission of small power. However, because of the strong transmission directionality of the technology, complex tracking and positioning systems are needed during operation, and there can be no obstacles in the transmission path [3]. Obviously, the limitation of the technique is relatively large and the application is small. Second, electromagnetic induction wireless power transmission technology. This technology belongs to the electromagnetic field near-field coupled radio energy transmission technology, based on the law of electromagnetic induction, through the original coil and secondary coil coupling electromagnetic field to achieve radio energy transmission. The electromagnetic induction wireless energy transmission technology can increase the transmission power and improve the transmission efficiency by adding high magnetic conductivity material to the air magnetic circuit. However, the effective transmission distance of this technology is limited, which is usually used in cases where the distance is less than 10cm and the original and secondary coils are relatively fixed, and is generally suitable for charging and supplying power to small portable electronic devices or household appliances, etc. Third, magnetic resonance radio power transmission technology [4]. Magnetic resonance wireless energy transmission technology also belongs to electromagnetic field near field coupled radio energy transmission technology, It adds two resonant coils with high quality factor Q to the electromagnetic induction wireless power transmission technology, through the resonant coils of these two high q values, a higher intensity magnetic field can be generated in space, enabling the efficient transmission of electric energy at a further distance. The technology is characterized by no obvious directionality, the transmission distance is far more than the electromagnetic induction, the theory can achieve thousands of watts of power transmission at medium distance, and can be transmitted through non-metallic materials, the impact on the human body and the surrounding environment is relatively small, more safe and reliable.

The theory of mutual inductance coupling is the basic method for analyzing the electromagnetic field near-field coupled radio energy transmission technology. Its basic principle is magnetic field coupling:

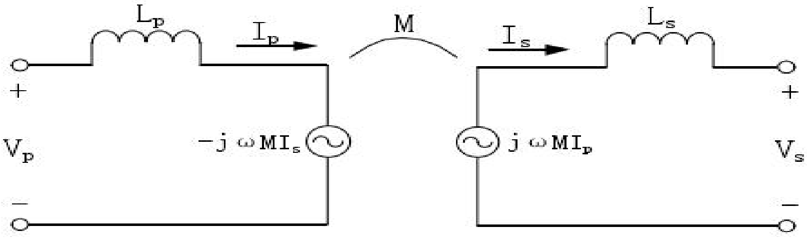


Fig. 1 Coupled mechanism mutual inductance model

where L_p is the primary coil, L_s is the secondary coil, I_p is the current value in the primary coil, I_s is the current value in the secondary coil, and M is the mutual inductance between the primary coil and the secondary coil. When the high frequency AC voltage with the angular frequency ω is connected in the primary coil, the high frequency electromagnetic field will be generated in the space around the coil. Because of the coupling between the primary and secondary coils, assuming that the mutual inductance value is M, when the secondary coil senses the high-frequency electromagnetic field generated by the original stage coil, the high-frequency inductive voltage will be generated [5]. The inductive voltage on the secondary coil is determined by the original stage coil current I_p, equal to

$j\omega MI_p$. At the same time, the primary coil will also produce a high-frequency induction voltage, determined by the secondary coil current I_s , equal to $-j\omega MI_s$. Obviously, the transmission power and efficiency of the coupling mechanism can be improved by increasing the angular frequency of the AC input to the primary coil. However, the impedance of the coil will also become very large with the increase of the angular frequency. in order to reduce the reactive power loss and make the transmission power maximum, the capacitance will generally be added to compensate the coupling mechanism to work in the resonant state [6]. There are two kinds of resonant compensation methods commonly used, namely series compensation resonance and parallel compensation resonance. When the primary coil and the secondary coil adopt series compensation resonance or parallel compensation resonance respectively, they can constitute four basic coupling topologies: SS, SP, PS and PP, as shown below:

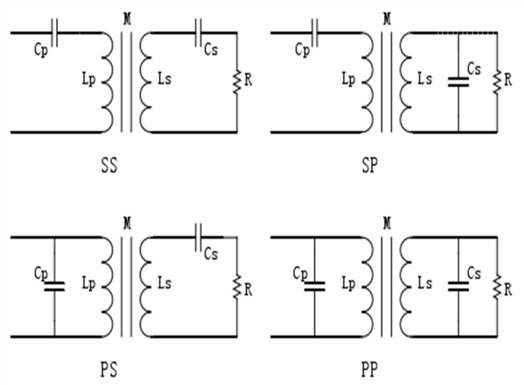
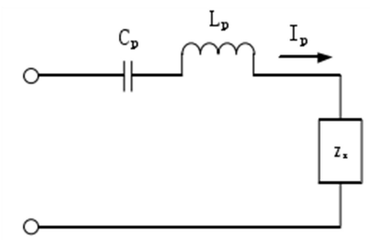


Fig. 2 Basic Topology

The equivalent impedance of the secondary coil acting on the primary coil, as we call it, is usually expressed in Z_r :



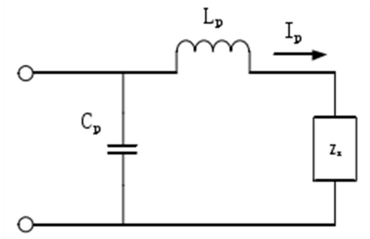


Fig.3 Schematic diagram of the original stage circuit with reflected impedance

Z_r is determined by the angular frequency ω of the AC voltage in the primary coil and the mutual inductance M between the primary coil and the secondary coil:

$$Z_r = \frac{\omega^2 M^2}{Z_s} \quad (1)$$

Z_s is the equivalent impedance of the secondary coil, which can be calculated according to formula (2):

$$Z_s = \begin{cases} j\omega L_s + \dfrac{1}{j\omega C_s} + R \\ j\omega L_s + \dfrac{1}{j\omega C_s + 1/R} \end{cases} \quad (2)$$

The real part of the reflected impedance reflects the active power transferred from the original stage coil to the secondary coil, and the imaginary part reflects the reactive power transferred from the original stage coil to the secondary coil.

2.2 Feature parameter extraction

Feature extraction needs to select the appropriate network as the feature extraction network of the algorithm according to the actual needs. A feature extraction network common in Faster R-CNN algorithm is ZF-NET, whose network structure is shown in the following figure:

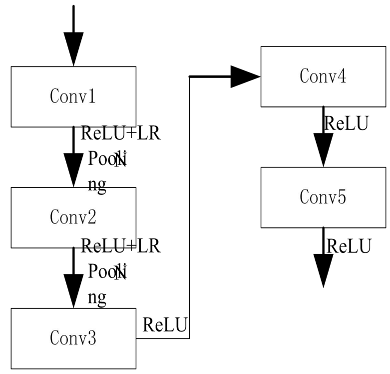


Fig. 4 ZF-NET Network Structure

Conv1 to conv5 in figure 4 represents the convolutional layer, relu represents the activation layer, lrn represents the local corresponding normalization layer, and pooling represents the pooling layer.

Artificial neural network is one of the main research contents of pattern recognition processing. The artificial neural network based pattern recognition method has obvious advantages over the traditional pattern recognition method, which is embodied in the following aspects: (1) It has strong fault tolerance and anti-interference ability and is not easily affected by noise input; (2) Adaptive learning ability, can achieve automatic adjustment to approximate the objective function; (3) The process of pre-processing and identification can be carried out simultaneously; (4) Adopting a parallel mode of operation; (5) Using distributed memory for information, information is not easy to lose and robust [7]. Typical neuronal models are shown in the figure:

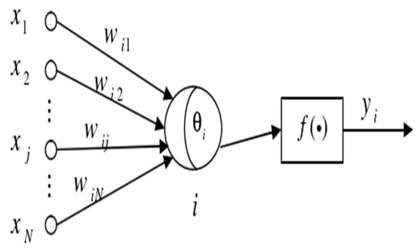


Fig.5 Artificial neuron model

$x_j \left(j = 1, 2, ..., N \right)$ is the input signal of the neuron. w_{ij} is the connection weight.

The activation function is used to perform the transformation between network input and output in a variety of forms, the most common of which are threshold function, piecewise linear function and sigmoid function. The threshold function is also called a step function, as shown in the following figure:

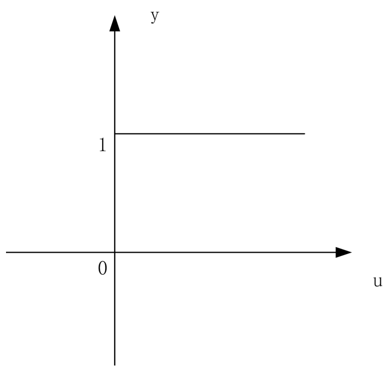


Fig.6 Step function

The symbolic functions shown below are also often used as neuronal excitation functions:

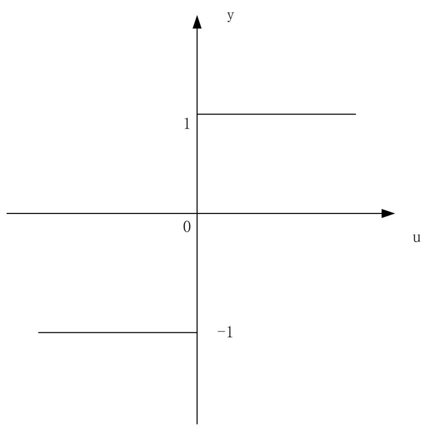


Fig.7 Neural excitation function

Feature parameter extraction is the process of extracting data that can reflect pattern features from input signals. Different patterns contain their own inherent characteristics, which are intrinsic factors and prerequisites for distinguishing different patterns [8]. The square difference of each time period is connected to the square difference curve of the whole disturbed time period, and the square difference of each time period represents the degree of data fluctuation in the time period. The variance curves of backward Rayleigh scattering caused by different disturbance modes are different, so the characteristic curves obtained by squared difference processing are as follows:

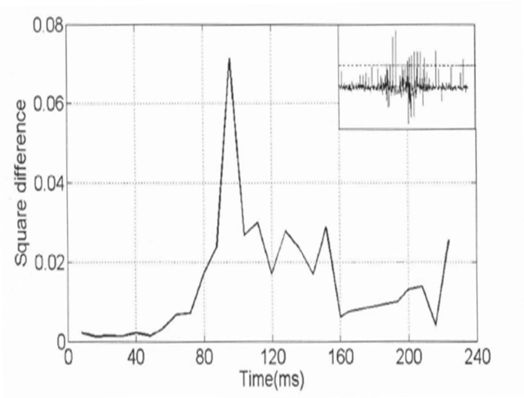


Fig.8 The characteristic curves obtained by the square difference processing

As shown above, external disturbance signals affect the phase of the sensing signal, zero crossing rate is a basic method to extract the signal frequency-time, reflecting the frequency of the signal vibration near the zero level per unit time. the main advantage is that the operation is relatively simple and can suppress the subtle frequency change of the signal, so the short-term average frequency of the signal can be extracted to achieve the purpose of analyzing the external disturbance signal [9]. Over-level rate refers to the number of times a signal passes through a certain level when it changes near the level. It is a basic method of extracting the frequency-time of the signal, reflecting the frequency of the disturbance of the signal at a certain level per unit time.

$$L_{CR} = \frac{\sum_{n=0}^{N-1} \partial\left(I\left(n\right) \geq \beta\right)}{N} \qquad (3)$$

Where $I\left(n\right)$ is the amplitude of the input signal point, β is the set level threshold, ∂ is the indicator function, and the value is 1 when the condition in parentheses holds, otherwise 0. The short-time over-level rate will change with the change of the short-time average frequency and the short-time phase fluctuation of the sensor output signal. Therefore, the characteristic information of the disturbance signal can be understood by analyzing the short-time over-level rate of the signal.

2.3 Spark-KNN Fast Pattern Recognition Algorithm

The basic idea of the KNN algorithm is that if most of the K most similar samples of a sample in the feature space belong to a certain category, then that sample also belongs to that category. Since the KNN method mainly relies on the surrounding limited adjacent samples, rather than the discriminant domain method, therefore, the knn method is more suitable than other methods for the pending sample sets with more crossover or overlap of the class domains. The establishment process of the pattern is as follows: establish and maintain a priority queue of size K by distance from large to small for storing nearest neighbor training samples [10]. The missing samples were randomly selected from the training samples as the initial nearest neighbor samples. the distance from the test samples to this k samples was calculated separately, and the training sample labels and distances were stored in the priority queue. Traversing the training sample set, calculating the distance between the current training sample and the test sample, comparing the resulting distance L with the maximum distance $L_{\max}$ in the priority queue. If $L \geq L_{\max}$ discards the sample and traverses the next sample. If $L < L_{\max}$, remove the sample with the maximum distance in the priority queue and store the current training sample in the priority queue until the traversal is complete. After the priority queue is updated and determined, the majority class of K samples in the priority queue is calculated and taken as the category of the test sample to complete the pattern recognition process.

3 Simulation experiment

In order to verify the validity of the communication network data transmission pattern recognition method, use traditional method 1 and traditional method 2 to compare with this method, a control experiment is proposed to obtain the test results.

3.1Preparation process

Because the experiment needs to process a lot of data information, the requirements of the experimental platform are high, so the T330 model data processor is selected to complete the experiment. The specific parameters are as follows:

Table 1 Data processor specific parameters

Name	Specific parameters
Model	T330
structure	Tower type
category	Scalable single tower server
Number of internal hard disks	8
Disk array card	S130、H330、H730、

	H730P
CD drive	DVDRW
Hard disk type	SAS；SATA；SSD
Memory type	ECC
Maximum memory capacity	Maximum 64 GB
processor	Intel Xeon processors
CPU type	E3-1200 v6
CPU frequency (MHz)	3.0GHz
Mainboard expansion slot	4 PCIe interfaces
Applicable working temperature	25℃
FSB	Four thread
Embedded network controller	Broadcom 5720 dual port Gigabit
System support	Windows Server2008/2012

In order to ensure the validity of the experiment process, the advantages and disadvantages of traditional method 1 and traditional method 2 and the design method are analyzed in the form of comparative experiments. A test environment that needs to be designed to match the test method. A good test environment is beneficial to the implementation of the test method, and makes the test results more accurate and more efficient. The experiment uses socket to simulate the communication network data transmission process, which can be regarded as one of the endpoints in the communication connection when two network applications communicate. When communicating, one of the network applications writes a piece of information to be transmitted to the socket of its host, which sends this piece of information to the socket of another host via the transmission medium of the network interface card, enabling it to be transmitted to other programs. In network application design, because the core content of TCP/IP is encapsulated in the operating system, if the application is to use TCP/IP, it can be implemented through the programming interface of TCP/IP provided by the system. In the Windows environment, the network application programming interface is called Windows socket. To support users in developing application-oriented communication programs, most systems provide a set of application programming interfaces based on TCP or UDP, often in the form of a set of functions, also called sockets. The details are as follows:

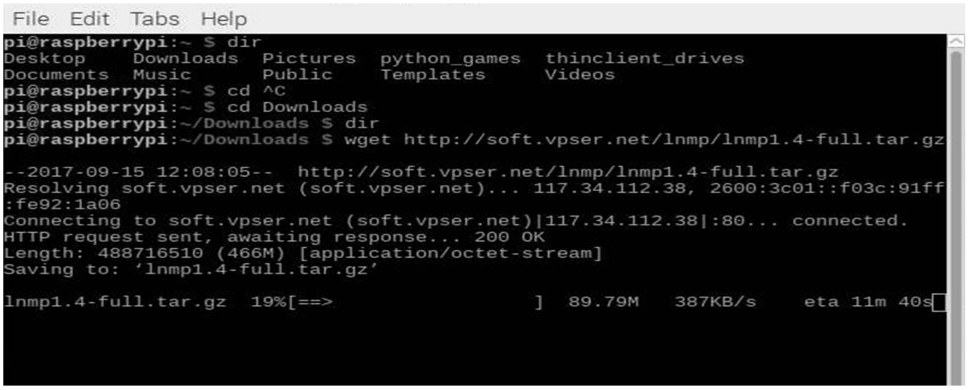


Fig. 9 Operation process

After the above preparation is completed, the experiment is carried out to draw the conclusion.

3.2Interpretation of result

Specific control results are shown below:

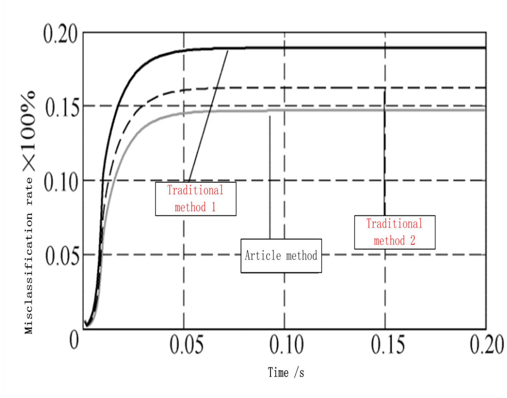


Fig.10 Experimental results

According to Fig. 10, when the time passes 0.2s, the error classification rate using traditional method 1 is 19%, the error classification rate using traditional method 2 is 16%, and the error classification rate using this method is 14.8%. It can be seen that the error classification rate using this method is the lowest, and its data transmission pattern recognition error is low.

The following table is available:

Table 2 Experimental results

fau	traini	Test	Accuracy rate%

lt type	ng sample	samples	Traditional method 1	Traditional method 2	Article method
Z	25	25	84.00	84.00	92.00
N	25	27	81.48	85.19	85.19
X	25	49	83.67	87.76	89.80
Y	25	57	82.46	84.21	87.72

From the above results, the average accuracy rate using traditional method 1 is 82.9%, the average accuracy rate using traditional method 2 is 85.3%, and the average accuracy rate using this method is 88.7%. From this, the accuracy of the proposed pattern recognition method is obviously higher than that of the other two traditional methods.

4 Conclusion

In order to solve the problems of large error and low precision in data transmission pattern recognition of communication network, this paper proposes a method of data transmission pattern recognition based on the number of terminals with constraints. Using the mutual inductance model of the coupling mechanism to extract the characteristic parameters, and using Spark-KNN fast pattern recognition calculation, the data transmission pattern recognition of the communication network with constraints on the number of terminals is realized. The recognition method has high precision and small error, and can provide new ideas for research in related fields.

Reference

[1] LIU Yunxiang, ZHANG Wei. LEACH protocol improvement of wireless communication network for mine [J]. Modern Electronics Technique, 2017,40 (09): 66-69

[2] WANG Liang, FANG Liang, CHI Yaqing, et al. A cross-clock-domain data transmission method based on indicator signals [J].

Computer Engineering and Science, 2017,39 (12): 2192-2197

[3] JIN Huiying, MA Gang, SU Yong. Approach to high performance data transmission control of RTU on narrowband asymmetric channel [J]. Electronic Measurement Technology, 2017,40 (11): 170-174

[4] PENG Xin, DENG Qingyong, TIAN Shujuan, et al. Data dissemination scheduling algorithm for V2R/V2V in multi-channel VANET [J]. Journal on Communications, 2019,40 (03): 92-101

[5] ZHANG Siyi, ZHOU Ming. Researches on DNA-based parity generator/checker for error detection during data transmission [J]. Journal of Molecular Science, 2019,35 (02): 175-176

[6] LIN Weijie. Optimization of big data transmission technology based on baud-spaced spread spectrum

[J]. Information Technology, 2019,43 (04): 73-76 + 81
[7] RUAN Fu, WAN Bao. Simulation of Network Data Transmission to Prevent Attack Security Assessment [J]. Computer Simulation, 2018,35 (07): 351-354 + 413
[8] TANG Zhiguo, TANG Mingze, LI Jinzhong, et al. Discussion on the Resemblance of Different Partial Discharges and Accuracy of PD Pattern Recognition of GIS Equipment [J]. High Voltage Engineering, 2018,44 (08): 2479-2485
[9] TIAN Hao, ZHAO Xiaohu, ZHANG Kai, et al. Design of data transmission system in coal mine underground based on 6LowPAN [J]. Industry and Mine Automation, 2019,45 (08): 6-12
[10] YAN Ping. Real-time PCM Telemetry Transmission System Based on FPGA [J]. Microcontrollers & Embedded Systems, 2018,18 (01): 38-40