



Online Teaching Method of Conductive Characteristics of Graphene Materials Based on Big Data Mining

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Abstract. In view of the low effectiveness of traditional online teaching method based on principal component analysis and multilayer perceptron neural network, an online teaching method based on big data mining is proposed. Firstly, the conductive characteristics of graphene materials are extracted, and on this basis, the big data mining technology is used to construct the charge accumulation teaching model, and the online teaching of charge accumulation characteristics is completed through the teaching model. The experimental results show that the proposed method can effectively complete the online teaching of graphene material conductivity characteristics, and has high effectiveness.

Keywords: Big data mining · Graphene conductive materials · Conductive characteristics · Online teaching

1 Introduction

With the rapid development of information technology, people increasingly rely on computer technology to solve problems [1]. People's ability to produce, collect, store, and process information and data is constantly increasing. People's current data operations can no longer meet their needs. They hope to dig out valuable information from the current large amount of data. The same is true for the education industry [2]. The current online teaching database system can not meet this demand. On this basis, data mining emerges as the times require. As a new information processing technology, the process of extracting, transforming, analyzing and other modeling processing of a large number of data in the database is its main feature [3]. At the same time, data mining in multiple fields can extract the data that is very important for project decision-making. The essence of data mining is to carry out algorithm operation from a large number of noisy, uncertain and fuzzy real business data, and finally discover the data knowledge that has not been recognized or can not be clearly recognized and has a certain practical meaning.

The form of data analysis results obtained by data mining is not conventional. The form of results can be mathematical expressions with strong logic, or visual display results that can be easily understood by ordinary users. The application fields of data

mining are also very extensive, especially in the fields of market analysis, scientific research, social research and so on. In the process of development, data mining has been applied more and more in many fields, which also shows the importance of data mining technology. The current popular clustering ensemble learning algorithm has defects, that is, it can not give the appropriate processing scheme according to the different characteristics of different data sets. The traditional ensemble learning algorithm has the defect that it can not classify according to the characteristics of data. Traditional online teaching methods, such as principal component analysis and multi-layer perceptron neural network, are inefficient.

Aiming at the problems of these algorithms, a novel online teaching method based on big data mining for conductive characteristics of graphene materials is proposed:

- (1) The conductive characteristics of graphene materials are extracted, and the charge accumulation teaching model is constructed by using big data mining technology.
- (2) Based on the charge accumulation teaching model, the online teaching of charge accumulation characteristics of graphene conductive materials was completed.
- (3) Experimental verification.

2 Extraction of Conductive Characteristics of Graphene Materials

Traditional online teaching methods of conductive characteristics of graphene materials, such as principal component analysis and multilayer perceptron neural network, are inefficient and easy to fall into local optimal solution. The online teaching method of conductive characteristics of graphene materials based on big data mining has better teaching effect, has important theoretical and practical value, and has broad development prospects.

The goal of conducting feature mining of graphene materials is to maximize the distance between different classes and minimize the within class distance. The mining process is divided into two stages: the first stage maximizes the distance between different classes; the second stage minimizes the intra class distance while ensuring the low space and time complexity of the algorithm

$$\begin{aligned} S_b &= H_b H_b^t S_w = H_w H_w^t S_t = H_t H_t^t \\ H_t &= A - m e^t \in R^{d \times n} \end{aligned} \tag{1}$$

In formula (1), S_b is the inter class matrix, S_w is the intra class matrix, and S_t is the overall dispersion matrix. m is the global mean, d is the d -dimensional vector space; A is the data matrix, and each a is a d -dimensional data space.

$$e^i = (1, \dots, 1)^t \in R^{n \times 1}; \cdot e = (1, \dots, 1)^t \in R^{n \times 1} \tag{2}$$

In formula (2), n is the number of rows in the matrix, l is a column value, and t is a constant.

$$H_b = \left[\sqrt{N_1}(m_1 - m), \dots, \sqrt{N_c}(m_c - m) \right] \in R^{d \times c} \tag{3}$$

In formula (3), N is the column of the matrix.

$$H_w = A - [m_1 e_1^t, \dots, m_c e_c^t] \in R^{d \times n} \quad (4)$$

The goal of this algorithm is to solve the following optimization problems:

$$G = \arg \max_{G'G=1} \text{trace}(G', S_b, G) \quad (5)$$

The objective of optimization problem (5) is to maximize the distance between classes. The solution of (5) can be obtained by solving the eigenvalues of S_b or by QR decomposition of the central matrix C . the specific calculation process is to make $C = QR$, that is, to solve C by QR , where $Q \in R^{n \times c}$ and each column is orthogonal. If $Q \in R^{n \times c}$ is an upper triangular matrix, then $G = QV$, V is an arbitrary orthogonal matrix. Among them:

$$C = [m_1, m_2, \dots, m_c] \quad (6)$$

In formula (6), C represents the center ID. By determining the center ID, the conductive characteristics of graphene can be extracted.

3 Online Teaching Model of Conductive Characteristics Based on Big Data Mining

According to the conductive characteristics of the graphene material extracted above, an online teaching model is constructed. Data mining is a process of extracting potentially useful information and knowledge from a large amount of, incomplete, noisy, fuzzy, and random data that are hidden in it, people do not know in advance, but are potentially useful [4, 5]. To define data mining from the perspective of the database, data mining technology is the process of sorting and categorizing a large amount of data in the database to create hidden valuable information. The overall process of data mining is shown in Fig. 1.

The common data mining technology is fuzzy set method, that is to use fuzzy set theory to carry out fuzzy evaluation, fuzzy decision-making, fuzzy pattern recognition and fuzzy clustering analysis on practical problems [6]. The higher the complexity of the system, the stronger the fuzziness. Generally, fuzzy set theory uses the degree of membership to describe the fuzzy things and the other [7]. In the case of given sample variables, it directly obtains the deprived index according to the membership function defined for each variable, and uses the obtained value to reflect the relative degree of individual deprivation, instead of using the values of upper and lower limits to determine whether an individual meets the criteria [8]. Therefore, the method is not only completely fuzzy, but also relative.

A set A on the domain of fuzzy set U makes elements in u not absolutely belong to set A , that is to say, there are elements belonging to or not belonging to set A in different degrees. This set A is called fuzzy set. The establishment method of fuzzy membership function is fuzzy statistical method. The membership function is determined by experimental statistical method [9, 10]. Suppose the universe U , $u \in U$, how to

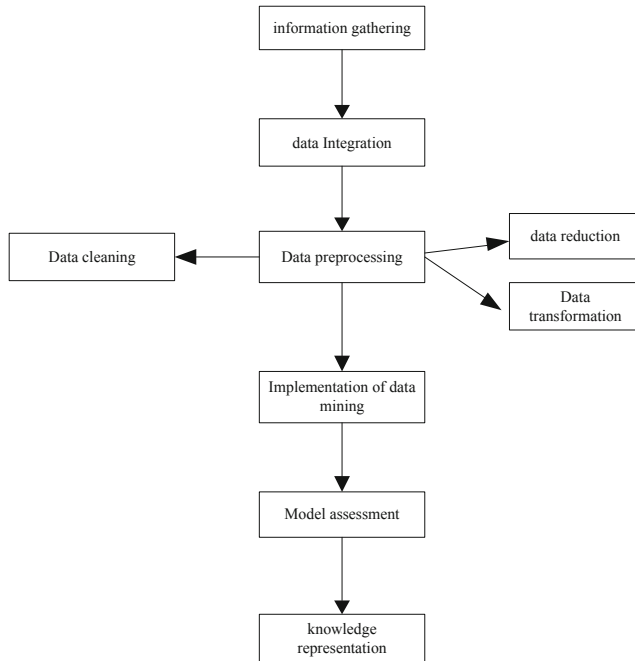


Fig. 1. Overall process of data mining

determine the membership degree of u to set A is as follows: there are n The electric field strength experimental results, in which m times $u \in A$, m/n is the membership frequency of u to A . With the increase of n , the membership frequency will be stable, and the number of this stability is the membership degree of u to A [11–13]. The flow chart of fuzzy set induction is shown in Fig. 2.

The conductive characteristic is a time-varying process, and the change rate of the characteristic decreases with time. The surface charge accumulation of insulator is a dynamic process, which gradually reaches saturation state with the increase of pressurization time. First of all, the effect of surface charge accumulation on insulator surface is investigated when the effect of surface charge accumulation on insulator is investigated. The main sources of surface charge are: insulator body conduction, gas side space charge accumulation and insulator surface conduction. For a long time, on-line teaching staff of conductive characteristics usually teach based on macroscopic insulator body conductivity, gas conductivity and insulator surface conductivity. In fact, the accumulation of space charge on the gas side is carried out through the micro mechanism of the generation, recombination, migration and diffusion of space ions. The gas conductivity is only the overall performance of the above micro mechanism. The micro mechanism instead of the macro gas conductivity can recognize the conductive characteristics in essence.

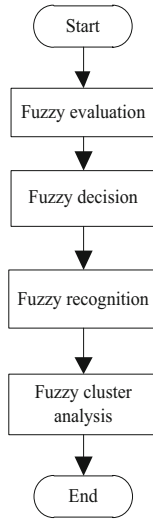


Fig. 2. Fuzzy set induction process

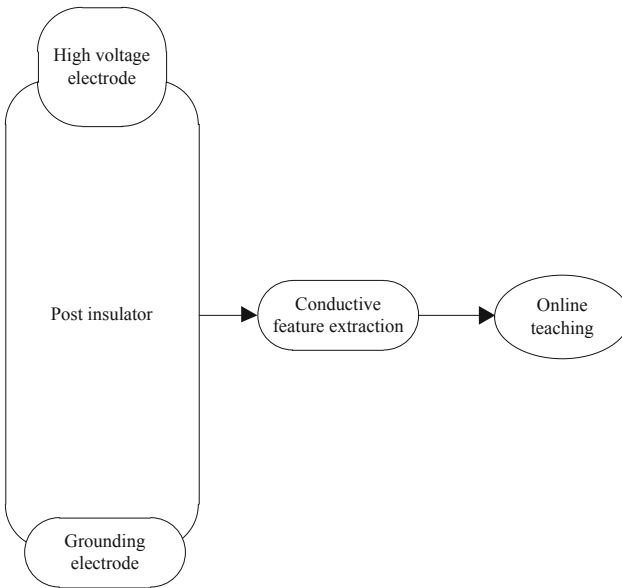


Fig. 3. Online teaching model

In order to realize the online teaching of conductive characteristics of graphene materials, the online teaching model of conductive characteristics was established. The main effects of conductive particles on the surface charge of insulator are attached to the surface of insulator and suspended near the insulator. For the conductive particles attached to the insulator surface, the research shows that the conductive particles always locate on the flashover path along the insulator surface. In order to realize the online

teaching of conductive characteristics of graphene materials, the online teaching model of conductive characteristics was established. The main effects of conductive particles on the surface charge of insulator are attached to the surface of insulator and suspended near the insulator. For the conductive particles attached to the insulator surface, the research shows that the conductive particles always locate on the flashover path along the insulator surface Fig. 3.

The online teaching model can effectively realize the online teaching of conductive characteristics of graphene materials.

4 Experiment

4.1 Experimental Background

In order to verify the effectiveness of the proposed teaching methods, comparative verification is carried out. The experiment verified the accuracy and efficiency of charge accumulation feature extraction of online teaching method based on big data mining. It is carried out under the electric field intensity of +800 kV and -800 kV respectively.

4.2 Comparison of Feature Extraction Accuracy

(1) The electric field intensity is +800 kV.

At +800 kV, the experimental results of the proposed method and the actual graphene materials are shown in Fig. 4.

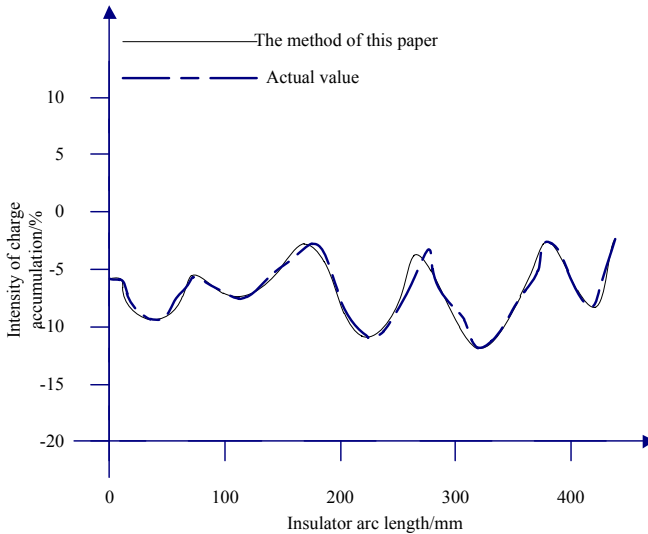


Fig. 4. Figure of experimental results under +800 kV environment

Under the electric field intensity of +800 kV, the extraction accuracy of conductive characteristics of graphene materials by the proposed method is basically consistent

with the actual extraction value. Therefore, it fully shows that the proposed method can extract the conductive characteristics of graphene materials with high accuracy.

(2) The electric field strength is -800 kV.

Similarly, when the applied voltage is -800 kV, the experimental diagram of the extraction results and actual values of graphene material conductivity characteristics of the proposed method is shown in Fig. 5.

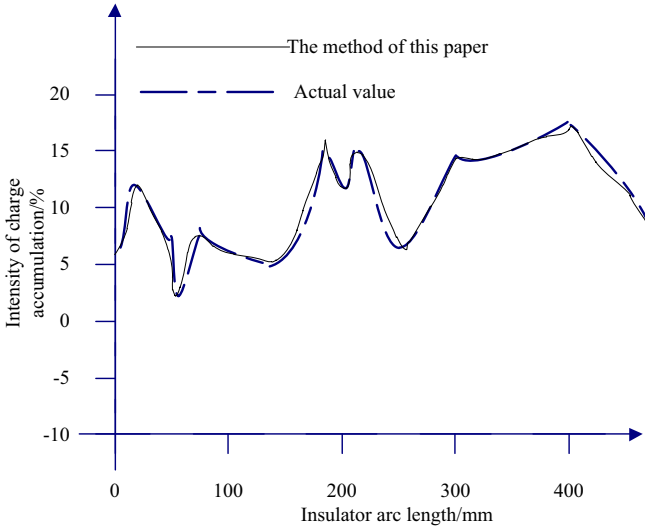


Fig. 5. Figure of experimental results under -800 kV environment

At -800 kV electric field intensity, the proposed method can still obtain more accurate results of graphene conductive feature extraction.

Under the two electric field intensities, the feature extraction accuracy of the proposed method is consistent with the actual value, which fully demonstrates that the proposed method has high feature extraction effectiveness.

4.3 Comparison of Teaching Efficiency

Based on the above contents, taking online teaching efficiency as the experimental comparison index, the traditional principal component analysis, multilayer perceptron neural network feature extraction method and online teaching method based on big data mining extraction method are compared and analyzed respectively. The results are shown in Table 1.

Table 1. Comparison results of teaching efficiency of three methods

Time/min	Teaching efficiency /%		
	Principal component analysis	Multilayer perceptron neural network	Based on big data mining
10	42	78	95
20	41	70	90
30	58	65	91
40	50	69	95
50	49	62	90

It can be seen from Table 1 that the online teaching efficiency of kernel principal component analysis method is always lower than 60%, while that of multilayer perceptron neural network method is between 60% and 80%. Using the online teaching method based on big data mining, the teaching efficiency is higher than 90%, which has higher teaching efficiency.

5 Conclusion

In order to solve the problem of low teaching efficiency in traditional online teaching method of graphene material conductive characteristics, an online teaching method based on big data mining is proposed. The performance of the method is verified from both theoretical and experimental aspects. The method has high extraction accuracy and teaching efficiency in online teaching of conductive characteristics of graphene materials. Therefore, the proposed online teaching method is highly effective.

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