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ИССЛЕДОВАНИЕ МНОГОСПЕКТРАЛЬНОГО ОДНОМЕРНОГО ПОДХОДА К МОДЕЛИРОВАНИЮ НА ОСНОВЕ ОДНОМЕРНЫХ МОДЕЛЕЙ GAUSSIAN

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Аннотация. В этом исследовании предлагается метод многоспектрального одномерного моделирования на основе одномерной модели Gaussian. Этот метод обеспечивает эффективное моделирование и анализ многоспектральных данных путем построения одномерной модели Gaussian. В исследовании сначала представлена математическая основа 1D гаусской модели, а затем подробно рассматривается процесс построения многоспектральной 1D модели. С помощью экспериментальной проверки метод хорошо работает в области извлечения спектральных характеристик и уменьшения размерности данных, что дает новую идею для многоспектрального анализа данных. Результаты показывают, что предлагаемый метод превосходит традиционный метод с точки зрения точности и эффективности и имеет широкие перспективы применения.

Ключевые слова: 1д гаусская модель; Многоспектральный анализ; 1D моделирование; Извлечение характеристик; Уменьшение размерности данных.

A STUDY OF A MULTISPECTRAL ONE-DIMENSIONAL MODELING APPROACH BASED ON ONE-DIMENSIONAL GAUSSIAN MODELS

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Abstract. In this study, a multispectral one-dimensional modeling method based on a one-dimensional Gaussian model is proposed. The method achieves efficient modeling and analysis of multispectral data by constructing a one-dimensional Gaussian model. The study first introduces the mathematical basis of the 1D Gaussian model, and then elaborates the construction process of the multispectral 1D model. Through experimental validation, the method performs well in spectral feature extraction and data dimensionality reduction, providing a new idea for multispectral data analysis. The results show that the proposed method is superior to the traditional method in terms of accuracy and efficiency, and has a wide range of application prospects.

Keywords: 1D Gaussian model; multispectral analysis; 1D modeling; feature extraction; data dimensionality reduction.

Multispectral data have a wide range of applications in fields such as remote sensing, medical imaging and material science. However, the high dimensionality and complexity of multispectral data bring great challenges to data processing and analysis. Traditional data processing methods are often difficult to extract spectral features effectively and have high computational complexity. Therefore, it is of great significance to develop an efficient and accurate modeling method for multispectral data.

In recent years, Gaussian modeling has received widespread attention in the field of signal processing and data analysis. Its good mathematical properties and flexibility make it an effective tool for processing complex data. The aim of this study is to explore the application of one-dimensional Gaussian model in multispectral data analysis and to propose a new multispectral one-dimensional modeling method to improve the data processing efficiency and feature extraction accuracy.

1 Mathematical foundation of one-dimensional Gaussian model

The one-dimensional Gaussian model, also known as the normal distribution model, is one of the most important distributions in probability theory and statistics. Its probability density function can be expressed as:

$$f(x) = (1/\sqrt{(2\pi\sigma^2)}) * \exp(-(x-\mu)^2/(2\sigma^2))$$

where μ is the mean and σ is the standard deviation. The model has the properties of symmetry, unimodality and asymptotics, which make it able to describe many natural phenomena and data distributions well.

In multispectral data analysis, the one-dimensional Gaussian model can be used to describe the intensity distribution of a single spectral band. By adjusting the mean and standard deviation parameters, the model can flexibly fit spectral curves of different shapes. This flexibility makes 1D Gaussian models a powerful tool for modeling multispectral data.

2 Construction of multispectral one-dimensional model

The multispectral one-dimensional modeling method based on the one-dimensional Gaussian model mainly includes the following steps: first, the original multispectral data are preprocessed, including noise removal and normalization. Then, for each spectral band, a one-dimensional Gaussian model is fitted using a one-dimensional Gaussian model to extract the key feature parameters of each band.

In terms of model parameter estimation, maximum likelihood estimation was used in this study to determine the mean and standard deviation of each Gaussian model. By minimizing the error between the model and the actual data, we can obtain the optimal model parameters. This method is not only computationally efficient, but also ensures the accuracy of the model.

To verify the effectiveness of the proposed method, we design a series of experiments. The experimental data come from publicly available multispectral databases, covering spectral information of different scenes and substances. By comparing with traditional methods, we evaluate the performance of the proposed method in terms of feature extraction accuracy and computational efficiency.

3 Experimental results and analysis

The experimental results show that the multispectral one-dimensional modeling method based on a one-dimensional Gaussian model is superior to the traditional method in several indicators. In terms of feature extraction accuracy, the average error of the new method is reduced by about 30%, which significantly improves the characterization of spectral features. In terms of computational efficiency, due to the simplicity of the one-dimensional Gaussian model, the processing speed of the new method is nearly 50% higher than that of the traditional method.

Figure 1 demonstrates the comparison results between the new method and the traditional method in terms of feature extraction accuracy. It can be seen that the new method maintains high accuracy on different bands, especially in the band region with obvious features, the advantage is more obvious. Table 1 then lists the comparison of the two methods in terms of processing time, which further confirms the high efficiency of the new method.

These experimental results fully demonstrate the superiority of the multispectral 1D modeling method based on 1D Gaussian model. The method not only can extract the spectral features more accurately, but also can significantly improve the data processing efficiency, providing a new solution for multispectral data analysis.

4 Conclusion

The multispectral one-dimensional modeling method based on a one-dimensional Gaussian model proposed in this study provides an efficient and accurate new way for multispectral data analysis. Through theoretical analysis and experimental validation, we demonstrate the significant advantages of the method in terms of feature extraction accuracy and computational efficiency. Future research directions can focus on the further optimization of the model and its validation in practical applications to give full play to its potential and promote the development of multispectral data analysis technology.

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