Researches for spectrum databases of typical ground objects based on information resources

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Abstract: Information resources is attracting dramatically increased research interests in recent years, it can demonstrate the characteristic features of objects in our world. In this paper, we designed spectrum database system, which includes the functions of the system, the strategies of data storage and the structure of the system for various ground objects. As an experiment, our system has successfully loaded all rock and vegetation spectrum data publicly provided by USGS, JPL and ASTER. Furthermore, the system also implements the visualization for all these data and feature extracting based on information resources.

Key words: information resources; spectrum databases; ground object spectrum

1 Introduction

The ground object information resource include collecting and sorting of ground object data, establishing ground object database and implementing data management function, realizing the spectral data visualization, realizing geophysics electromagnetic source feature extraction technology and algorithm, realizing stored content retrieval algorithm.

In this paper, we introduce the design and implementation of spectrum database system for typical ground object, such as vegetation and rock. The main issues are data storage and management, the database design for the system, spectrum visualization, feature extraction and spectrum matching problem and so on.

The paper is organized as follows: in section two, we introduce the backgrounds for the system; in section three, we propose the new function of the system and the implement technology; in section four, we give the structure design and the spectrum data storage strategies for the system, implement this system; in section five, we make a conclusion.

2 Backgrounds

The established spectrum database systems don not consider the environment influence of spectral, and they don not implement the function of spectrum visualization, feature extraction and spectrum matching either, while our spectra database takes environment elements into consideration. Beside these, we realize the spectral data visualization, feature extraction and spectrum matching, these all exhibit the comprehensive characteristics of the ground object information resource.

USGS spectrum database has included 498 spectrum data and contain 423 rocks data, 17 vegetation data. JPL spectrum database has 160 spectrum data about different kind of rock. ASTER spectrum database embraces 2000 spectrum data[1]

3 Functions of the system

3.1 function introduction

We have designed the new function of the spectrum database system; it is constituted by the module of management and analysis.

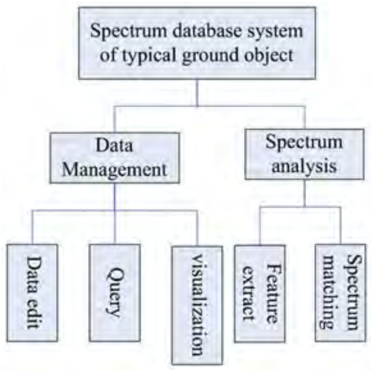

Figure 1: the function of spectrum database systems

From this figure, the function of the management module may include the data compiling, data querying and spectrum visualization.

(1) Data compiling means adding, modifying, deleting, saving the spectrum data, while the input and the amendment of parameters all adopt the mode of screening, all of the parameters have been showed in pop-up windows.

(2) The querying of the system primarily refers to the querying of attributes. The querying of attributes may have many ways, we not only can choose any of measure date, measure place, the measure instrument etc to query, but also can use the keyboard to input attributes data, and the system may accomplish our querying according to requirement.

(3) The visualization of spectrum curve means that if we input some unfamiliar spectrum data, this function can show the curve of spectrum on the screen, which has reflected the obvious characters of spectrum and has provided the foundation for extracting the absorption features.[3]

The function of the spectrum analysis module may contain the spectrum absorption feature extraction and the mode database of spectrum matching.

(1) The absorption features of vegetation has 13 parameters, while the absorption features of rock has 5 parameters, the methods used for absorption features extracting may contain derivative spectrum, hereditary algorithm, it is the first step of the spectrum matching. We extract the absorption features of unknown spectrum at first, and match these features with the standard features stored in the feature database next, the more features we have matched successfully, the more similarity these ground objects may have.[4]

(2) The mode database of spectrum matching mainly store some typical matching modes such as spectral angle matching （SAM）, spectrum similarity （SCF）, spectrum information degree （SID）, we can use them to calculate the reflectivity of unknown spectrum, and through comparing these results we can classify these ground objects and decide whether they are the same material or not.

3.2 The implement of technology

The derivative spectrum can be used for extracting these absorption features; the formula of derivative spectrum is as the following[2]

$$d'(x_i) = [x_{(i+1)} - x_{(i-1)}]/2\Delta x \qquad (1)$$

$$d''(x_i) = [d'_{(i+1)} - d'_{(i-1)}]/2\Delta x \qquad (2)$$

The mode of SAM, SCF, SID can be used for spectrum matching, the formula of Spectral Angle matching（SAM）:

$$\cos\alpha = \frac{A\cdot B}{|A|\cdot|B|} = \frac{\sum_{i=1}^{N} A_i B_i}{\sqrt{\sum_{i=1}^{N} A_i A_i}\sqrt{\sum_{i=1}^{N} B_i B_i}} \qquad (3)$$

N means quantity of wavelengths, A= (A1, A2... An), B = (B1, B2...Bn). Ai, Bi means the reflectivity of two spectral vectors.

formula of Spectrum similarity（SCF）:

$$\gamma_{xy} = \frac{\delta_{xy}\delta_{xy}}{\delta_{xx}\delta_{yy}} = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2}\sqrt{\sum_i (y_i - \bar{y})^2}} \qquad (4)$$

N means quantity of wavelengths, X= (X1, X2... Xn), Y = (Y1, Y2...Yn). Xi, Yi means the reflectivity of two spectral vectors.

formula of spectrum information degree（SID）

$$\begin{aligned} SID(A,B) &= D(A\|B) + D(B\|A) \\ D(A\|B) &= \sum_{i=1}^{N} p_i \log(p_i/q_i) \\ D(B\|A) &= \sum_{i=1}^{N} q_i \log(q_i/p_i) \\ p_i &= A_i / \sum_{i=1}^{N} A_i,\; q_i = B_i / \sum_{i=1}^{N} B_i \end{aligned} \qquad (5)$$

N means quantity of wavelengths, A= (A1, A2... An), B = (B1, B2...Bn). Ai, Bi means the reflectivity of two spectral vectors.

4 the structure and storage of system

4.1 The structure of the system

We have designed the new structure of spectrum database system, the database have been divided into two classes---rocks and vegetations, the figure two about the structure of spectrum database system is as following.

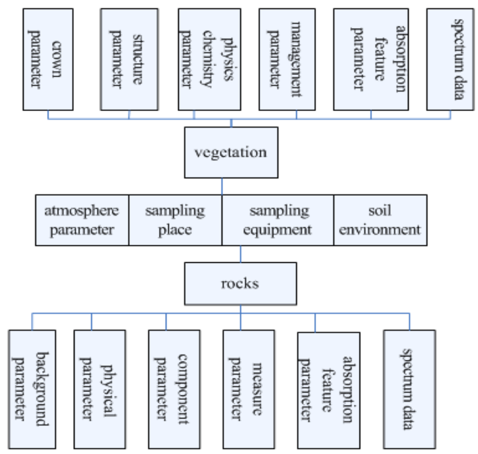

Figure2: the structure of spectrum database system

From this figure, both vegetation and rock database share the same environment tables. Vegetation ID is the primary key in vegetable database and should be unique; Rock ID is the primary key in rock database and should also be unique too.[4]

4.2 Data storage strategies

We have proposed the new spectrum data storage strategies about the system; the rock storage strategies are defined as figure 4; the vegetation storage ones are defined as figure 5; the environment storage ones are defined as figure 6.

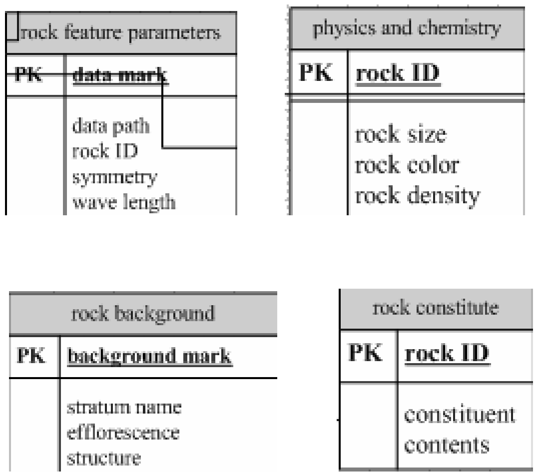

Figure4: Rock data storage strategies

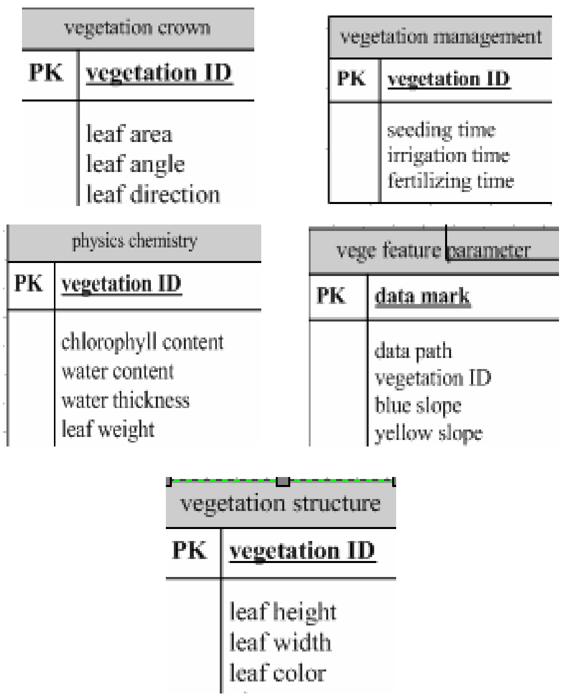

Figure5: vegetation data storage strategies

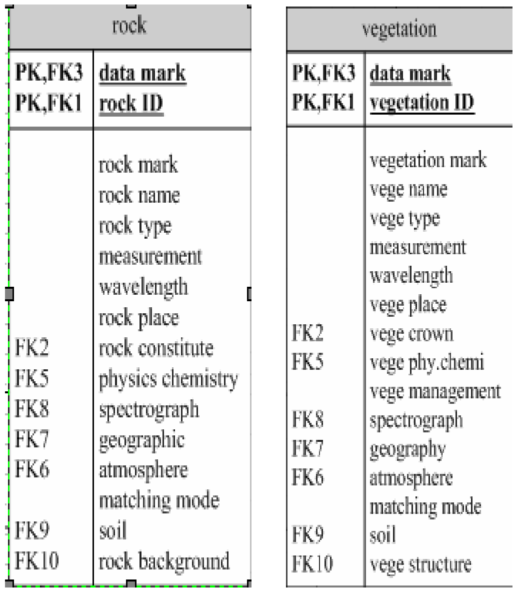

Figure3: Rock and vegetable data storage strategies

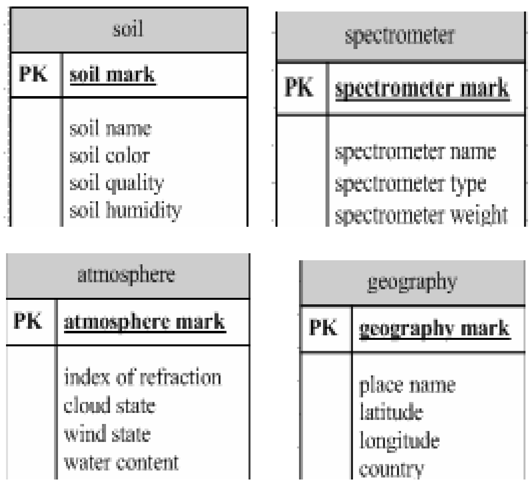

Figure 6: environment storage strategies

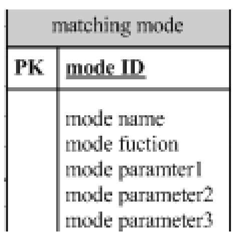

Figure 7: the matching mode storage strategies

The spectrum data table mainly stores the querying path of spectrum data for vegetation and rock, the ground object ID is the primary key, it connects the attributes tables and the spectrum data table, in this way we can combine these tables together, and illustrate that they are the same ground objects. Because ID must to be unique, so we have designed new regulation for this ID, the object name, the object size and the spectrometer type constitute this ID[5]

4.3 system implementation

Our spectrum database system has no high requirement for hardware, we use the software called VC++6.0 to achieve the visualization of spectrum curves and choose the OEACLE 10g to construct the system, and the implementation of the system is as the following[6]

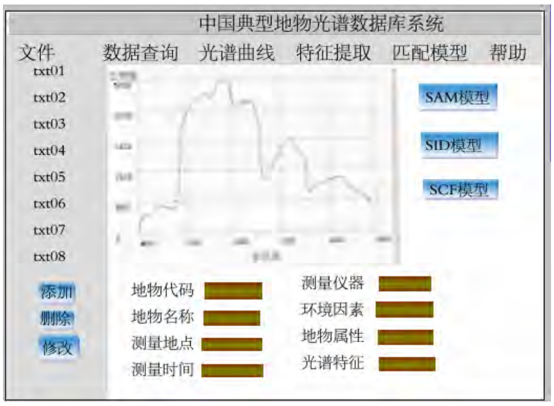

Figure8: the implement of spectrum database system

We can see from this implement, it has contained all of function the system would perform, such as visualization of spectrum curve, the adding, deleting, modifying the spectrum data, querying according to the ground object ID, name, measure time, place, equipments, object attributes, environment elements, absorption feature; the spectrum feature extraction can extract the absorption features of vegetation and rocks mentioned above with derivative method, while the mode of SAM, SID, SCF used for spectrum matching also are presented in this implement[7]

5 Conclusions

Based on the theory of ground object information resources, our system is reliable and can be expanded; it is certain to have an essential function in future research. However, our spectrum database system may have some defective problems that need to be modified at each aspect; it should deserve our further deep research and presentation.

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