A Snow Dynamic Monitoring Information System

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Abstract: A snow dynamic monitoring information system is presented. It consists of preprocessing module, database module and snow map output module. In the preprocessing module, a dynamic cluster method is used for the recognition of the snow. The snow database is a relational database. A query language is designed for region retrieval, geographic feature retrieval and visual retrieval.

1. Introduction

The snow reserves is an important water resources. Continuous surveying and monitoring of the snow cover on an operational basin for a better management of the water resources, is of great importance. Satellite remote sensing techniques can offer timely accurate information over large areas. This information is useful for understanding dynamics of the snow cover.

The machine-aided techniques like snowmapping systems could be used for analysis in almost real time for longterm operational snowmapping of relatively large areas. The techniques include preprocessing of original images, snow interpretation, statistical evaluation and output of snow map results. Because the data from satellites are very huge and have to be processed everyday, these data must be compressed and stored efficiently. Then it is necessary that a image database system be used for efficient storing and integrated management of the snow data. It can highly enhance queries of the snow data access.

In order to make monitoring of the snow covers more effective and timely, it is reasonable to establish a snow dynamic monitoring information system(SDMIS). The SDMIS system is a combination of the snowmapping system and the database system. When original data are sent into the system, snow maps, produced by using snow interpretation, are reserved in the database. Then the snow distribution information can be acquired through the query process for the database. In the following sections, the SDMIS system will be discussed.

2. Structure of the SDMIS System

The SDMIS system is a man-machine interactive system. It consists of three modules: preprocessing module, database module and output module.

(1) Information Sources

Input original information of the system come from different sources such as LANDSAT, NOAA/AVHRR, etc. The low ground resolution data with high time repetition rate could be used for monitoring the daily changes in the snow cover. The high ground resolution data with low repetition rate would be used for calibrating the results.

(2) Preprocessing module

The preprocessing module includes several functions:

a. Geometric correction and registration of the original images by using ground control points(GCP) method.

b. Grey level correction, histogram equalization, multispectral spatial filtering and image transformation, etc.

c. Snow classification with dynamic cluster algorithm.

d. Mutual transformation among raster format data, run-length coding data and other format data, so the techniques of contour tracing and region filling will be used.

(3) Database Module

The snow database is a relational database which links up snow map information with the administration information(Such as geographic and field information). The snow map information are compressed by encoding. All database operations , including database creation and management and snow map retrieval, can be realized in a completely man-machine interactive manner.

(4) Output Module

There are many output forms of results from snow data retrieval, depended on different output devices. For instance snow maps, graphics, tables and numerals, etc.

3. Snow Interpretation

A dynamic cluster algorithm is used in snow interpretation. It is a unsupervised classification method which doesn't need training samples. Snow is easy recognizable feature on practical remotely sensed data in general terms. Then this method can satisfy the demand for high classification accuracy, at the same time, time for snow classification can be greatly shortened. the proposed method, called semi-fuzzy k-means algorithm(SFKM), is a improved fuzzy k-means algorithm[1,2]. It limits fuzziness to a prespecified number of cluster for each pattern. The algorithm in practice is as follow:

a) Select initial cluster centers based on the combinations of the peaks in each uni-dimensional histogram, limit memberships of patterns to a fixed cluster number kt.

b) Initialize fuzzy k-partition matrix using seleted initial cluster centers.

c) Calculate the k cluster centers with the fuzzy k-partition matrix, if there are no changes between the current centers and the last centers, goto step e); otherwise, continue step d).

d) Update fuzzy k-partition matrix using new centers, limit memberships of each pattern to the kt centers which have greater values than the others, goto step c).

e) Calculate hard k-partition of patterns, each pattern is assigned to the cluster which has the maximum membership value.

f) Eliminate the centers that have no pixel.

4. Snow Database and Query Language[3]

(1) Snow Database

The schema of database is a relational schema. Snow map data and administration data are represented by relation files respectively. A file is created corresponding to each relation. All image entities are encoded by a run-length coding. That will save large memory and the run-length coding data could be transformed to raster data easily.

conventional database operation functions, such as definitions of the relations, sub-schemas and attributes, modification, deletion and insertion of the relations, are provided by the SDMIS system. Then user could define the structures and the attributes of data. A database is created while all relations have been built.

(2) Query Language

Query language of SDMIS provides an interface between a user and the database. It could be used to manipulate both symbolic data and pictorial data . The query language of the system, based on relational algebra and image algebra, can perform conventional relation queries and other special queries of snow information retrieval. Combining these queries, the SDMIS can realize various snow data retrievals according to user's demands.

a. Region retrieval

The regions include administration regions, geographic basins, rivers, etc. The region information consist of the geometric information and the character information, i.e., the position and the shape information of regions and the character and the numerical attribute information of regions. Based on these information, the region snow map retrieval can be performed in a graphic manner or a character manner. In the former case, when a point is appointed, the graphic and the character information of daily snow distribution in the region which encloses this point can be acquired by searching the database. In the latter case, a region is appointed by the character description.

b. Geographic Feature retrieval

Sometimes users may want to know some information about some pieces of snow, the snows near some geographic feature and the snows in some interested field. Then the SDMIS provides query functions which satisfy these needs.

Using the piece query, the change and the history of any piece of snow in a snow map could be acquired. Using the arbitrary field query, the daily snow distribution and change in arbitrary enclosed region which is drawn by user on a displaying administration map could be search out.

c. Visual Retrieval

the visual query is a process from a image to a relation. Based on displaying, windowing and zooming techniques for the region image, user could glance over the whole database and search out the interested snow data with satisfying accuacy. All the operations are interactive. Then it is convenient to the user who knows few about the snow database.

5. Conclusion

The SDMIS system is a relatively perfect system used for the dynamic monitoring of snow. It could handle different original data. Its query process of database is quite powerful. The design of the system is using the method of module design. That guarantee the independence between any two modules. Then it is rather easy to modify and extend the system without changing the structure of the system.

Reference

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[3] T. Chen, A Knowledge-based Image Database Management System GBASE, M.Sc. dissertation, Univ. of Sci. and Tech. of China, Hefei, China, 1986.