A Method of Intelligent 3-D Aided Planning for Land Consolidation

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1. INTRODUCTION

Agricultural land rearrangement planning is a key step of land consolidation project, which involves in many spatial and ground features such as field leveling、facilities of irrigation and drainage、road and so on. All of these years, it is workable that expert system and geographic information system respectively have been applied for the agricultural land rearrangement planning. However, the expert system needs to make the knowledge interacting with the computer heavily in the traditional method so that reduce practicality and rationality of planning result. Moreover, two-dimensional geographic surface based land rearrangement planning is difficult to process topographic features of hilly areas, and do not take full advantage of existed geospatial information to impact data analysis or visualization. Recent years, because many high resolution satellite images and more efferent computers are available, it will be feasible to integrate the expert knowledge and GIS technique into a method of intelligent 3-D aided planning for land consolidation. However, there are still several problems as follows: (i) the representation of the land consolidation planning knowledge is so not quantified that the computer can't be identified immediately; (ii) the land consolidation planning knowledge is separated from spatial element models and there is no correlation with each other; (iii) it is difficulty that the spatial element models are edited dynamically in 3-D virtual geographic scene. Therefore, this research try to use the techniques of rule base and template library, and then give a procedure of intelligent 3-D aided planning for agricultural land rearrangement.

2. RULE BASE

That the knowledge is represented by production rule is most common form in an expert system, which is mainly composed of three basic components: rule base, database and inference engine. Rule-base is used to store production rules, the basic syntax of the rule is:

IF <condition> THEN <action>

Database contains a series of facts which is used to match condition of rule in the knowledge base. The implementation of inference engine is matching the rules and the facts and is used to connect the rules with facts. This study expresses the land consolidation planning knowledge with a series of if-then production rule. These rules and reasoning are packaged by object-oriented technology. A spatial element of land consolidation is defined as a class. The attributes of the class contain the rules produced by the conditions and results of the two components; the operation of the class is used to describe the reasoning of inference rules. These rules are summarized into three categories: (i) the geometry and property of the land consolidation element rules; (ii) the rules among the land rearrangement elements; (iii) the rules between the land rearrangement elements and geographical environments. The inheritance and derived relations between one class and another class are built. In order to facilitate retrieval of the rules, various rules of the class are organized into rule sets in a chained list according to the inheritance and derived relations, the rule sets of the same nodes in the class hierarchy form a rule group, the rule group of all nodes are linked together to form the rule base (see figure1).

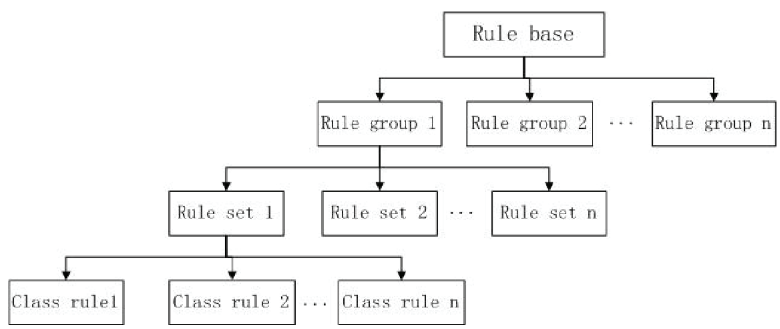

Figure 1. Structure of Rule Base

3. TEMPLATE LIBRARY

To exhibit these objects of the planning elements in 3-D scene, the method of building a template library of various objects is adopted. Selected CSG model can represent some regularly shaped basic volume element, such as the cube which can transform and do regular Boolean operations (union, intersection, difference), then to be combined into one object. An object on the surface can be described as the CSG model with a tree structure: the tree leaf node corresponds to a geometric object and records the basic parameters of the geometric object, and the middle node is a regular set of Boolean operations. This study builds the template library for the land rearrangement elements using the CSG model to transform the tree structure into the class structure (see figure 2). The operation of the CSG object class describes regular Boolean operations, and defines the basic volume elements composing object as nested class. The geometric data of basic volume element on leaf node is disposed by Boolean calculation to show the characteristic of object. In addition, the identifier is set up in both of the element class and the CSG model class to build a mapping between them with the tables and to achieve the rules in the element class associated with data in the template library.

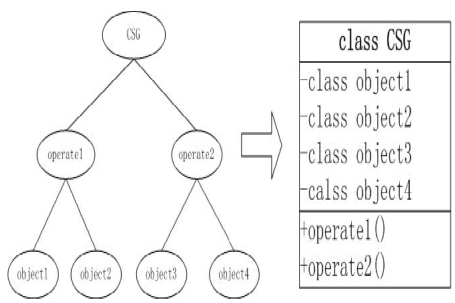

Figure 2. Transformation of the structure

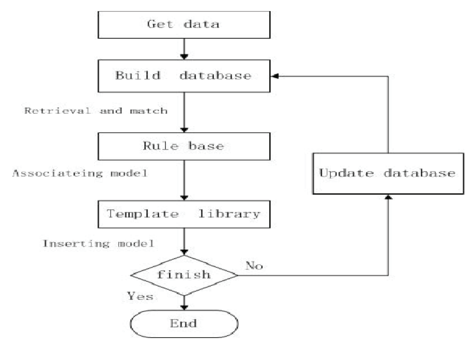

Figure 3. Reasoning Process

4. PROCEDURE OF PLANNING

The procedure of the land rearrangement planning is following as key technique steps as below:

Generating three-dimensional terrain scene: topographic map is used to create TIN surface model and high-resolution satellite image or air photo is used to match the existing TIN model to generate three-dimensional planning scene. Meanwhile, the slope and aspect analysis is used to evaluate land adaptability from the terrain point of view.

Arranging elements: the layout of land rearrangement elements can carried out by rule reasoning from the rule base, matching model from the template library, editing model dynamically as well as displaying model. Among them, the rule reasoning process make a decision for associating the rule with the model, which based on forward chaining start from the known data and processing with the data move forward, which is shown as figure 3.

Model matching: after a model is selected from template library, the GSG model is established by TIN in the field where the CSG model can be inserted into terrain TIN model because of the same format.

Dynamically editing model: if not meet the requirements, the old model will be deleted. In the template library, the model must be modified and reconstructed by the model editing algorithm. For example, if a road needs an extension, the original road model can be deleted, after modifying the road size in the template library, the new road model can re-imported into the planning scene.

Displaying model: Under planning with larger scale, levels of detail model may be created. The selection of appropriate model is based on distance from a viewer or degree for planner and these operations can be automation in the template library.

5. CONCLUSIONS

This method of the rule base and template library based can be implemented by computer so that intelligently make the aid planning of land consolation. Integrated the expert system with GIS improves the efficiency, accuracy and visualization of land rearrangement planning. However, the rule retrieval and matching efficiency should do more research.

6. REFERENCES

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