ISSN: 1813-4890

Design and Implementation of Information System of Cultivated Land Gravity Center based on GIS Component Technology

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Abstract

With computer and GIS technology as the core and the support of ArcEngine secondary development component, Visual Studio 2008 as the development platform, using VB and JavaScript language, the cultivated land gravity center information system was established by calculating cultivated land area and using mathematical model of cultivated land gravity center. The calculations of area, gravity center and its moving distance as well as deviation direction of cultivated land were realized and displayed in the form of various thematic maps. The functions and uses of system were more convenient and flexible.

Keywords

ArcEngine secondary development component, cultivated land gravity center, system design.

1. Introduction

Cultivated land is a special public resource and the most precious natural resource[1,2]. With the rapid development of urbanization, land use methods have also undergone continuous and dramatic changes[3], and a large area of arable land has been reduced [4]. The change of regional land use can reflect the change trend of land use direction in the area [5] , the scarcity of arable land resources in China has become increasingly prominent and has become a bottleneck factor in agricultural production and the sustainable development of the national economy[6].The rational development, utilization and protection of cultivated land has become a hot issue in the world today. In order to better develop and utilize cultivated land resources, protecting cultivated land is a non-negligible link in future social and economic development. It is very important to strengthen the construction, management and protection of cultivated land quality[7]. At present, the research on cultivated land mostly focuses on the qualitative research on the temporal and spatial changes of regional cultivated land [8], and there is no report about the establishment of the information system for the movement of the center of gravity of the cultivated map. This system takes arable land area data and basic geographic data as the research object, realizes the dynamic monitoring of arable land, can grasp the center of arable land and its area changes in time, and has very important practical guiding significance for the rational planning and utilization of arable land and the effective protection of arable land.

2. Research Method

2.1. Component Gis Development Technology based on Vb.Net and Arcgisengine

At present, geographic information has become the basis for analyzing spatial framework and data [9]. Geographic information system combines cartography, surveying and mapping, geography, remote sensing technology, global positioning system, etc,[10] to analyze the spatial information of target objects and has powerful spatial data analysis functions. Visual Studio.net is based on NET Framework and can use ArcGIS Engine components to build user applications. This system is based on the calculation of the cultivated land area and the center of gravity of the cultivated land based on the .NET standard development environment on the ArcGIS software platform.

2.2. Model Support

2.2.1. Mathematical Model of Arable Land Area Calculation

Map spot refers to the continuous distribution of polygons represented by the geographic information system [11]. The area calculation of the farming map spot is based on the mathematical model of the area of an arbitrary polygon. According to the unevenness of the farming map spot, the polygon boundary is divided into upper and lower parts. The polygon area is the difference between the integral value under the upper half of the boundary and the integral value under the lower half of the boundary. Use the point sequence P1 (x1, y1), P2 (x2, y2), ..., Pn (xn, yn) to represent the boundary of the pattern, and its area is:

$$S = \frac{1}{2}\sum_{i=1}^{n}\begin{vmatrix} x_i & y_i \\ x_{i+1} & y_{i+1} \end{vmatrix} \quad (1)$$

2.2.2. Mathematical Model for Calculating the Center of Gravity of Cultivated Land

The center of gravity, as a physical concept derived from classical mechanics, refers to the point of action of each part of the object by gravity [12]. The calculation of the center of gravity of the cultivated land is based on the mathematical model of the calculation of the center of gravity of the area target. The calculation of the center of gravity of the area target can be divided into two situations, namely, the center of gravity of the area target and the center of gravity of the area distributed discrete target.

(1) Mathematical model for calculating the center of gravity of area targets, seeFig. 1,Fig. 2.

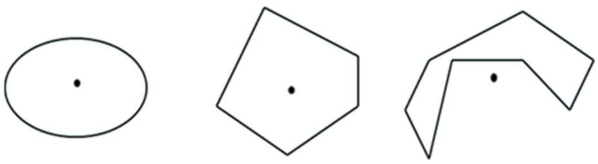

Fig. 1 Arbitrary multilateral

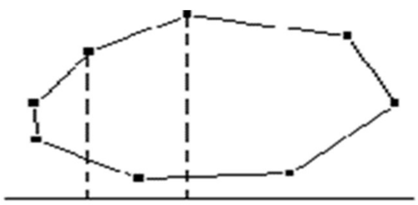

Fig. 2 Trapezoid

The center of gravity of the planar target is the balance point in the polygon (Figure 1). After each vertex of the polygon is mapped to the x-axis, a series of trapezoids (Figure 2) are obtained. The balance point in the polygon is obtained by calculating the average value of the trapezoid's center of gravity. The center of gravity of all trapezoids is combined to get the center of gravity of the entire polygon. The vertex sequence (xi, yi) of the polygon is coded clockwise, and the formula for calculating the center of gravity is:

$$X_G = \sum \overline{X_i} A_i \,/\, \sum A_i \quad (2)$$

$$Y_G = \sum \overline{Y_i}\, A_i \,/ \sum A_i \tag{3}$$

Where: $\overline{X_i}$ and $\overline{Y_i}$ are the x and y coordinates of the center of gravity of the i-th trapezoid; Ai are the area of the trapezoid.

$$\begin{cases} A_i = (y_{i+1} + y_i)(x_i - x_{i+1})/2 \\ \overline{X_i} A_i = (x_{i+1}^2 + x_{i+1}x_i + x_i^2)(y_{i+1} - y_i) \,/\, 6 \\ \overline{Y_i} A_i = (y_{i+1}^2 + y_{i+1}y_i + y_i^2)(x_i - x_{i+1}) \,/\, 6 \end{cases} \tag{4}$$

(2) Mathematical model for calculating the center of gravity of discrete targets with planar distribution.

The center of gravity of the discrete target in the area distribution is the weighted average center of the discrete target, and its calculation formula is:

$$X_G = \frac{\sum_i W_i X_i}{\sum_i W_i} \tag{5}$$

$$Y_G = \frac{\sum_i W_i Y_i}{\sum_i W_I} \tag{6}$$

In the formula: i is the discrete target feature, Wi is the weight of the target feature. Xi is the abscissa and Yi is the ordinate.

3. System Design and Implementation

3.1. System Structure Design

This system uses 2010 and 2015 image maps of the northern foot of Yinshan Mountain in Inner Mongolia as the main data source. The basic data of cultivated land in 2010 and 2015 are extracted through data processing and stored in the Microsoft Access database. With the support of geographic information system, C/S is adopted. A three-tier distributed structure, including the basic data layer of the system, the middle application layer, and the customer service layer, establishes a farmland center of gravity system to realize the functions of query, update, and management of farmland information.

3.2. Database Module

The cultivated land spatial distribution database is the core part of the cultivated land center of gravity system, which is mainly composed of point, line and area entities. The point entities are mainly residential areas; the line elements are mainly roads; the area elements mainly include administrative district layers and cultivated map spots in different years.

3.2.1. Data Generation

Use MapGIS7 K9 map editing software to digitally acquire point (.WT), line (.WL) and zone files (.WP) for remote sensing images. District files mainly refer to land-type map spots, and all farming map spots are extracted from the district file. Finally, use the MapGIS software to convert the farming map spots in the .WP format into the map spots in the .SHP format.

3.2.2. Database Design

The spatial data of cultivated land is divided into three layers: point, line, and area. First, use ArcCatalog software to convert the cultivated land data file in .shp format into .mdb format data, and then use the Microsoft Access 2003 .mdb format to organize the points, lines, and lines of cultivated land Surface data.

3.3. System Function Design

(1) On the left side of the interface is a list of layers, a data view on the right, and the bottom list is the calculation result information. The center of gravity of the cultivated land can be calculated for multiple time nodes at a time, and marked in the order of layers, and the calculated center of gravity data can also be exported to a shape file. It should be noted that the data file must be the data in the projected coordinate system, and that is, several layers of a batch calculation must use the same spatial reference, seeFig. 3.

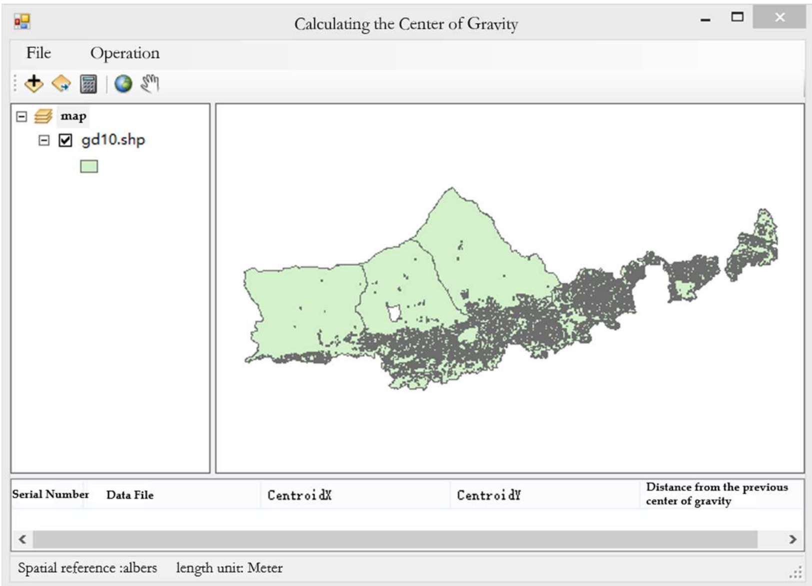

Fig. 3 System interface diagram

(2) Annual arable land area and center of gravity calculation: the total arable land size and center of gravity position in any year can be calculated through the [Calculate]-[Operation] command in the menu, and the center of gravity coordinates are highlighted on the map for users Provide convenience with relevant departments, seeFig. 4.

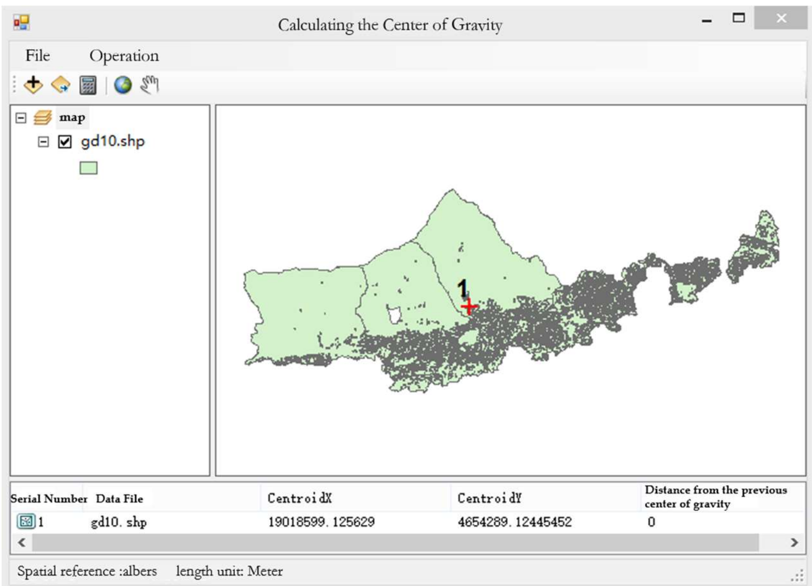

Fig. 4 Calculation of area and gravity center of cultivated land

(3) Calculation of annual arable land area and center of gravity change: The system can further calculate the annual arable land area and center of gravity change by calculating the arable land information for each year, including the movement direction and distance of the annual arable land area and center of gravity, seeFig. 5.

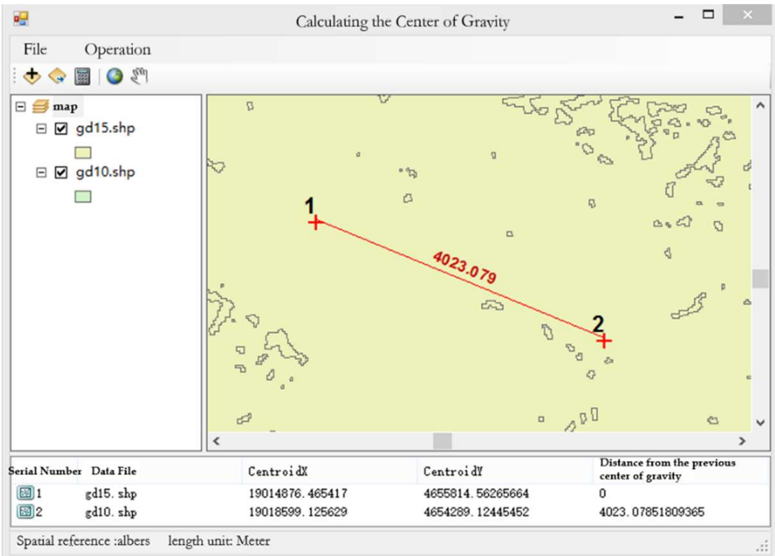

Fig. 5 Calculating the change of the cultivated land gravity center

(4) The order of the layers can be adjusted by dragging with the mouse, but after adjustment, it needs to be recalculated to follow the sequence number and arrangement order in the new bottom list. This article can perform simple symbol settings, right-click on the layer name to find the corresponding options, seeFig. 6.

Fig. 6 Modified symbol

4. Conclusion

With computer technology and GIS technology as the core, it uses GIS component technology and the mathematical model of cultivated land area and center of gravity calculation to develop the cultivated land center of gravity geographic information system. This system effectively integrates spatial information and attribute information, and can analyze qualitatively, quantitatively and positioning The evaluation of cultivated land information has greatly improved the information management level of cultivated land, and laid a technical and data foundation for land development and utilization, land environmental protection, and land resource management. Through this system, the total cultivated land area in a certain year and the area of a certain cultivated map can be counted, and the position of the center of gravity of the total cultivated land in a certain year (indicated by latitude and longitude) can be counted, so that the cultivated land area and the annual change rate of the center of gravity can be counted . Through statistical query, we can intuitively see the changes of cultivated land in different periods, and provide a theoretical basis for decision-making departments.

Acknowledgments

Fund Project: Supported by the Experimental Teaching Project of Inner Mongolia University (YZ2017016).

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