INTEGRATED PLATFORM DESIGN AND REALIZATION OF LAND USE CHANGE DETECTION BASED ON ERDAS WITH AO AND EML

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ABSTRACT:

Remote sensing change detection technique has been an important method to observe the land use change. At present, there are lots of algorithms of **land use change detection**, but there isn't an existing integrating frame and platform: the new-developed change detection platforms have limitation of supporting data sources and developing always consumes long time; while the change detection modules in the existing commercial software platforms are not appropriate for practical application.

Thus, in this paper, based on the present mature commercial software ERDAS IMAGINE, the integrated platform is acquired, the flow of change detection is realized and the algorithms of land use change detection are integrated on this platform with ArcObjects(**AO**) of ArcGIS and ERDAS Macro Language (**EML**). The main modules of this **platform** include image preprocessing, single object change detection, multi object change detection, change polygon postprocessing and change statistics and output totally five sub-modules. The important **interfaces** and **functions** are introduced in detail in this paper.

According to experiments and analysis, it is concluded that this platform has three advantages: Firstly, this platform has multi-source supporting and flexible import/Export capabilities. Secondly, this platform separates the artificial work and automatic work availably. Thirdly, this platform has friendly operation mode. Therefore, this integrated platform can be reference for realization and application of land use change detection Flows.

1. INTRODUCTION

As the fast development of society, economic and scientific techniques, the land use change brought by human exploitation has become the main part of globe environment changes (Zhao Y. S., 2003). Remote sensing change detection technique has been an important method to observe the land use change. At present, there are lots of algorithms of land use change detection(Liu Y. et al., 2003), but there isn't an existing integrating frame and platform: new-developed change detection platforms have limitation of supporting data sources and developing always consumes long time; while the change detection modules in the existing commercial software platforms are not appropriate for practical application. Thus, in this paper, based on the present mature commercial software Erdas, the integrated platform and the main flow of integrated change detection are presented.

2. INTEGRATATED PLATFORM DESIGN

2.1 Software Choice

In this paper, ERDAS IMAGINE is chosen to be the software on which the integrated platform is designed and the reasons are listed as follows:

Firstly, as professional software of remote sensing data processing, ERDAS IMAGINE has the advantages in geometric correction, spectral analysis, classification and interpretation etc. and widely applied to different remote sensing projects (Dang A. R. et al., 2002). Based on ERDAS IMAGINE, the secondary development can effectively integrate the modules in ERDAS IMAGINE and it is helpful to reduce the workload.

Secondly, as a remote sensing technique application system, ERDAS IMAGINE provides a series of client tools including Erdas Macro Language (EML)- an interface development tool and Spatial Modeler Language (SML)-a modeling tool, by which developed programs can be easily loaded in main interface of ERDAS and it also support load of other developed executive program by other secondary languages and interfaces.

Thirdly, many data formats can be supported in ERDAS IMAGINE, and batch processing and parallel processing can be realized by the secondary development. Thus, platform design based on ERDAS is helpful to save the time of basic Input/Output (I/O) interface design and batch processing.

Therefore, in this paper, ERDAS IMAGINE is chosen as the software to realize and integrate the landuse change detection work flow.

2.2 Landuse Change Detection Work Flow

At present, traditional landuse change detection work flow can be concluded as four steps - image preprocessing, change detection and extraction, polygon processing, statistic and evaluation (Figure 1), in which, both steps of change detection and polygon processing can be automatic carried out. Thus the work flow can be divided into artificial operation and automatic realization effectively.

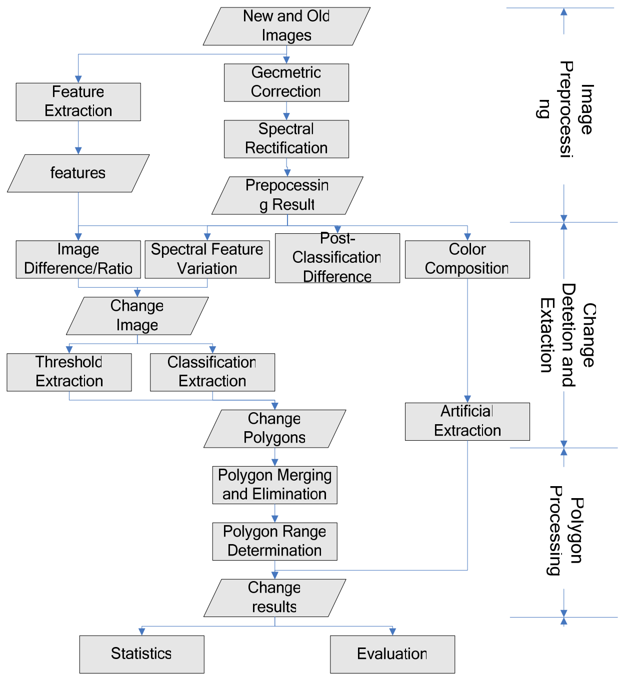
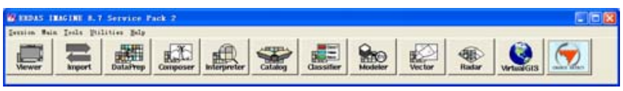


Figure 1. Work Flow of Landuse Change Detection

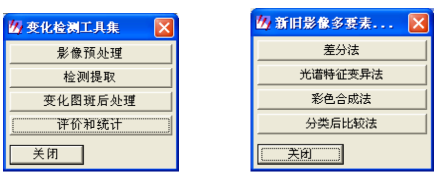
Based on this workflow division, the main interfaces and modules of integrated platform are fulfilled.

2.3 Interface Design with EML

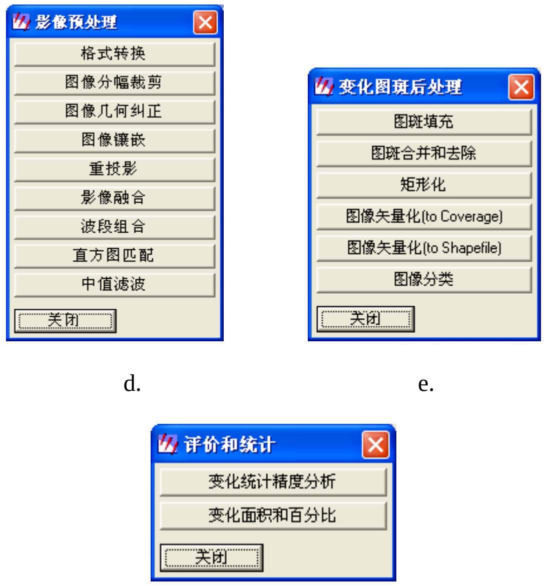
EML, as a kind of macro language supported by ERDAS, is applied to defining the client interface structure and content. It can provide some edit capabilities of basic process (Liu J. J. et al., 2003, Programming Reference Guide-Erdas Macro Language). Interface designs with EML include ERDAS standard Graphical User Interface (GUI) modification and self-definition of individual GUI these two methods. In detail, modifying the file “Imagine.eml” in “$Imageine Home/Script” can be applied to adding the controls of GUI and the follow GUI interface could be acquired(Figure 2):



a.



b. c.



d. e. f.

Figure 2. Main Interface of Landuse Change Detection

The main interface(Figure 2.a) of this integrated platform is added to ERDAS. By choosing “Change Detection” icon, change detection tool set module can be used(Figure 2.b). In this module there are four sub-modules including preprocessing sub-module (Figure 2.d), change detection and extraction sub-module (Figure 2.c), polygon processing sub-module (Figure 2.e), statistics and evaluation sub-module (Figure 2.f). All the module interfaces are designed with EML.

2.4 Sub-Module Functions

1) Preprocessing Sub-module

The useful functions in ERDAS are integrated by EML, including format transforming, subseting, image geometric correcton, mosaicing, projecting, image fusion, band composition, histogram matching and median filter. In detail, these functions can be loaded by main module program, for example format transformation is realized by “on mousedown load”import.eml””(Wang J. X. et al., 2006), the function interfaces are same as those of ERDAS and are available to centralize the preprocessing operation.

2) Change Detection and Extraction Sub-module

The development is carried out with EML. The traditional landuse change detection methods include image difference, spectral feature variation, color composition and post-classification difference and the work flows of all the methods from histogram matching, change detection to threshold extraction can be antomatically executed.

3) Polygon Processing Sub-module

The development is carried out with EML and AO. With AO, the polygon processing functions are produced as “*.exe” and added into the main integrated platform. With AO the secondary development functions contain polygon filling, polygon rectangular range acquiring and polygon vectorization(to shapeFile and DWG).

4) Statistics and Evaluation Sub-module

This module realizes the accuracy analysis and change area statistic functions, in which the accuracy analysis makes use of the Accuracy Assessment function of ERDAS IMAGINE with EML. The change area statistics function is carried out with AO and added into the main integrated platform in the form of "*.exe".

2.5 Module Development and Realization

2.5.1 Module Development with EML

Image differencing method is realized with EML and the main function and interface are listed as follow:

1) Realization of two operational modes. One is middle input/output; the other is automatic flow processing.

In Figure 3, for the first mode, after every output box there is a button "OK", which is helpful to single processing and output. If you want to input a middle file, you can choose the diamonds after the output names and press the relative buttons "OK".

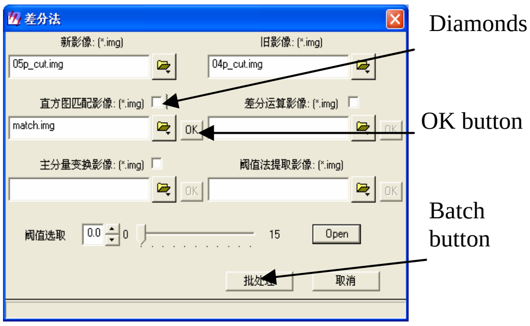


Figure 3. Two Modes

Considering the input and output box types in ERDAS are different, the key technique for the middle control processing is setting two type boxes at the same location and with a diamond to control which type of box displays.

In second mode, the processing dialog has a batch processing button in the end, which executes the workflow to end at once with the original images and parameters input.

For histogram matching, image difference, principle component transformation and threshold extraction, in ERDAS, there are already different models. In order to undo the relative repeated work, integrating these models is chosen to realize the workflow. The parameters of every model are separated, some parameters are fixed for user, and all the interfaces are integrated in one GUI interface.

2) Realization of synchronous display

The *meternumber* and *viewer* control in EML are applied to thereshold extraction and synchronous display (Figure.4). As the threshold changes, the viewer displays different results relatively.

Figure.4 Realization of Synchronous Display

2.5.2 Module Development with AO

Polygon processing method is realized with AO and the main function and interface are listed as follow:

1) Module development with AO

Module development with AO (ArcGIS Develop Help-VB6, Zhao W. F. et al.., 2004) is helpful to make good use of the main function of ArcGIS, such as polygon vectorization (to shapeFile) which cites the *IConversionOp* interface and *RasterDataToPolygonFeatureData* of AO. Based on VB environment, the "shape.exe" executive program is acquired.

2) Embedding program

Under the EML environment, by "*on mousedown {"own/toshape.exe";}*" the AO functions can be loaded.

3. EXPERIMENTS AND ANALYSIS

3.1 Experiment

On the integrated platform mentioned above, integration of the automatic processing work flow and fast processing are realized. TM satellite images in Beijing acquired in 2004 and 2005 are applied to landuse change detection experiments of the integrated platform to test its efficiency. the processing time comparative results are listed in Table.1.

Method	Flow Steps	No Use Platform	Use Platform	Differ-ence
Image Differen-ce	Preprocessing	1	1	0
	Chang Detection	1	0.6	-0.4
	Threshold Extraction	5	1	-4
	Classification Extraction	25	25	0
	Polygon Processing	10	4	-6
	Evaluation	30	30	0
	Statistics	4	0.5	-3.5
	Sum	76	62.1	-13.9
Spectral Feature Variation	Preprocessing	8	5	-3
	Chang Detection	7	3.1	-4.9
	Threshold Extraction	6	2	-4
	Classification Extraction	30	30	0
	Polygon Processing	12	5	-7

	Evaluation	30	30	0
	Statistics	4	0.5	-3.5
	Sum	97	75.6	-21.4
Color Compo-sition	Preprocessing	3	1.1	-1.9
	Chang Detection	1.5	1.5	0
	Artificial Extraction	60	60	0
	Evaluation	30	30	0
	Statistics	4	0.5	-3.5
	Sum	97	93.1	-3.9
Post-classi-fication difference	Classification Extraction	75	60	-15
	Polygon Processing	7	1	-6
	Evaluation	30	30	0
	Statistics	4	0.5	-3.5
	Sum	116	91.5	-24.5

Table 1. Change Detection Efficiency Comparative Table (unit-minites)

3.2 Result analysis

According to experiments, it is concluded that:

1) The efficiencies of the change detection methods mentioned above without the integrated platform are higher than those with the integrated platform. Based on the reduced time in order from high to low, they are post-classification difference, spectral feature variation, image difference, and color composition in turn.

2) During the change detection and extraction step, the efficiencies of change detection, threshold extraction and statistics have been improved distinctly, and the work load of artificial input and output of data has been saved. It is indicated that this platform effectively separates the automatic and semi-automatic processing work flow.

3) The extracted threshold can be adjusted availably and the whole operation is convenient, which is helpful for operators with fast interpretation and comparison.

4) Middle input/output processing patterns could correct the wrong data without redoing the former steps, which is helpful to fast correction and acquiring the final change results.

4. CONCLUSIONS

In this paper, software choice reasons of the integrated platform are summarized and the landuse change detection work flow is presented. In detail, Interface design with EML, main modules and relative functions, module development of this platform are introduced in detail. This designed platform has advantages of integrating multi-functions in ERDAS IMAGINE, and separating the manual work and artificial semi-automatic operation. According to experiments and analysis, this platform enhances man-machine interaction capability and improves the change detection efficiency, which can provide reference to application of secondary development based on existing remote sensing professional software.

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