APPLICATION OF EXPERT SYSTEM AND IMAGE PROCESSING TECHNIQUES FOR DETECTING BUILDING CHANGES IN GEO-SPATIAL DATABASES

Prof. Bock-Mo Yeu
Dept. of Civil Engineering, Yonsei University

Prof. Duk-Jae Sohn
Dept. of Civil Engineering, Daejin University

Prof. Hwan-Hee Yoo,
Dept. of Urban Engineering, Gyeongsang National University

Senior Researcher Jae-Hong Yom
Geographic Information Research Institute, Hanjin GIS Co.

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ABSTRACT

Researches are active in the field of photogrammetry to automate interpretation of cartographic objects. An attempt is made here to design an automated system which could be applied to practical municipality administration of handling geo-spatial data. Existence of past vector maps in digital format is assumed which is used as a priori knowledge as well as to confirm visually the result of the automated detection.

1. INTRODUCTION

Detecting new buildings and changes to existing buildings in urban areas to check for compliance with regulations and permits, is one of the responsibilities of all urban municipalities in Korea. Detecting these changes is being carried out manually by interpretation of aerial photos and comparing to past maps of the same area. Efforts have been made to automate this process by applying image processing techniques used in remote sensing such as producing image ratio maps and difference maps of the same area acquired at different points of time. But detecting annual building changes involve large scale aerial photos and involves interpretation of details which are not available in the smaller scale satellite imageries.

Manual photo interpretation is carried in local municipalities to identify new buildings and changes in building structure by means of aerial photograph. Identified changes are then marked onto a paper map and to a paper form. The form sheet is then used as a reference material to check for illegal buildings and take necessary measures. The changes are classified into general area and development restriction area. The types of changes for general area is divided into new construction, extension of building, remodeling of building. The types of changes for development restriction area is divided into 7 different types, new construction, extension of building, remodeling of building, landuse change, cutting woodland and others.

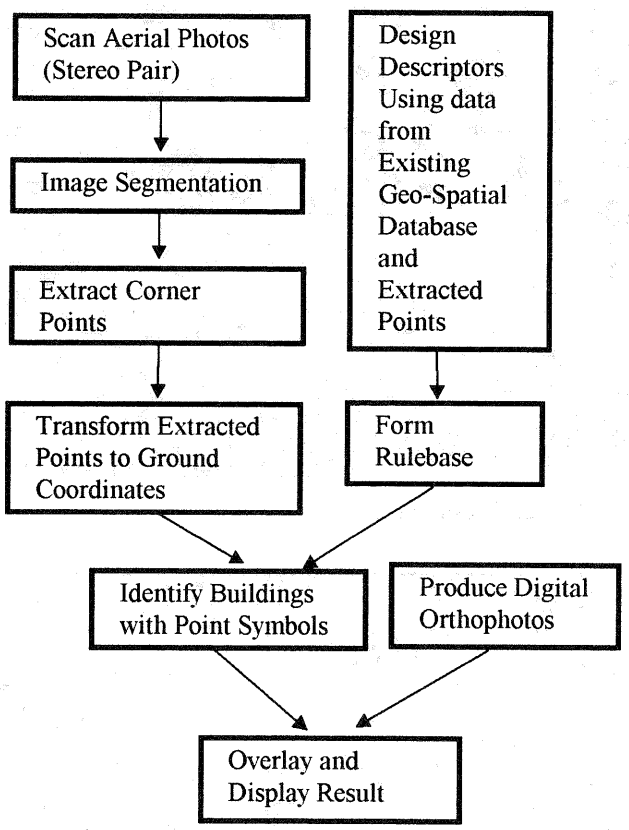
The main problem of the present method of handling photo interpretation is that it is time consuming for timely update of the building records. Also lack of manpower for photo interpretation poses a problem as the changes in cities get faster and larger in terms of spatial extent.(Yeu, 1994)

Image segmentation can be applied to large scale scanned aerial photos and the extracted features are then labeled and values for various descriptors are computed

and stored together with the label in a database. Expert system technique is introduced during the detection of buildings with these descriptor values. After rules are generated and tested and accuracy of interpretation evaluated, ground coordinates of features of detected buildings are computed and projected to an existing Geo-Spatial Information System vector map.

2. THE DETECTION PROCESS

The detection process to automate the identification of building changes is designed as follows.



Aerial photos taken at a scale of about 1/3,000 are used as base material for interpretation. The films are then scanned and image segmentation is carried out with the scanned images to segment into regions and also labeled. Coordinates of corner points of segmented regions are transformed to object space. To test if the labeled regions are buildings, expert system is introduced. Descriptors of regions are formulated to be used in the generation of a rulebase which will decide if the selected region is a building or not. A symbol will be generated at the centroid of the region and placed to represent the identified buildings.

The symbols of detected buildings is again superimposed over the scene so that the user can visually confirm the result of the identified building. Buildings vector polygons with a symbol inside the polygon, will be buildings that are unchanged between the production of the vector maps and the exposure of the aerial photos. Newly built buildings will be those symbols that do not have an enclosing building vector polygon, and building vector polygons without a symbol inside will those that have been removed. Digital orthophotos are produced and displayed onto the screen. Vector maps of the same area, produced prior to the exposure of the aerial photographs, are superimposed over digital orthophotos as well as the point symbols representing detected buildings.

3. APPLICATION OF IMAGE PROCESSING

Image segmentation is the process of generating uniform and homogeneous areas for feature extraction. There are many different methods to segment digital images such as local line detection method, edge detection method, region growing method. Although many researches are being made to improve the quality of segmentation, many methods are of the ad hoc type leaving the user with no information about the quality of the result and the segmentation is not performed under the restriction of an object model requirements (Stokes, 1992.). Region growing method such as blob coloring is commonly used. The algorithm is described as using an L-shaped window mask to scan an image (Ballard and Brown, 1982.). The rows are examined by rows to check for differences in gray levels and if the difference is beyond a set value

labels are assigned to those pixels. This results in segmentation of image with each segmented region having its unique label.

Filters can be used to outline the edges of an image with dark lines against a white background. The boundary pixels are then transformed from image scale to object scale. These points files are restructured to be consistent with the existing digital vector maps. Rules are generated from these newly formed vector files to identify buildings.

4. APPLICATION OF EXPERT SYSTEM

Unlike some of the former attempts where descriptors are designed and form based on features at image scale, (Murakami, 1992) descriptors are designed at object scale after transformation to a GIS. This has the advantage of making use of existing data, visual check with existing vector maps as well as information fusion with attribute data of the database management system. It also has the advantage of a direct incorporation to a GIS user environment for practical purpose.

Expert system can be applied during the extraction of corner points of building lines, formation of polygons from extracted points and in the identification of buildings.

5. ANTICIPATED RESULTS

Implementation of the system is underway, although much experiments and refinements should be made before it is possible to be applied to practical use. Some anticipated results of the implementation is introduced.

Fig 5.1 Aerial photo of a typical urban area

Fig 5.2 After thresholding

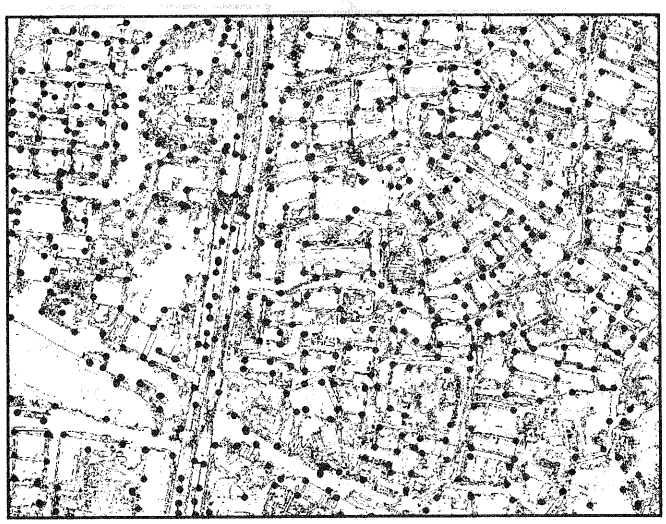


Fig. 5.3 Extraction of corner points and end points

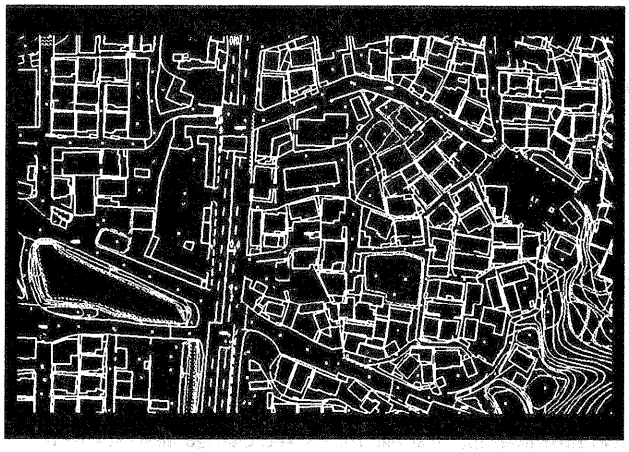


Fig. 5.4 An existing digital vector map of the area

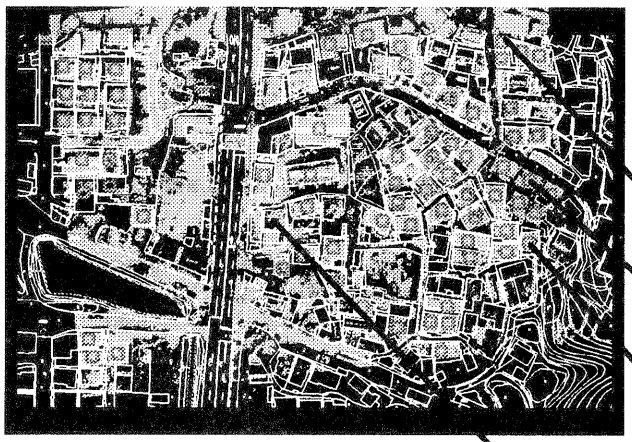


Fig. 5.5 Result of detecting building changes

The figures are illustrated to show what is expected after a very optimistic implementation of the system. For example in Fig. 5.5, symbols without an enclosing polygon could also imply a false detection and polygons without symbols could imply a missed detection. Much refinements is expected before a practical system can be developed, but it is hopeful because the utilization of existing database provides plenty of accurate a priori knowledge as well as an evaluation capability.

6. REFERENCES

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