AUTOMATIC CARTOGRAPHY FROM AERIAL IMAGES (SITE OF SALE, MOROCCO)

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ABSTRACT

The maps or database of geographic objects (DBGO) are generally - except for some works [1,2,4,5] - create and update by topographers from measures executed on the lot. This manual update and creation of maps are today a laborious task, long, no exempt of errors and several years separate map versions.
The goal of this paper is to present a new automatic process of creation and update maps from aerial images based on the utilisation of the image processing techniques (low and high levels) and neural networks. The comparison of the results with the Photopolis project[4] shows the performance of our approach. This work has two objects:
- Create new maps.
- Update the ancient maps.

RESUME

Les cartes ou base de données d'objets géographiques (BDOG) sont généralement (à part quelques travaux[1,2,4,5]) crées et mis à jour par des géomètres topographes à partir de mesures effectuées sur le terrain. Cette mise à jour manuelle est aujourd'hui très longue, plusieurs années séparent les différentes versions de cartes.
Le but de cet article est de présenter un nouveau processus automatique d'élaboration de cartes à partir des photographies aériennes. Notre approche est basée sur l'utilisation des techniques de traitement d'images bas et haut niveaux et réseaux de neurones. La comparaison des résultats avec ceux du projet PHOTOPOLIS [4] montre la performance de notre approche.
Ce travail a un double intérêt:
- La création des nouveaux cartes pour des nouvelles villes.
- La mise à jour des anciennes cartes.

1 INTRODUCTION

The central theme of our project is the development of powerful tools for cartographic applications. In particular, image processing methods will be developed that delineate and detect man-made structures mainly buildings in aerial imagery. The main emphasis will be on digital urban mapping. The tools will allow greatly reducing the requirement for expensive manual labour.
Our approach consists of comparing two sets of information in order to detect the divergences. The first information is a real representation (an aerial image, Figure.2) ,the second is a symbolic representation (maps, city plan). These informations are differents. In the purpose to remedy to this problem, we segment the aerial images by a split and merge segmentation method in order to obtain comparable data.
The matching step between objects in the segment image and objets in map is realised by a neural network. We use the following criterion: the geometric shape, the gray level and textural parameters. The map is used in training phase. The interpretation results gives information on buildings, roads and so on, built or removed.
Our project is organized in the following steps (Figure 1.):
- Aerial images acquisition.
- geometric and relief corrections
- Aerial images filtering and segmentation
- Matching objects by neural network
- Updating ancient map.

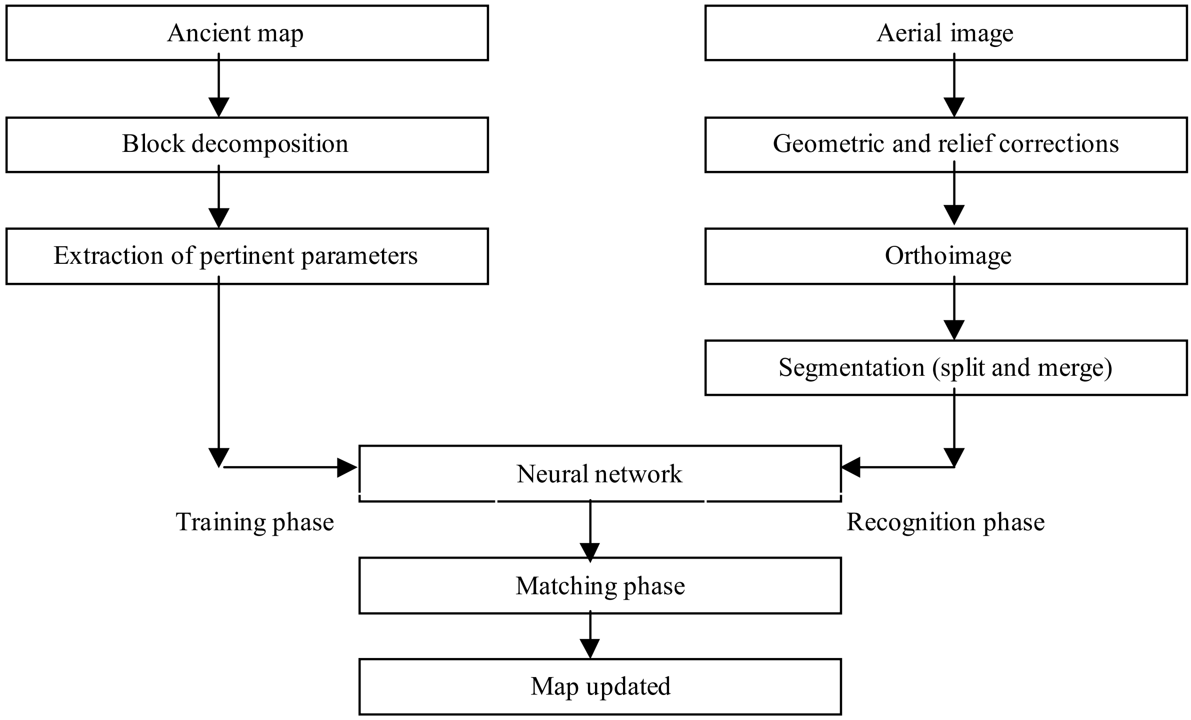

FIgure 1. Our project of automatic cartography from aerial images

2 DATA AND STUDY AREA

City: Sale (Morocco)
Scale of aerial photographs: 1/20.000
Date of photographs: 7/99 (Figure 2)
Resolution: 550 dpi
Data acquired by: ACFCC.

Figure2 : Aerial image of Salé (Morocco)

3 SEGMENTATION

3.1 Definition

let I denote the digital image, and let Pred be a logical predicate defined on a set of contiguous picture points. Then a segmentation can be defined as a partition of I into disjoint subsets (regions) R1, R2, . . . ,Rn such that:

$I = \cup Ri$, i=1, . . ., n.
Ri, i=1, . . ., n is connected.
Pred(Ri) = *TRUE*, for i=1,2, . . .,n.
Pred(Ri $\cup$ Rj) = *FALSE* for $i \neq j$, where Ri and Rj are adjacents.

The segmentation is a preliminary and fundamental stage before image interpretation. The aerial images are characterised by the presence of homogeneous and textural zones [5,6,7,8] at the same time. Our approach consists in the use of both the contour and region segmentation based on the split and merge algorithm. The split algorithm is founded on the use of the cooccurrence matrices. In a first time, the image is divided using a criteria founded on the gray level. Then, we calculate the texture of the regions. The two parameters (texture and gray level) are used in merge step.
When two adjacent regions have the gray levels average very different, their common contour is well detected and the result of division was sufficient to initialise the merge process. On the other hand. at the time of the presence of textured zones of similar luminance, the split algorithm, which uses the gray level only don't divide the two regions. It is so necessary to use texture features in segmentation algorithm.

3.2 Split and Merge Algorithm

The basic idea of region splitting [9] is to break the image into a set of disjoint regions which are coherent within themselves:
- Initially take the image as a whole to be the area of interest.
- Look at the area of interest and decide if all pixels contained in the region satisfy some similarity constraint.
- If *TRUE* then the area of interest corresponds to a region in the image.
- If *FALSE* split the area of interest (usually into four equal sub-areas) and consider each of sub-areas as the area of interest in turn.
- This process continues until no further splitting occurs. In the worst case this happens when the areas are just one pixel in size.

If only a splitting schedule is used then the final segmentation would probably contain many neighboring regions that have identical or similar properties.
Thus, a merging process is used after each split which compares adjacent regions and merges them if necessary.
Algorithms of this nature are called split and merge algorithms. To illustrate the basic principle of these methods let us consider an imaginary image.

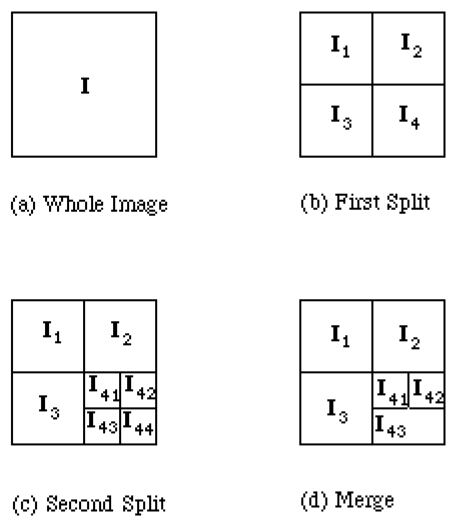

Figure3. Example of region splitting and merging

- Let I denote the whole image shown in Fig. 3. (a).
- Not all the pixels in I are similar so the region is split as in Fig. 3. (b).
- Assume that all pixels within the regions I_1, I_2, and I_3 respectively are similar but those in I_4 are not.
- Therefore I_4 is split next as in Fig. 3. (c).

- Now assume that all pixels within each region are similar with respect to that region, and that after comparing the split regions, regions I_{43} and I_{44} are found to identical.
-These are thus merged together as in Fig. 3. (d).

The matching step between objects in the segment images and map objets is realised by a neural network. We use the following criterion: the geometric shape, the gray level and texture parameters.

4 COMPARISON AND RESULTS

figure 4. result of segmentation method

The figure 4. shows the result of segmentation method and the following table (table1.) illustrates the comparison between our project and Photopolis [4] project.

	Our project	Photopolis project
Segmentation algorithm	Split and Merge	An algorithm which divide the image on segments
Matching	Neural network	Probabilistic relaxation
The training	It does not performed on courant image (gain of time)	Repeated Processes integrated in the method
Recognition phase	It does globally on the image	Relaxation phase

Table 1. Comparison between our project and Photopolis [4] project

5 CONCLUSIONS

In this study a new creation and update method for maps from aerial images has been developed. This technique which consists of using image processing and neural networks has the advantage of being simple.

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