

RESEARCH THE CHANGE OF THE BUILDINGS BEFORE AND AFTER EARTHQUAKE BY USING AIRBORNE PHOTOGRAPHS

Y. Sidar^b, B. Bayram^a, C. Helvacı^a, H. Bayraktar^{a*}

^aYTU, Civil Engineering Faculty, 34349 Besiktas Istanbul, Turkey - (bbayram, chelvacı, hbayrak)@yildiz.edu.tr

^b Ugur Harita Muh. Burosu, Alemdag Cad. No:210/1-B, Umraniye Istanbul, Turkey- ysidar@yahoo.com

Commission VII, WG VII/5

KEY WORDS: Earthquake, Change, Detection, Photogrammetry, Geometry, Statistics

ABSTRACT:

Recently the possibility of an earthquake has become one of the most important subjects in lots of countries especially in Turkey. For that reason, the possibility of an earthquake gains ground due to its devastating physical and psychological effects. Because of these physical losses and its psychological effects, people who experience the earthquake generally become sensitive and provident. Although disaster management had been established before the earthquake, the studies after the earthquake prove the fact that decreases in the loss of lives is inadequate. In this study, the aerial photographs have used which have been obtained before and after the earthquake. An algorithm is developed that determines the damaged buildings as semi-automatic. The principle of this study is analyzing the buildings' image histograms and determining their conditions. Gölcük and Adapazarı regions before and after the earthquake have been used for the analysis of the image histograms that belong to the buildings in the aerial photographs. Our empirical results have shown that the histograms of the undamaged and damaged buildings have different forms. For this reason, utilizing the histogram analysis, the conditions of the damaged buildings have determined by using a semi-automatic process. The important pre-condition for this study is the digital maps of the study area to be in existence. Briefly, to form the histograms, the coverage areas of the buildings that are after the earthquake photographs in vector format are found and the image histograms are calculated from those areas. The purpose is to determine the damaged buildings quickly during the earthquake and contribute to the disaster management. It is thought that, through the results that are to be obtained, it will be possible to direct the rescue mission correctly, estimate the number of loss of lives and take healthy precautions.

1. INTRODUCTION

The result of development of the computer technology, the problems of the photogrammetry and remote sensing are carried to vector data. Due to the accessibility of advanced software and hardware systems, it is possible to do computer based photogrammetric process. Also, it is feasible to detect the changes through the development of the satellite technology. Monitoring the change is meant to present reliable, quick and up-to-date data relating to the analyzed area to the deciders. (Gunduz, 1996). Systematic and effective manipulation of remotely sensed data is necessary for the utilization of data from resource satellites and low-level airborne platforms for monitoring and analyzing the dynamic phenomena of the Earth's surface. Because data capture is sequential over time, multiple images for any particular area contain potential information about changes of surface features or conditions. (Raafat, 1991)

Increasing migration within our country accelerates the change in the usage of lands as well, especially in metropolitan areas. To determine the changes, remote sensing techniques play an important role. This process requires using the data sets taking in different dates. Environmental factors affect the reliable on determination of changing.

One of the fundamental tasks in image understanding is the automated extraction of man-made objects from aerial or space borne imagery (Kim, 1999). The extraction of buildings in particular, has attracted a lot of attention in photogrammetric research (Lammni, 1999). A case in point is the photo-

interpretation of aerial images where we want to assess how much specific algorithms and/or features aid in the completion of vision tasks. In such vision tasks as target detection, battle damage assessment, delineation of buildings and man-made objects, the segmentation map represents an intermediate level intelligence to the human operators (Letournel, 2002).

After natural disasters happen, the damages have to be determined and an effective disaster management has to be conducted in a short time. This was observed to be a very important problem in the earthquake of 17 August 1999, Kocaeli. (Bayram, 2001).

In this study, aerial photographs which are taken before and after the earthquake are used. The algorithm and application which determine the deformation of the buildings after the earthquake are explained with change detection.

2. APPLICATION OF THE ALGORITHM

In the pre-researches, the histograms of the undamaged and damaged buildings are analyzed. The typical forms of histograms are shown in Figure-1.

* Corresponding author.

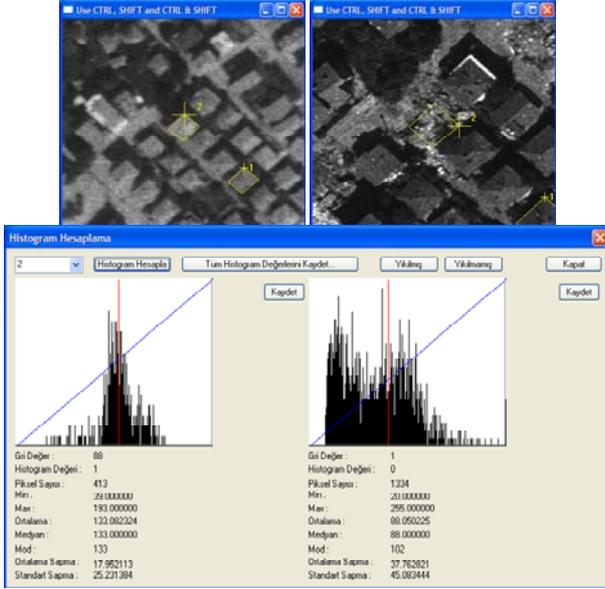


Figure.1 Histogram of damaged and undamaged building.

The used photographs are taken in Gölcük in 1993 and 1999 and in Adapazarı in 1994 and 1999.

The aerial photographs which are used have different scales. The scale of the photographs before the earthquake is 1:35000, after the earthquake is 1:18000. The general specifications of both photos are given below:

- Photographs of Gölcük; date 1993 and 1999 related
- Photographs of Adapazarı, date 1994 and 1999 related
- The reports of the camera calibration belong to the all photographs.
- Exterior orientation parameters belong to the all photographs.

The critical point of this study is the vector data of buildings before the earthquake are superimposed correctly to the aerial photographs after the earthquake. For this reason, aerial photographs after the earthquake are transformed into the geocoded coordinate system. In this stage, the model are formed which belongs to the stereo photos after the earthquake. Coordinates of photos and exterior orientation parameters which have three dimensional coordinates belonging to the vector data are shown in equation (1) and (2) as the parameters of interior orientation are known, image coordinates are obtained from the photograph coordinates by the application of the affine transformation.

Basically, for an automatic recognition of building regions in images, altimetric information in addition to planimetric information have to be used because the usage of images only can not completely lead us for building recognition (Seresht, 2000). Because of the earthquake the region is deformed. Also, the elevations of the damaged buildings are changed. Between the reality and theoretical model, undesirable differences have occurred. In other words, after the earthquake photos, the vector data does not superimpose correctly on the buildings. For that reason, the user can modify regions interactively. The deformation is the ground moved in different direction, but the buildings are moved systematically in each different direction.

Therefore, to superimpose vector data and raster data that belong to the buildings, the user can draw a selection polygon and moved the selected area opposite of the deformation direction.

$$x = -c \frac{a_{11}(X - X_0) + a_{21}(Y - Y_0) + a_{31}(Z - Z_0)}{a_{13}(X - X_0) + a_{23}(Y - Y_0) + a_{33}(Z - Z_0)} \quad (1)$$

$$y = -c \frac{a_{12}(X - X_0) + a_{22}(Y - Y_0) + a_{32}(Z - Z_0)}{a_{13}(X - X_0) + a_{23}(Y - Y_0) + a_{33}(Z - Z_0)} \quad (2)$$

where

c = focal length

X, Y, Z = ground coordinates

x, y = photograph coordinates

X_0, Y_0, Z_0 = Photograph middle point

coordinates

a = orientation matrix

Image coordinates of the vector data belonging to a building before and after the earthquake are calculated from the photographs. Histograms which are related to these areas are calculated automatically. Deciding whether a building is damaged or not by using the developed algorithm, the calculation of the number of pixels forming the building, grey values average of a set of pixels, minimum and maximum pixel grey values, mode, median average deviation and standard deviation are calculated. These values are used for initial parameters for the algorithm.

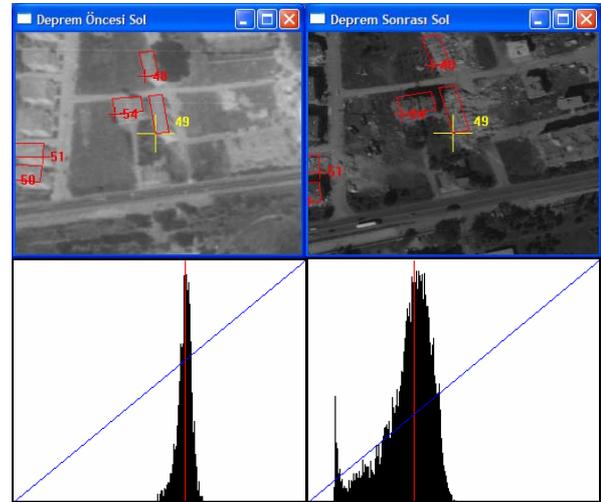


Figure 2. Histograms and photos of damaged and overlapped buildings

When the region of Gölcük's histogram and statistical values are analyzed, the differences of standard deviations before and after the earthquake appear to be useful information in the stage of decision. If the differences of standard deviations before and after earthquake are used to determine the situation, the ratio of accuracy is %95.88 where the number of the building are 94 and 21 of them are damaged (Figure 2.).

3. CONCLUSION

In this study by using digital map information and aerial photographs, the condition of the damaged buildings are determined after earthquake. Usually the histograms which are used as a source of image contrast in digital image processing applications; in this study, they are used in texture analysis too. Especially, the study can supported with addition studies in the regions that have maximum earthquake risk. The obtained building ID's should combined with the addresses and identity information in GIS. Thus, the damaged building addresses and the number of influenced people in that region can be known by the algorithm.

If two GPS and high-precision gyroscope used for exterior orientation during the fly after the earthquake, the orientation problem can be solved real-time. Then the evaluation of the algorithm can be done automatically in short time.

In our country, after the earthquake especially disaster management centers sent rescue and support teams to the earthquake region. If our developed algorithm is used five hours after the earthquake, it can provide useful information for disaster management systems.

4. REFERENCES

Bayram, B., Alkis Z., 2001. The Coastal Line Change Detection in Gölcük Region Before and After Earthquake. The 3rd National Turkey's Coastal and Sea Areas Conference, Proceeding 1, pp. 489-495, Istanbul.

Gündüz, A., 1996. Probability, Statistic, Risk and Reliability in Engineering, Kure, Istanbul, pp. 8-17.

Kharki, O., Sadgal, M., Ouahman A., Himdy A., Belaid M. A. 2000, Automatic Cartography From Aerial Images (Site Of Sale, Morocco). International Archives of Photogrammetry and Remote Sensing, Amsterdam, Vol. XXXIII, Part B2, pp. 179-183.

Kim T., Muller, J. P., 1999. Development of a graph-based approach for building detection, Image and Vision Computing, vol.17, pp. 3-14.

Lammni, J., 1999. Automatic Building Extraction Using a combination of Spatial Data and Digital Photogrammetry. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series, No.117 pp. 223-230.

Letournel, V., Sankur, B., Pradeilles, F., H. Maitre, 2002. Feature Extraction For Quality Assessment Of Aerial Image Segmentation. Photogrammetric Computer Vision ISPRS Commission III, Symposium pp. A-199 ff.

Raafat, H. M., Gauthier, D. A., 1991. An Extended Relational Database For Remotely Sensed Image Data Management Within GIS. IEEE Transactions on Geoscience And Remote Sensing, Vol. 29(4)

Seresht, M. S., Azizi, A., 2000. Automatic Building Recognition From Digital Aerial Images. International Archives of Photogrammetry and Remote Sensing, Amsterdam, Vol. XXXIII Part B3, pp. 792-798.