DETECTION OF DAMAGED BUILDINGS AFTER AN EARTHQUAKE USING ARTIFICIAL NEURAL NETWORK ALGORITHM

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ABSTRACT:

It is obvious that an earthquake always is counted a threat to species life. It is necessary to react both accurately and precisely to the disaster. The most damages refer to the buildings and the roads between manmade structures and the paper is devoted to detection of damaged buildings after an earthquake. According to two points which the first is the importance of the cost and time of the disaster management and the other is absence of the data which has acquired before the event, leads to the use of the data after an earthquake. An earthquake usually acts nonlinear then the Neural Network algorithm can be an appropriate method. The results which have been obtained are satisfactory.

1. INTRODUCTION

Disaster management is an important problem in the urban management. Detection and determination the destructions of disaster are considered as significant items in disaster management. Among all disasters, earthquake is discussed as a natural disaster that includes more dangers and ruins therefore it is more noteworthy to various experts particularly to urban experts. Determination the damage extent of earthquake in an urban environment counts a vital issue.

In relation to the most ruination of urban environments, we can point to widespread buildings damages. Consequently detection of the damaged buildings immediate after event counts the main requirement in urban management. In recent years Remote Sensing and the technology of image (High Resolution Satellite Images) generation have had more developments and they have provided a comprehensive scope over urban management applications.

Also many researchers in these years have concentrated on the employ of the technologies in building detection and severance of undamaged and damaged buildings.

The investigations that involve disaster management usually apply the data of before and after the events.

Satellite images, aerial images, altimetry data and digital maps are the data can be used in the researches.
These researches have focused on comparing the damaged area conditions before and after the incident so they use both pre and post data to detect damaged buildings and determine their damage extents.

But always the data of before event are not available therefore using these methods leads to some problems. Hence it necessitates suggesting some methods that they just exert the data of after the incident to evaluate the damage extent over the buildings. When the post data are applied in detection of both damaged and undamaged buildings all data which can be used are image texture information, image colour information and altimetry information that altimetry information can be produced through stereo aerial photos or stereo satellite images even we can achieve it through the LIDAR data.

Lack of the data before the disaster makes for improvement of the utilized algorithms; thereupon our method proceeds to being more accurate and precise.

In the approach we have suggested in this research the image colour data and image texture data of Bam-Iran Buildings are used as data and buildings are separated of other features as damaged buildings are detached of undamaged buildings.

In recent months Iran has been known as sixth countries in the world which is dangerous in the point of view the hazards.

According to the prior studies and using the image classifications techniques we could classify the behaviours and the major characteristics of buildings at high-resolution images in our study which texture and colour declare these characteristics.
Finally we investigated the information of after incident till to evaluate the type and effects of the behaviours then model them to extend artificial neural network over them.

Artificial neural network has been chosen in this paper due to which results in more accurate information.

As we know artificial neural network algorithm has a nonlinear behaviour also the behaviours of buildings and other man-made features have unpredictable behaviours consequently it is a good choice for this estimation.

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In both statuses, which buildings are undamaged or they are damaged, they have remarkable height differences with respect to the other features that are near to them. Moreover they have different colour and texture.

These data have a very important role in buildings detection. In the other side in partitioning of damaged and undamaged buildings, image texture information has a major importance due to damaged buildings have coarsely textures and low grey values with respect to undamaged building.

Here we have utilized an artificial neural network algorithm to extend it, which applies the image colour data and image texture data as source. Then the available image is classified to three classes:

Background, undamaged buildings, damaged buildings.
One of the main advantages of this approach is generation a rapid damage map and faster and in point of the precision view posed as an analogous method.

To evaluation of the results we use at first some ground truths that are acquired through field and at second use the results of prior studied specifically comparing studies.

Results show that in the most cases building detection have been done well and damage and undamaged buildings severance have done with better precision but in comparison with the other assays that use post and pre data declare that use of pre data will improve the precision particularly if digital maps are available.

2. APPLICATION OF THE ALGORITHM

If earthquake ruins a building, the texture of the roof changed, then we can use the texture data to classify building pixels .Neural Network locates the both damaged and undamaged buildings but with relative accuracy, also it classifies the texture data.
Here co-occurrence matrix calculates the texture. The image has acquired by Quick Bird after Bam earthquake is only our data.

Figure 1. Quick Bird image before Bam earthquake.

Figure 2. Quick Bird image after Bam earthquake.

Maybe there is not any specific definition about texture, nowadays texture calculation divided to four class and we choose the statistical class and choose the method that is based on co-occurrence matrix which is symmetric in the discussion.

$$GLCM_d^\theta = \frac{1}{R} \begin{bmatrix} \eta(0,0) & \eta(0,1) & . & . & \eta(0,N_{g-1}) \\ \eta(1,0) & \eta(1,1) & . & . & . \\ . & . & . & \eta(i,j) & . \\ . & . & . & . & . \\ \eta(N_{g-1},0) & . & . & . & \eta(N_{g-1},N_{g-1}) \end{bmatrix}$$

$\eta(i,j)$: the number of pixels with grey level i , j in direction of θ and with distance of d
Ng : Number of Gray Levels
R: Total Number of Possible Pairs

In recent decade Neural Networks were used extensively to satellite image classification because Neural Network can be a calculation system that is substituted the non linear function and one of its advantages is that it is not restricted to the data distribution. Here we use BNN Neural Networks with three layers. First layer is input layer which are indexed with co-occurrence matrix. In this research the numbers of repeats are 3000 and the difference between the real answer and the acquired answer is 10^{-16} . After network training to evaluate the accuracy of the network we classified the control data and results showed 74 percent of damaged buildings were detected. The visual investigation is useful to understand the claim. To validate this result we run the MLL algorithm on the data and the results showed the success with almost 10 percent reduction.
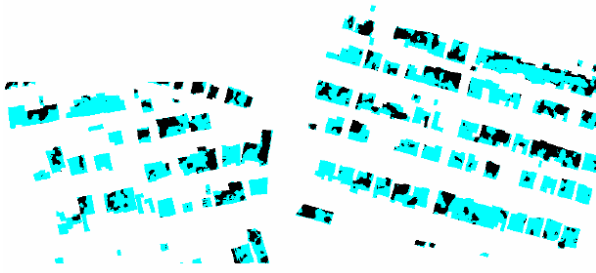
Figure 3. result of classification

Figure 3 shows the damaged buildings which are detected with the combined method. The parts that their colour is cyan are damaged and the others were classified to undamaged.

3. CONCLUSION

After combination between neural network algorithms with co-occurrence matrix, we can detect almost 60 percent of damaged buildings. Co-occurrence matrix helps us to calculate the texture of image and neural network classifies this texture which is changed after the earthquake, and the classification is restricted to 3 levels: high medium and low damage. This amount of percentage is related to the minimum data of the region but the use of stereo images leads to DSM generation which increases the percentage with altimetry Analysis's.

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