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Unsupervised Pixel Based Change Detection Technique from Color Image

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Summary

Change detection is an important process for many applications as monitoring the city development projects and monitoring the effects of environmental hazards and evaluation of crisis results. Automation of detected changes from two color images is a challenge because the two images are usually captured in different environments.

The objective of this research is to investigate an automated unsupervised technique for detecting changes from color image. The image pixel is represented as a function of its color channels' values, R, G and B which is called color signature of image pixel.

The correlation coefficients are calculated between color signatures of each two conjugate pixels from two different registered images for the same area of study. The detected pixels of changes are identified based on specific correlation value. The correlation value is identified based on degree of change sensitivity which is based on the importance of detection procedure that is considered as a main part of decision making risk and crisis management systems.

The investigated technique is unsupervised and fully automated. It can be applied through a real time process based on the processing capabilities and size and resolution of input images.

Introduction

Change detection is the process of detecting changes that are happened in the area of interest due to natural or industrial effects. The change detection technique using images has to be insensitive to changes illumination brightness [3]. These conditions represent the motivation of this research to investigate an unsupervised change detection technique. There are many techniques used in detecting changes from color and high resolution images based on data form image pixel without need of extracting features or objects [4-8]. The pixel based change detection algorithms need preprocessing methods as image registration and radiometric corrections. Image registration is necessary for identifying the two conjugate pixels in input images. Radiometric correction can be performed using many techniques and it needs more computations [4].There are different techniques for change detection based on image segmentation and object classification [9-13]. Object based change detection techniques needs more complex methods and computations, as classification and segmentation of image pixels to be able to detect changes. There are different change detection techniques based on a combination between pixel and object based methods [14, 15]. The proposed change detection technique is not based on any of the previous techniques. The change detection technique is based on an investigation of correlation between two data sets of color channels' values of each pixel in the input image of the area of study and the conjugate one in the other registered image of the same area of study. The implementation of the research algorithm for data processing, testing and validating the proposed change detection technique is executed through MATLAB environment. The real data which are available which are two high resolution satellite images captured from IKONOS satellite sensor without knowledge about the circumstances during the process of capturing images.

Research Algorithm and Methodologies

The research objective is to investigate the change detection technique based on applying statistical analysis on color channels of color image, so the first step of the research algorithm is to separate the color image to its preliminary components, red color channel, green color channel and blue color channel. The second step is to extract color signature of each pixel in RGB image. The correlation coefficient between each pixel in the first image and the conjugate one in the other input images is calculated. The statistical analysis is applied on the correlation coefficients results to identify the number and locations of pixels with respect to their degree of correlation. Image of change detection is produced to show the positions of pixels of changed features in the area of study. Figure 1 shows the schematic diagram of the work flow that is applied to fulfill the research objective.

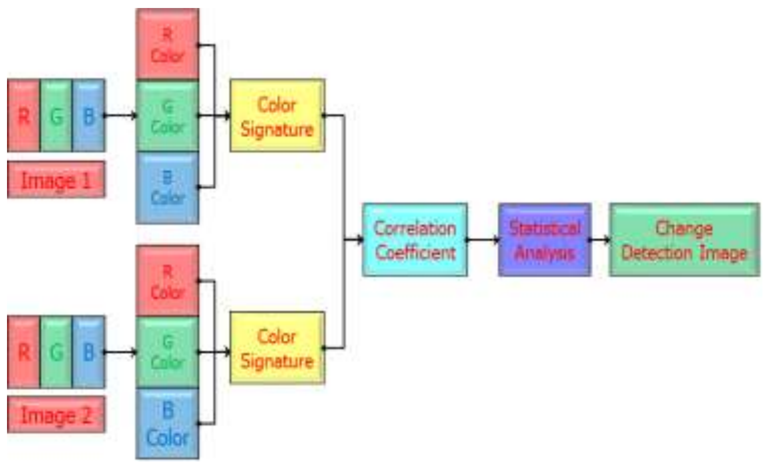


Figure 1: Work Flow of Research Algorithm

The color signature of a pixel is represented as a set of independent observations of R, G and B color channels as shown in Equation (1).

$$colorsig = [R.G.B] \quad (1)$$

where: $colorsig$ = color signature of pixel
R, G, B = color channels of the pixel

The correlation coefficient between any two sets of color channel observations can be determined by using the mathematical model that is shown in Equation (2) [16-19].

$$C_{f1f2} = \frac{\sigma_{f1f2}}{\sigma_{f1} * \sigma_{f2}} \quad (2)$$

where: C_{f1f2} = correlation coefficient between two sets $f1$ and $f2$
σ_{f1f2} = covariance of two sets $f1$ and $f2$
σ_{f1} = standard deviation of set $f1$
σ_{f2} = standard deviation of set $f2$

Change Detection Results and Analysis

Correlation coefficient represents the degree of correlation between each two pixels of same coordinates in the two images. The image pixels can be classified into five classes, strong correlation, high correlation, medium correlation, weak correlation and very weak correlation as shown in Figure 2.

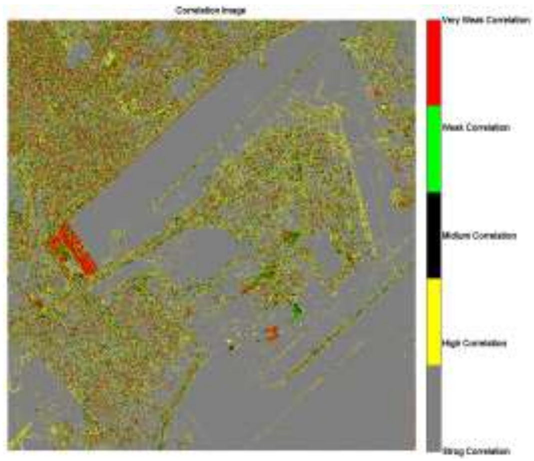


Figure 2: Image of Classification Based on Pixel Correlation

Changes can be detected from classified image for all pixels that give correlation coefficients not equals to 1. The required application controls the selected correlation values that indicate the degree of sensitivity for identifying pixels that can be taken in consideration as changed pixels. Table 1 shows the relations among the correlation values and different degrees of sensitivity.

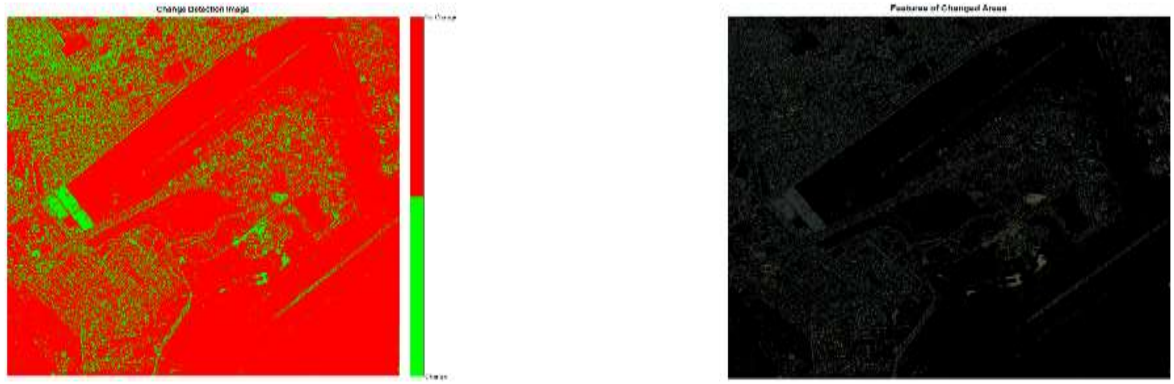
Table 1: Relations among Degree of Sensitivity and Correlation Values

Degree of Sensitivity	**Correlation Value**
1st Degree	30 %
2nd Degree	50 %
3rd Degree	75 %
4th Degree	90 %

Table 2 lists the number of detected pixels in all degrees of sensitivity. Figure 3 and Figure 4 show the image of changes in area of study and color image for the detected features in case of third and fourth degrees of sensitivity.

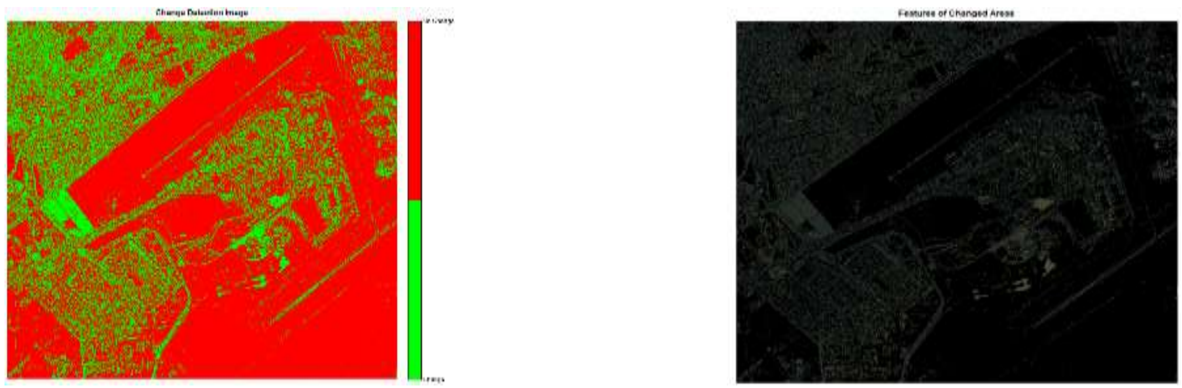
Table 2: Number of Detected Pixels

Degree of Sensitivity	**Number of Detected Pixels**	**Percentage from Area of Study Image**
1st Degree	1654538	5.610 %
2nd Degree	2919177	9.900 %
3rd Degree	4945463	16.770 %
4th Degree	7797125	26.440 %



(a) (b)

Figure 3: a) Image of Changes, b) RGB Image for Detected Features in Area of Study in Third Degree of Sensitivity



(a) (b)

Figure 4 a) Image of Changes, b) RGB Image for Detected Features in Area of Study in Fourth Degree of Sensitivity

Conclusions

Color images of same area of study may be captured in different environments. Color signature of image pixel is considered as a suitable representation for change detection from color image. The correlation coefficients are used to detect locations of changed pixels and then identifying the features in the input images. Correlation coefficients are used to define different degrees of change detection sensitivity based on specific application, targets, required mission or accuracy of required measurements. The degrees of sensitivity can be considered as a component of risk and crisis management systems that can be used for detecting and monitoring the effects of environmental hazards as floods and earthquakes. The investigated change detection technique is automated and unsupervised. It can be used as a real time technique based on the processing capabilities and size and resolution of input images.

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