IMAGE CHANGE DETECTION USING KERNEL SLOW FEATURE ANALYSIS WITH REGION BASED SEGMENTATION

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Abstract: Change detection (CD) is an extensive research field of remote sensing to analyze the changes between two multispectral/multi-temporal images. It has significant role within for the application of urban development monitoring to know how it enlarged within a particular period [1]. There are various standard ways and using a lot of techniques for the change detection. In this paper, we proposed a novel change detection methodology using Kernel Slow Feature Analysis (KSFA). Before that we are doing image compression that is one of the preprocessing techniques using Haar Transform. Then, KSFA is projected to extract the nonlinear temporally invariant options to separate changes and non-changes, to raise the change chance between corresponding multi-temporal images. Finally, the multi-temporal images were fused and segmented using Region Growing Technique. All these proposed methodology performed well in image change detection and segmentation.

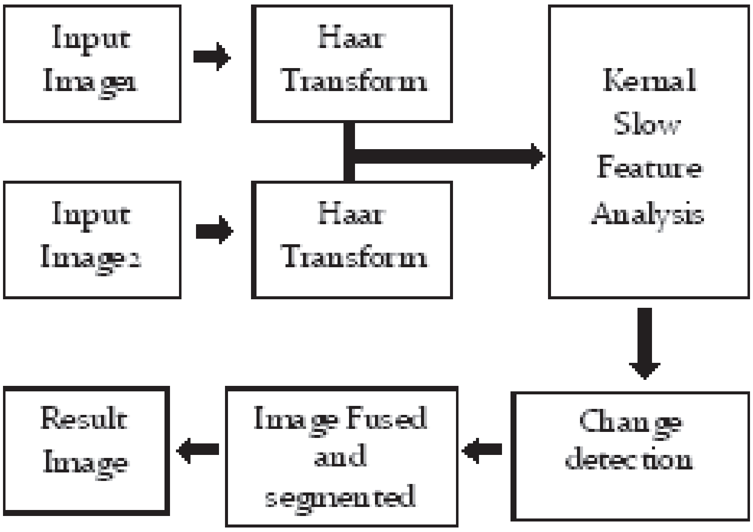
Keywords: Change Detection, Kernel Slow Feature Analysis (KSFA), Haar Transform, Region Growing Segmentation.

Introduction: Change detection is an important topic in the field of remote sensing. Remotely sensed data provide a quick representation of the whole real world. The changes done in earth surface might be caused by the human or natural disasters like earth quakes, flooding and unexpected forest fire. The human made changes can be the Infrastructure planning, mining, and deforestation. Change detection helps to monitor all these changes and also helps to maintain the natural resources [2]. Nowadays the high-resolution remote sensing data can also help us to find and classify the ground details with semantic labels such as industrial region, commercial region, and residential region. The rest of this paper is organized as follows: Section II details the proposed change detection methods. The experiments and discussions are presented in Section III. Finally, the conclusion is drawn in Section IV.

Methodology: The procedure which is followed is explained in figure 1.
The main steps are:

a. Pre-processing the multi-temporal images using Haar Transform to enhance the image by compression.
b. Implement KSFA algorithm to attain the change probabilities of multitemporal images.
c. Change Detection Result.
d. Fuse the multi-temporal images and apply Region-based segmentation using Region Growing technique.

The block diagram of the proposed system is shown in figure 1.



The Fig.1 Block diagram of Change Detection System

Haar Transform: In Change detection, there is a need of pre-processing and it includes filtering, compression and noise removal. Haar transform is one of the image compression techniques. The objective of compression technique is to represent the image pixels with less correlation. It is a simple, fast, and lossless image compression technique [3]. It's forward and inverse functions need addition and subtraction without convolution. Therefore the computational time and complexity can be reduced by this transform [4]. This compression technique follows orthogonal function. The Haar transform y_n of a n-input function x_n is

$y_n = H_n x_n$

The inverse Haar transform is $x_n = H^T y_n$

Kernel Slow Feature Analysis: Change detection in multi-temporal images is very difficult to find the changes due to the complex structure. The KSFA is a new method of learning invariant and slowly varying feature of the fast varying signal [5]. It can be applied to process high-dimensional input signal and extract complex feature. In this paper, KSFA is applied to get the pixel variation on multi-temporal images. Based on the difference we can take a binary decision whether there is a change or non-change between multi-temporal images.

SFA can be explained by giving a multidimensional temporal signal $s(t)=[s_1(t)....s_M(t)]^{T,}$ Here l ε $|t_0,t_1|$ indicates the time, we want to find a set of function $g_1(s)....,g_M(s)$ to confirm that the transformed output signals will be temporarily invariant. That means

$\min g_j \langle(g_j(s))^2\rangle_t$ (1)

under the constraints

$\langle g_j(s)\rangle_t = 0$ zero mean (2)

$\langle(g_j(s))^2\rangle_t =1$ unit variance(3)

$\forall i<j:\langle g_i(s)g_j(s)\rangle_t = 0$

decorrelation and order (4)

Here the bracket $\langle.\rangle_t$ indicates the mean value over time and g refers the first order derivative of the output signal.

(1) is used to minimize the temporal variance of the output signal.

(2) and (3) normalize all the output signal to the same scale to make sure their temporal variances are comparable.

(3) Make sure the output signal is mutually uncorrelated.

Segmentation using Region Growing: Region growing is a pixel based image segmentation technique. The main objective of this technique is to partition the input image according to homogeneous behavior of the region. That means the behavior may be pixel intensity, grey scale, color and texture. This approach starts with seed selection which is based on any one of the above criteria. The segmented region can be the basis of further tasks such as change detecting and recognizing an object [6].

Steps for Region Growing:

1. Select the seed pixel.
2. The region growing starts from the selected seed point and examine each and every adjacent pixel to decide whether it is similar to seed.
3. If it is similar to the seed value, it will be added to its region.
4. Else it will check another pixel until no more pixels can be added.

$s_{p1,\,p2}$ is the seed point or predicate value and is calculated based on any criteria. Also we need to define the threshold value (T) based on homogeneity.

$s_{p1,\,p2} \leq$ (T) Pixels are homogeneous.

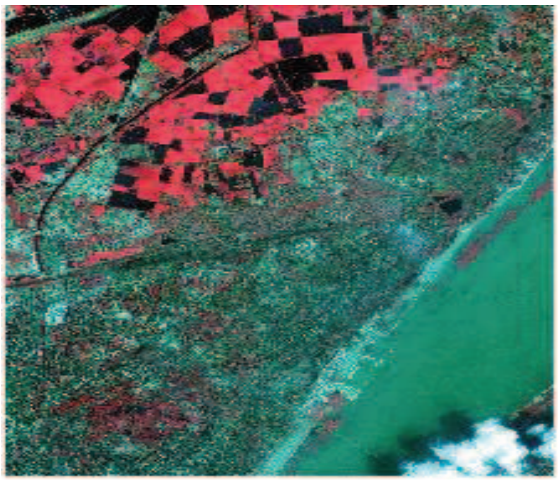
$s_{p1,\,p2} >$ (T) Pixels are not homogeneous.

This way the input images were partitioned. The selection of seed point and threshold value is important here to get good partitioning. This approach is not suitable for non-smoothly varying regions. Ex: texture.

Experimental Result:

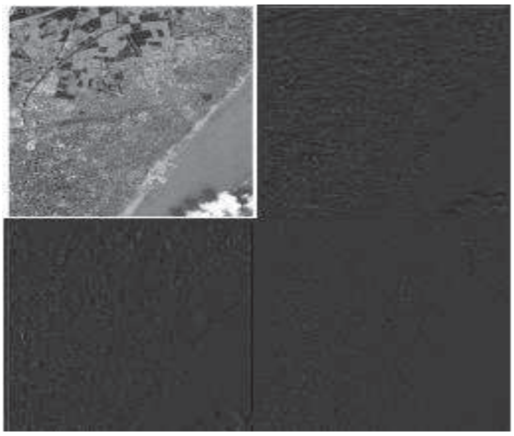
a) Original images

Input Image 1: year 2002

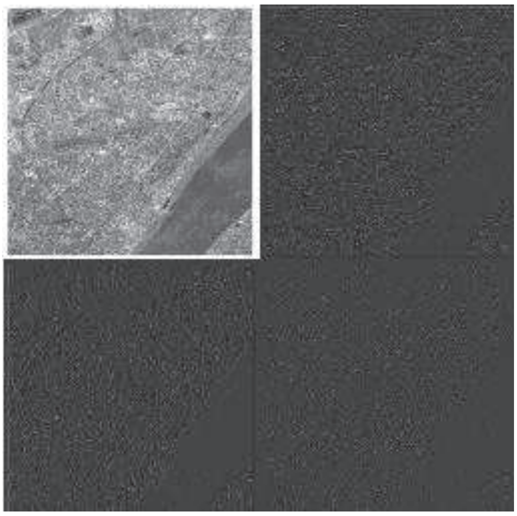


Input Image 2: year 2008

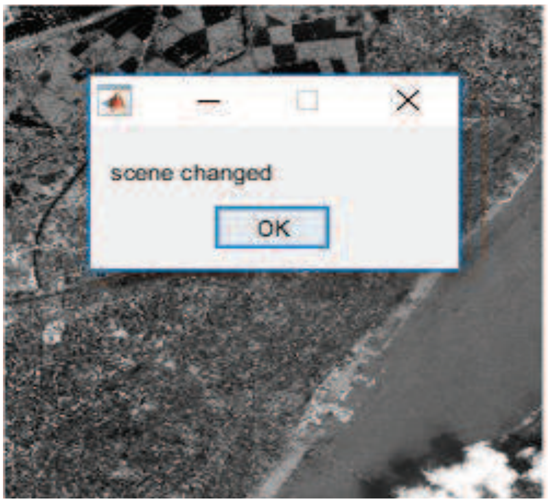
Haar Transform:
Input Image 1



Input Image 2



Kernel Slow Feature Analysis:



Changes occurred in multi-temporal images.

Segmentation Using Region Growing:

Conclusion: In this paper, we are using Haar transform for image compression and Kernel Slow Feature Analysis for change detection to conclude whether there is a change or Non-change present in multi-temporal images and we applied segmentation for region partition using Region growing method. All these techniques which are using here are performed well also having their own advantages and disadvantages. The future work will be, change transition where actually the changes occurred and classification of detected changes with improved accuracy.

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