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Multitemporal Image Fusion Based on Stationary Wavelet Transform and Change Detection using LDP Analysis

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Abstract:
This paper presents modification detection approach for hyper spectral images based on a picture fusion and supervised classifier system. The image fusion technique is introduced to generate image by exploitation complementary information from a mean-ratio image and a log-ratio image. SWT (Stationary wave transform) fusion rules primarily based on an average operator and minimum native space Energy area unit chosen for a low-frequency band and high-frequency band, severally to restrain the background information and enhance the data of changed regions within the amalgamate distinction image. The low frequency sub band constants area unit amalgamates by choosing coefficient having most abstraction frequency. It indicates the active level of a picture. The high frequency sub band coefficients area unit amalgamates by choosing coefficients having most LDP code price. The best details of 2 pictures area unit characterized by native directional pattern descriptors before fusion and it describes native primitives as well as differing kinds of curves, corners and junctions. LDP computes the sting response values altogether eight directions at every picture element position and generates a code from the relative strength magnitude. Finally, amalgamate two completely different frequency sub bands area unit inverse reworked to reconstruct amalgamate image. The system performance is evaluated by exploitation the parameters like Peak signal to noise magnitude relation, correlation and entropy.

Keywords: Image fusion, Stationary Wavelet Transform (SWT), LDP (Local Derivative Pattern), image analysis and change detection techniques.

I. INTRODUCTION

Image Fusion is the process of combining applicable information from two or more images into a single image. The fused image should have more complete information which is more useful for human or machine perception. The resulting image will be more explanatory than any of the input images. The input images are fused here to get more integral information and also some common redundant information. There are four kinds of image fusion are given below.

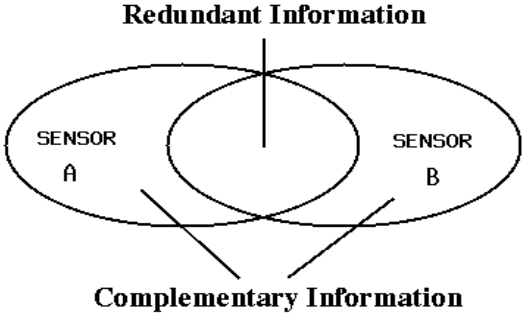


Figure.1. Basic Diagram of Image Fusion

- linear superposition
- non linear methods
- optimization approaches
- artificial neural networks
- image pyramids
- wavelet transform

The input images are fused here to get more complementary information and also some common redundant information. **Change Detection** techniques for space endured SAR data have not yet been fully explored. Change detection techniques for SAR data can be divided into several groups, each analogous to different image quality requirements. In a first category, changes are detected based on the temporal tracking of objects or stable image features of observable geometrical shape. Absolute calibration of the data is not required, but the data must be rectified from geometric distortions due to differences in imaging geometry or SAR processing parameters, and the accurate spatial registration of the multi date data is essential. Combining information captured from multiple sensors has become very popular in many signal and image processing applications. Two reasons are there in the case of earth observation. The first one is that the fusion of the data produced by different types of sensors provides integral which overcomes the limitations of a specific kind of sensor. The other reason is that, often, in operational applications, the user does not have the possibility to choose the data to work with and has to use the available archive images or the first acquisition available after an event of interest. This is exceptionally true for checking applications where image listing and change detection approaches have to be implemented on different types of data.

II. LITERATURE REVIEW:-

Literature inquiry is the most essential step in software development process. Before promote the tool it is necessary to

determine the time factor, economy and company strength. Once these things are satisfied, then next step is to determine which operating system and language can be used for developing the tool. Once the programmers start building the tool the programmers need lot of external support. This support can be obtained from senior programmers, from book or from websites. Before building the system the above considerations are taken into account for developing the proposed system.

A) An Introduction Image Fusion Techniques:-

Image fusion is the process of combining two or more images into a single image which preserve all the important features of original images. With fused image we will be get more information and complete image than any of the input images. This paper presents two approaches especially spatial fusion & transforms fusion and these are techniques such as principal component analysis, spatial domain technique and discrete wavelet transform, stationary wavelet transforms and discrete cosine transform which are transform domain techniques. So, in this paper presents comparison of PCA, DWT & DCT with SWT then with morphological processing. We get comparison with parameter like, spatial frequency, standard derivation, PSNR, NCC, etc. this type of parameters are using for getting high resolution and good quality. [1]

B) Analysis of Change Detection Techniques using remotely Sensed Data:-

Accurate information about description and extent of land cover changes especially in promptly growing areas is essential. Change detection plays very important role in different applications [6] such as video surveillance, medical imaging and remote sensing. It plays a very important role in land use and covers analysis, forest and vegetation analysis and flood monitoring. Semarang City, located on the north coast of island of Java, Indonesia that is very much prone to tidal floods. The objective of this research is to determine, evaluate and monitor the nature and extent of land cover changes in Semarang city through the period from 2012 to 2014 using remotely sensed Land sat multispectral images. Four change detection techniques namely; post-classification, image differencing, image regression and principal component analysis were applied. The objective is drawn out to consider the efficiency of each change detection technique respecting the ability to differentiate changed from unchanged areas based on the pixel-by-pixel analysis and calculating the overall number of changed pixels. The results indicated that the post classification change detection technique provided the highest accuracy while the principal component analysis technique gave the least accuracy. [2]

C) Change Detection Accuracy and Image Properties: A Study Using Simulated Data:-

Pretended data were used to interrogate the exchange between image equity and change detection accuracy in a systematic manner. The image properties examined were class reparability, radiometric normalization and image spectral band-to-band correlation. The change detection methods were analyzed post-analysis correlation and direct classification of multi date imagery, image differencing, principal component analysis, and change vector analysis. The simulated data experiments showed that the relative accuracy of the change detection methods varied with changes in image properties, thus confirming the hypothesis that caution should be used in generalizing from studies that use only a single image pair. In most cases, direct classification and post-classification comparison were the least sensitive to changes in the image properties of class reparability, radiometric normalization error and band correlation. Furthermore, these methods generally produced the highest accuracy, or were amongst those with a high accuracy. PCA accuracy was highly variable; the use of four principal components consistently resulted in substantial decreased classification accuracy relative to using six components, or classification using the original six bands. The accuracy of image differencing also various greatly in the experiments. Of the three methods that require radiometric normalization, image differencing was the method most affected by radiometric error, relative to change vector and classification methods, for classes that have moderate and low reparability. For classes that are highly divisible, image differencing was relatively unaffected by radiometric normalization error. CVA was found to be the most accurate method for classes with low reparability and all but the largest radiometric errors. CVA accuracy contributes to be the least affected by changes in the degree of band correlation in situations where the class means were moderately dispersed, or clustered near the diagonal. For all change detection methods, the classification accuracy increased as simulated band correlation increased, and direct classification methods consistently had the highest accuracy, while PCA generally had the lowest accuracy. [3]

D) Multimodal Image Fusion using Stationary Wavelet Transform and Fuzzy logic:-

The information extraction process of image, for example image taken from precise camera, is full of complexities and noises. As a result, cost spends on such processing like time and assets is high, particularly for large and complex amount of information. The image fusion is the process of merging two or more images into a single image preserving significant features from each. The result of fused image is a single image which is highly appropriate for person and machine observation or further image-processing missions. In this paper, we are going to extract image from two or more images.

The proposed fusion techniques are based on two processes. One is Stationary Wavelet Transform (SWT) and the other one is Fuzzy logic. Stationary Wavelet Transform provides higher level of decomposition for fused image fusion. And Fuzzy logic allows the problems to be solved in linguistic terms. It can provide number of possible result. [4]

E) Comparative Study of Image Fusion Techniques based on Spatial and Transform Domain:-

Image Fusion is the process of combining two or more images into a single image which can retain all important features of all original images. Fused image will be more informative and complete than any of the input images. This paper presents two approaches to image fusion, namely Spatial Fusion and Transform Fusion. These papers describe procedures such as Principal Component Analysis, spatial domain technique and Discrete Wavelet Transform, Stationary Wavelet Transform which are Transform domain techniques. Performance metrics without reference image are implemented to evaluate the performance of image fusion algorithm. Empirical outcome commenced that image fusion method based on Stationary

Wavelet Transform is remarkably better than Principal Component Analysis and Discrete Wavelet Transform. [5].

III. EXISTING SYSTEM

Discrete Cosine Transform Method:-

Discrete Cosine Transform (DCT) is separates the image to number of blocks. In these blocks first block has the low frequency information.

We can see clear information in low frequency sub band.DCT fuses the corresponding areas of the original images according to the DCT coefficient high frequency energy.

Drawbacks of Existing System:-

- Contrast information loss due to averaging method
- Maximization method sensitive to sensor noise and high spatial distortion
- K means - It is not suitable for all lighting condition of images
- Difficult to measure the cluster quality.

IV. PROPOSED METHOD

SYSTEM MODEL:-

Image fusion and scene change detection based on satellite images are given below,

Methodology:-

1. Stationary Wavelet Transform
2. Probabilistic Neural Network
3. Pixel Level Image Fusion

Proposed Mechanism:-

1. Stationary Wavelet Transform:-

Wavelet Transform is a category of signal delegation that can give the frequency willing of the signal at a particular instant of time or spatial location. Stationary wavelet transform decomposes the image into different sub band images, it splits component into numerous frequency bands called sub bands. They are LL, LH, HL, and HH sub bands. A high-frequency sub band contains the edge information of input image and low-low sub band contains the clear information about the image. Up sampling of coefficient will be performed for factor 2 after each row and column decomposition process to make lossless representation of edge details.

Process Flow:-

Change Detection:-

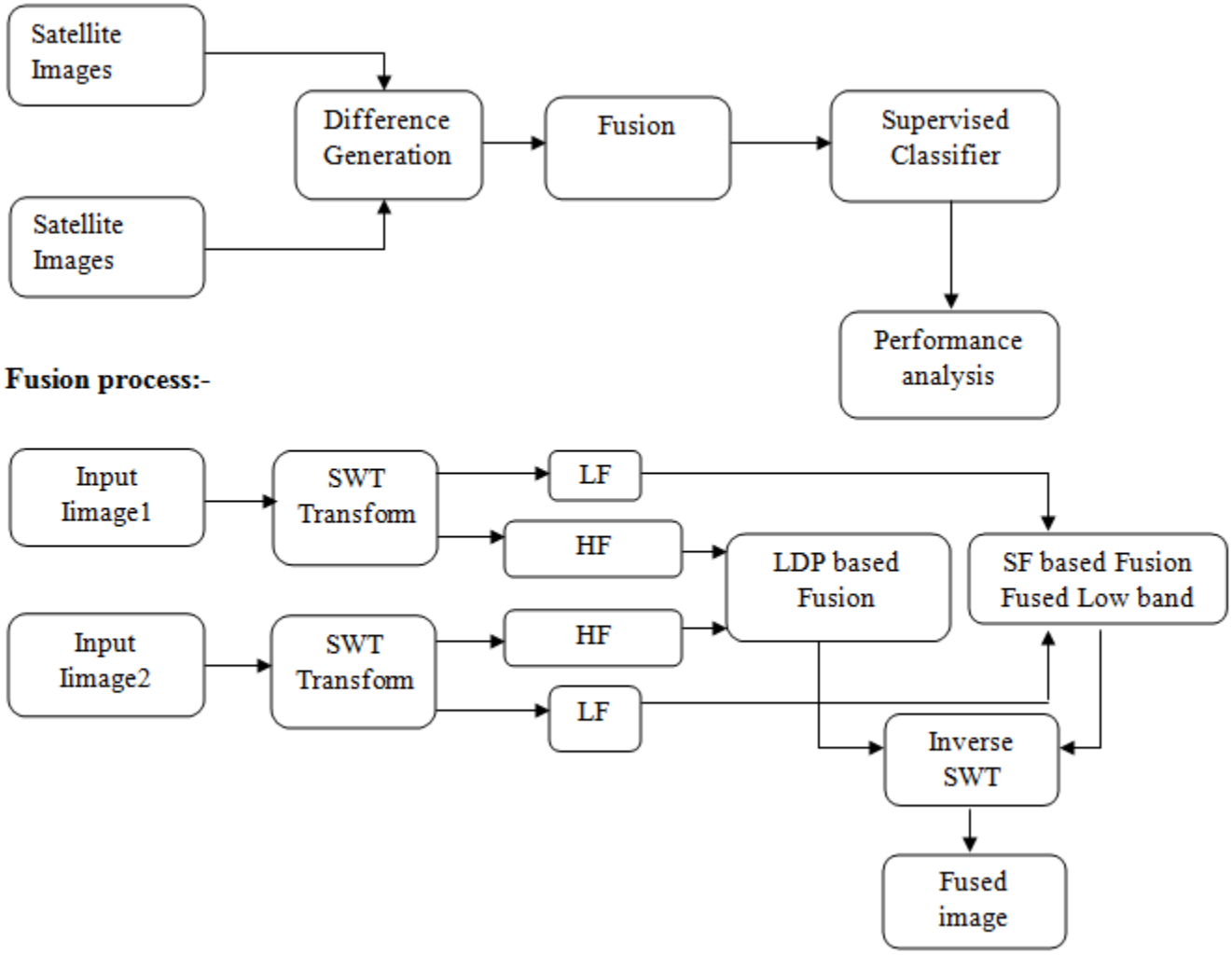
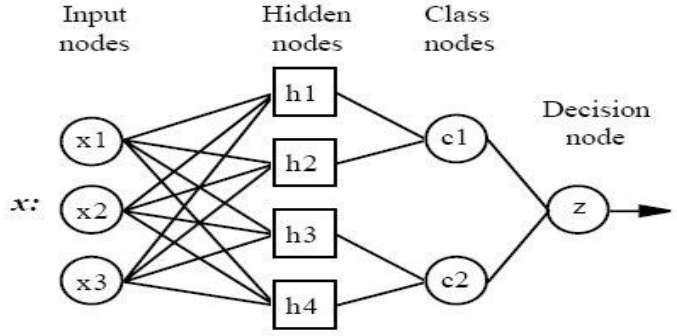


Figure.1. Proposed Method Block Diagram Using SWT Method:-

2. Probabilistic Neural Networks (PNN): Probabilistic neural network and generic relapse neural network is also complementary architectures, but there is a fundamental difference: Probabilistic networks perform classification where the target variable is categorical, whereas general regression neural networks perform regression where the target variable is continuous. If you select a probabilistic neural network or general regression neural network will automatically select the correct type of network based on the type of target variable.

Architecture of A PNN:



All PNN Networks Have Three Layers:

1. **Input Layer:** There is one neural in the input layer for each predictor variable. In the N-1 neurons are used where *N* is the number of categories. The input neurons or processing before the input layer standardize the range of the values by subtracting the median and dividing by the inter quartile range. The input neurons feed the values to the hidden layer.
2. **Hidden Layer:** This layer has one neuron for each case in the training data set. The neuron stores the values of the witch variables for the case along with the target value. When present the *x* vector of input values from the input layer, a hidden neuron computes the figure out distance of the test case from the neuron's center point and then applies the RBF kernel function using the sigma values. The resulting value is passed to the neurons in the pattern layer.
3. **Decision Layer:** The decision layer is different for PNN and GRNN networks. The decision layer compares the weighted tally for each target category accumulated in the pattern layer and uses the largest vote to predict the target category.

For GRNN networks, the decision layer divides the value accumulated in the numerator summation unit by the value in the denominator summation unit and uses the result as the predicted target value. The following diagram is actual diagram or propose network used in our project.

3. Pixel Level Image Fusion:

Image fusion is done at pixel level the source images are combined without any pre-processing. The pixel level fusion (also called image level fusion) algorithms vary from simple image averaging to very complex algorithms. The simplest MSIF is to take the average of the grey level source images pixel by pixel. This technique would produce several undesired effects and reduced feature contrast. Multi focus image fusion is performed with pixel level fusion rule called maximum method. The low frequency sub band coefficients are fused by selecting coefficient having maximum spatial frequency. It indicates the overall active level of an image. The high frequency sub band coefficients are fused by selecting coefficients having maximum LDP code value.

SF Based Fusion:-

The spatial frequency, which had its beginning with the study of the human visual system, indicates the overall active level of an image. The row frequency (RF) and column frequency (CF) of an 8x8 image. Spatial frequency is defined by following, $SF = RF^2 + CF^2$

Fusion of Low-Frequency Coefficients:-Since the images' estimated information is built by the low-frequency coefficients, average rule is adopted for low-frequency coefficients. Presume $B_F\ (x, y)$ is the fused low-frequency coordinates, then

$$B_f(x, y)=B_1(x, y) +B_2(x, y)/2$$

Where $B_1\ (x, y)$ and $B_2\ (x, y)$ denote the low-frequency coefficients of source images.

Fusion of High-Frequency Coefficients:-High-frequency coefficients always consist of edge and texture features. We define region energy by computing the sum of the coefficients' square in the local window. Suppose $C\ 1^k$ (x y) is the high-frequency CT coefficients, whose position is (x, y) in the sub band of k^{th} direction at l^{th} decomposition scale. The region energy is defined as follows:

$E_1^k(x,y)=\sum_{m,n\in Sm,n} C_1^k\ (x+m, y+n))^2$

where $Sm \times n$ denotes the provincial window and its size is M × N (typically 3×3).Region energy, rather than single pixel value, will be more reasonable to extract features of source images by utilizing neighbors' information.

Log Ratio Approach:-

D1 = | log X2 – log X1| Where,

X2 is Input image1 and X1 is Input image2

Mean Ratio Approach:-

D2 = 1 – min (u1/u2, u2/u1); Where,

U1 is average filtered image1, U2 is average filtered image2.

Performance Evaluation Metrics:-

Root Mean Square Error (RMSE)

This metric is computed as the root mean square error of the corresponding pixels in the reference image, and the fused image. This metric will be nearly zero when the reference and fused images are similar. This will increase when the dissimilarity increases.

Peak Signal to Noise Ratio (PSNR):-

Peak signal-to-noise ratio exhaust between two images. This ratio is used to aspect evaluations between the original and reconstructed image. The higher the PSNR, the better is the quality of the reconstructed image. To gauge the PSNR, first we have to compute the mean squared error (MSE).

Its value will be high when the fused and reference images are similar. Higher value implies better fusion. The peak signal to noise ratio is computed as:

$$PSNR=10*\log_{10}(Peak^2|MSE)$$

Table.1. Performance Analysis:-

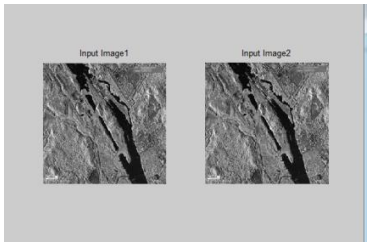
Performance Evaluation	IMAGE 1	IMAGE 2
PSNR	66.8173	42.6929
RMSE	0.0135	31.8272

Advantages:-

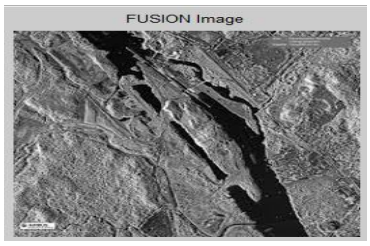
- Accurate detection of foreground changes by fusion
- Less sensitive to noises and less processing time.

V.RESULT ANALYSIS:-

Here we report some experimental results that illustrate the performance of the proposed approach. The experiments were performed under windows and mat lab running on a desktop machine.

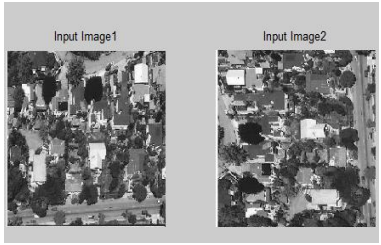


5.1 Input Image:-

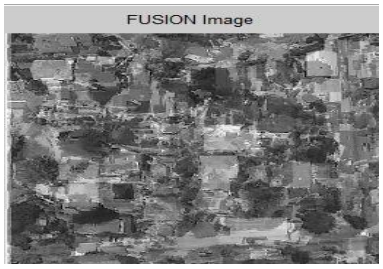


5.2 Fusion Image:-

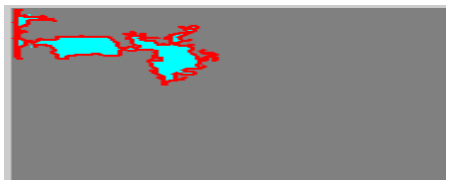
5.3 Change Detection:-



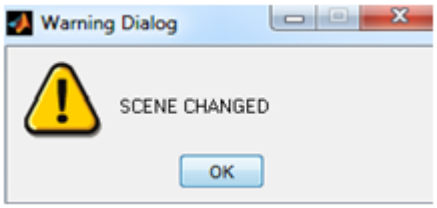
6.1 Input Image

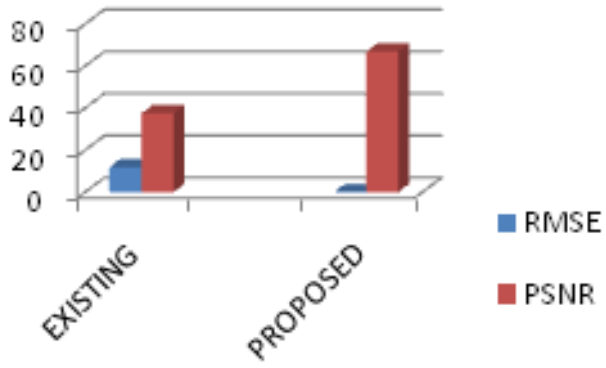


6.2 Fusion Image:-



6.3 Change Detection:-





PERFORMANCE ANALYSIS:-
Root Means Square Error: 42.6929
Peak Signal to Noise Ratio: 31.8272

VII. CONCLUSION:-

The analysis of multi temporal images has been done. The energy function is altered by utilizing not only the membership but also the number of same class of neighborhood pixels. Thus we are able to decide whether the central pixels are in the homogenous region or in the heterogeneous region. The new approach does not consider the use of any prior knowledge about the scene but it considers only the use of gray-level intensity. The main advantages of change detection approach is reducing the speckle noise, making the computations are simpler and it has low complexity. To compute the images by the technique of image fusion, the image is normally converted from discrete waveform to Stationary wavelet transform (SWT). This technique is achieved and efficiency is also increase.

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