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TWIN-TIER WITH LIFTING WAVELET APPROACH FOR FEATURE EXTRACTION OF SATELLITE IMAGES

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ABSTRACT - Feature extraction methods are broadly being utilized in satellite imagery and standing out enough to be noticed for remote detecting applications. The best in class feature extraction strategies are fitting as indicated by the classifications and structures of the items to be distinguished. In view of particular calculations of each feature extraction technique, various kinds of images are chosen to assess the performance of the strategies. In this stage, we proposed Twin-Tier with Lifting Wavelet Approach for Feature Extraction of Satellite Images. The feature extraction process is accomplished by joining numerous features twin-tier feature extraction implies (statistical and GLCM) and Lifting Wavelet (LWT) features to assemble the feature vector. Two degrees of feature extraction distinguish fine features from the satellite images. The exploratory outcomes demonstrated the proposed approach gives an incredible outcome.

Keywords: [Feature Extraction, satellite images, Twin-Tier, Lifting Wavelet, feature vector, statistical and GLCM.]

1. INTRODUCTION

Satellite Image Processing is a huge field in inventive work and involves the images of earth and satellites taken by the strategies for fake satellites. Pre-handling is a normal name for errands with images at the most decreased level of reflection - both information and yield are power images. These popular images are of a comparable kind as the primary information got by the sensor, with a strong picture typically addressed by a framework of picture work esteem (brilliance's). The place of pre handling is an improvement of the picture information that stifles hesitant twists or redesigns some picture highlights critical for extra handling, but geometric changes of images (for instance turn, scaling, translation) are organized among pre-handling techniques here since equivalent methodology are used. Accuracy altered things are major for employments of satellite imagery requiring high precision, for instance, arranging, map updates and change disclosure. Such applications subsequently require a one of a kind pre-handling strategy.

Airborne and satellite imagery collection are significant for different application domains, including land stock and vegetation checking [1,2]. Much exploration has been done on imagery collection techniques, amendment and registration of airborne imagery [3,4]. Quick advancement in information collection has been found as of late because of lower expenses of information collection and further developed technology [5]. In any case, imagery has minimal importance unless it is handled and meaningful data is recovered. As of late, a few techniques have arisen to mechanize the course of data recovery from satellite imagery, and a few application domains have been designated [6–8]. Existing strategies for addressing the article acknowledgment task normally depend on segmentation and feature extraction [9–15]. One of the significant difficulties that many created calculations face is their inapplicability to different domains. Numerous answers for picture segmentation and classification figure out impeccably for one specific issue and frequently for one specific district with notable occasional changes in imagery. It should be referenced that due to the previously mentioned progress in acquisition technology and unnecessary resolution, picture segmentation is frequently not of interest, and picture information can be trimmed into regions with fixed dimensions.

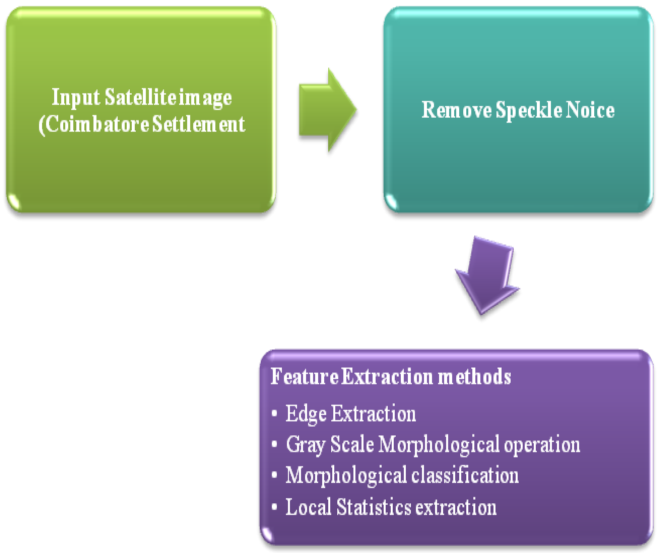

Figure 1. Feature extraction Methods

For this exploration study, nineteen features are removed from the 385 images put away in the ORSSI storehouse. It is ordered as follows: 12 surface features removed are: Energy, Entropy, Contrast, Homogeneity, Correlation, Autocorrelation, Sum Average, Sum Variance, Sum Entropy, Sum of Variances, Difference Variance and Difference Entropy; 3 shading features separated are:(based on reflectance) Cluster Shade, Cluster Prominence and Dissimilarity and 4 article features extricated are: Mean, Median, Mode and Standard Deviation.

2. EXISTING METHODOLOGY

1. Veera Basavanthaswami et al. proposed a SPIHT calculation and at a given piece rate, the emotional visual top-notch is progressed to a specific volume. Simultaneously, considering the ignoring of insignificant information looking at, the most un-troublesome 25% data changed into dealt with. The memory has been saved and the coding viability has been improved. Considering everything, the arrangement of rules may be broadly used inside the memory-restricted and steady conditions. Additionally, DWT and Lifting Wavelet alter are in connection through the utilization of SPIHT computation for CR, PSNR and encoding and interpreting time. Higher PSNR is acted in a Lifting plan in contrast with DWT. This SPIHT estimation performs speedy strain and decompression, saves part of information transmission, enables fast transmission and requires less capacity memory. The SPIHT estimation should be possible to warm research fields, for instance, logical order, correspondence territory, and so on In which fast transmission of photo records from one locale to some other can be cultivated through securing fine of photo indistinguishable.

2. Jun Zhang et.al, proposed a computer analysis based on image analysis, the image segmentation is the best. For time-saving strategies, the programmed Thresholding technique is an absolute necessity, and we involved the OTSU strategy for the Thresholding technique in their picture division technique. The 2D Otsu procedure additionally can be known as a Two-dimensional strategy that acts well-distributing pictures sign noise proportion from one-dimensional (1D). Nonetheless, it gives satisfactory results exactly when the amounts of pixels in each class are close to each other. Else, it gives inappropriate results. At this moment, a projection histogram has been used to address the Otsu edge. The one-dimensional histograms are procured in x and y by two-dimensional histogram projection hatchets. We took speedy computations in checking out the expected histogram that had been proposed reliant upon wavelet change at this moment. In our renal biopsy tests, the preliminary test shows the outcome is better when contrasted and some other Otsu techniques.

3. S. NirmalRaj et.al, proposed a method to expand the quality and proficiency of the images taken from an unrestrained climate and a pressure method we used to work on the performance of the images. Picture pressure is a fundamental method for picture transmission that got through the channel. Critical method exceptional paper in this picture pressure had been finished using by the wavelet picture pressure-based, decay frameworks. SPIHT based picture pressure has been created for achieving picture pressure better high in pressure proportion. Entertainment results of SPIHT technique are contrasted and the diverse existing pressure methodologies, for instance, VD, DCT and DWT. Every one of the techniques used right currently are executed in MATLAB programming and the show is pondered using the parameters, for instance, PSNR, MSE, CR and stuffed size.

4. Xuelong Li et.al, proposed Hyper spectral picture is known as HSI, for the most part, has low spatial and high ghastly goals, Multispectral picture is known as MSI, for the most part, has low unearthly and high spatial goals. Both have this impediment due to equipment. The picture combination is the strategy to get the came about the picture in both high in phantom and spatial goals. The band reproduction technique is utilized in the combination of Hyper spectral and Multispectral Images. The Band recreation strategy is utilizing ghastly un-blending and it procures high goals pictures. It depends on the direct least squares.

5. Srinath Doss, Souvik Pal et.al proposed a Satellite Remote Sensing Image based for identifying Aircraft Using Transform Features (SPIHT, NSCT) and Detect Fuzzy Clustering, another hearty kind acknowledgment strategy for airplane focuses in high-goals remote detecting images has been proposed. The favourable primary position of the approach lies in that the technique can perceive airplane heartily and avoids the objective in the general shape extraction stage, which is typically remembered for the conventional acknowledgment strategies and isn't reasonable because of upsetting foundation. Every one of the current strategies gave a solitary extraordinary element to identify Aircraft. Those highlights were free and those strategies didn't consider staggering highlights. We have used all the shape attributes for applicant determination, which is imperative so as to separate precisely the airplane competitor. Accordingly, the Aircraft can be found even within sight of jumbled back Ground and other earthly aggravations. The work focuses on the most part on diminishing the hour of applicant Identification killing other earthbound unsettling influences.

3. PROPOSED METHODOLOGY

The feature extraction process is achieved by combining multiple features twin-tier feature extraction and Lifting Wavelet (LWT) features to build the feature vector. Two levels of feature extraction detect fine features from the satellite images.

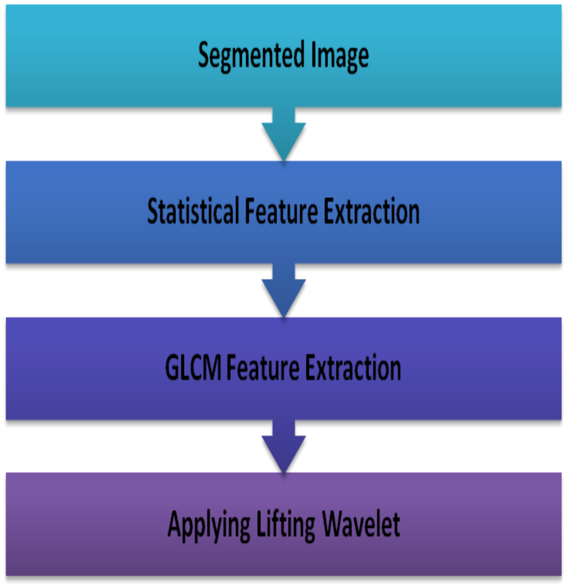

Figure 2. Twin-Tier Feature Extraction Approach Workflow

Twin-Tier Feature Extraction Approach

This work employs twin-tier feature extraction technique, which extracts features in two ways. Initially, the texture features are extracted by statistical and GLCM feature extraction techniques. Again, the same sets of features are extracted from the images after the application of LWT. All the extracted features are combined together to form the feature vector.

Statistical and GLCM feature Extraction

The GLCM utilizes a co-occurrence matrix to extract texture features of a picture utilizing statistical conditions. A co-occurrence matrix is a matrix or distribution that is characterized over a picture to be the distribution of co-occurring values at a given offset. Regardless of whether thinking about the power or greyscale upsides of the picture or different dimensions of shading, the co-occurrence matrix can gauge the texture of the picture. Since co-occurrence frameworks are normally enormous and inadequate, different measurements of the matrix are regularly taken to get a more valuable arrangement of features. The GLCM is an arrangement of how regularly various combinations of pixel brightness esteems (dim levels) happen in a picture. The conditions for computing the different GLCM features are given below.

Texture features

The following are the 12 texture features calculated, for all the 385 images from the ORSSI image repository and stored in the texture feature set, used for this research work.

Energy feature is calculated as

$$Energy = \sum_{i,j=0}^{N-1} (P_{ij})^2$$

Entropy feature is calculated as

$$\text{Entropy} = \sum_{i,j=0}^{N-1} In(P_{ij})P_{ij}$$

Contrast is calculated as

$$Contrast = \sum_{i,j=0}^{N-1} P_{ij}(i-j)^2$$

Homogeneity feature is calculated as

$$\text{Homogeneity} = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2}$$

P_{ij}=Element i, j of the normalized symmetrical GLCM

N =Number of gray levels in the image specified by number by Number of levels in under Quantization

Correlation feature is calculated as:

$$Correlation = \sum_{i,j=0}^{N-1} \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

μ = The GLCM mean (being an estimate of the intensity of all pixels in the relationship that contributed to the GLCM), calculated as:

$$\mu = \sum_{i,j=0}^{N-1} iP_{ij}$$

σ^2= The variance of the intensities of all reference pixels in the relationships that contributed to the GLCM is calculated as:

$$\sigma^2 = \sum_{i,j=0}^{N-1} P_{ij}(i-\mu)^2$$

This also approximates, but is not identical to the mean of all the pixels in the data window W, as it dependent upon the choice of spatial relationship in that algorithm.

Autocorrelation calculated as

$$\text{Autocorrelation} = \sum_i \sum_j (ij).p(i,j)$$

Sum average is calculated as

$$Sum\ average = \sum_{i=2}^{2N_g} ip_{x+y}(i)$$

Sum Variance is calculated as

$$\text{Sum Variance} = \sum_{i=2}^{2N_g} (i - \sum_{i=2}^{2N_g} p_{x+y}(i)\log\{p_{x+y}(i)\})$$

Sum Entropy Calculated as

$$Sum\ entropy = \sum_{i=2}^{2N_g} p_{x+y}(i)\log\{p_{x+y}(i)\}$$

Sum of variance calculated as

$$\text{Sum of variances} = \sum_{i=0}^{g-1}\sum_{i=0}^{g-1} (i-\mu)^2 p(i,j)$$

Difference Variances is calculated as

$$\text{Difference Variance} = \text{Variance of } p_{x+y}$$

Difference Entropy is calculated as

$$\text{Difference Entropy} = \sum_{n=0}^{N_g-1} p_{x-y}(i)\log\{p_{x-y}(i)\}$$

Colour features

The following are the 3 colour features calculated, for all the 385 images from the ORSSI image repository and stored in the colour feature set, used for this research work.

Shade feature is calculated as

$$Shade = sgn(A)|A|^{1/3}$$

Where $A = \sum_{i,j=0}^{N-1} \frac{(i+j-2\mu)^3 P_{ij}}{\sigma^3\left(\sqrt{2(1+C)}\right)^2}$

Prominence feature is calculated as

$$\text{Prominence} = \text{sgn}(B)|B|^{1/4}$$

Where $B = \sum_{i,j=0}^{N-1} \frac{(i+j-2\mu)^4 P_{ij}}{4\sigma^4(1+C)^2}$

Dissimilarity feature is calculated as

$$\text{Dissimilarity} = \sum_i \sum_j [i-j|.p(i,j)$$

Object features

The following are the 4 object features calculated, for all the 385 images from the ORSSI image repository and stored in the object feature set, used for this research work.

Mean Feature is calculated as

$$Mean(\mu_x) = \sum_i \sum_j i.p(i,j)$$

$$Mean(\mu_y) = \sum_i \sum_j j.p(i,j)$$

Median: Mean dataset are arranged in acceding order and the middle values taken as median

Mode: The mode of mean dataset is the value that occurs most often in mean dataset.

Standard deviation is calculated as

$$S.D(\sigma_x) = \sum_i \sum_j (i-\mu_x)^2.p(i,j)$$

$$S.D(\sigma_y) = \sum_i \sum_j (i-\mu_y)^2 . p(i,j)$$

The feature vector has 20 columns with 'n' rows, where n is the number of images multiplied by number of clusters segmented by the images in the dataset. Each column represents a feature. The data structure used to store the feature vector is a 2-dimensional matrix array as given in figure 3.

Feature 1	Feature 2	Feature3	Feature 5	……	Feature 19	Image Label
Real Value	Real Value	Real Value	Real Value	……	Real Value	1/2/3/4/5/6

Figure 3. Feature vector data Structure

The last column of the feature vector contains the integer code that acts as target (label) of each clustered image. The integer code 1 – 6 represents the value of the objects recognized in the satellite images.

Feature Extraction on LWT Applied Image

This work applies LWT, to have better capabilities. LWT is applied; as it is demonstrated to protect the phantom properties of a picture alongside better denoising ability. LWT is proposed during the '90s by Daubechies. The LWT is made out of three fundamental phases and they are parted expectation and update phase. This sort of wavelet depends on the double symmetrical wavelet with upgraded dualization. The split phase means to part a picture and this splitting system is known as a lazy wavelet transform. The pictures are separated into two gatherings and are named odd and even gatherings. The splitting system can be addressed as follows.

Let im_k be the data applied with LWT, and then im_k is decomposed into odd and even sample group. The odd and even sample group. The odd and even sample group are represented by odd_{k+1} and $even_{k+1}$. In the prediction phase, the odd sample group is predicted with the help of the neighbourhoods even sample group. This introduce a new entity called prediction factor and is denoted by P. High pass coefficient or detail coefficient hp_{k+1} is computed as prediction error, while handling the odd sample group. On the other hand, The prediction factor is utilized for even sample group and is represented by

$$hp_{k+1} = odd_{k+1} - P(even_{k+1})$$

In the update, the approximation coefficient ac_{k+1} is generated by updating the detail coefficient on the even sample group and is achieved by update factor (up). The update phase is denoted as follows.

$$ac_{k+1} = even_{k+1} + Up(hp_{k+1})$$

The satellite images are applied with LWT and the approximate bands of the images are extracted for further processing. Once the features of LWT applied images are extracted, the feature vector is formed by considering the first order, GLCM and LWT applied image features.

4. EXPERIMENT RESULT

Performance Evaluation Measures

The decision of standard execution appraisal measures empowers proper assessment of the proposed strategy with other existing procedures. The expectation accomplishment of the classifier might be assessed by looking at the disarray matrix. To break down the result information acquired from the application. TPR (genuine positive proportion) and TNR (genuine negative proportion) are determined by utilizing a disarray matrix. The exhibition of the item acknowledgment framework to perceive objects in satellite images can be controlled by the processing Object Recognition Rate (ORR) or affectability, False Alarm Rate (FAR) or explicitness and classification accuracy (CA).

Object Recognition Rate (ORR) – Sensitivity

The Object Recognition Rate (ORR) or the sensitivity ensures the test ability of the classifier. ORR or sensitivity regards only positive cases, for instance, it can be used to recognize the objects present in the satellite images. ORR or sensitivity was computed as for each object

$$ORR = \frac{number\ of\ true\ positive\ decisions}{number\ of\ actual\ positive\ cases\ for\ each\ class}$$

In other words,

$$Sensitivity = [TP/TP + FN(\%)$$

Where, TP= True Positive cases and FN= False Negative cases.

Accuracy

No of images	GLCM	Statistical + GLCM	Proposed Twin-tier with LWT
10	84	88	98
20	82	86	96
30	80	84	95
40	76	83	93
50	79	82	91

Table 1. Comparision of Accuracy

The Comparison table 1 of Accuracy of Value explains the different values of existing algorithm GLCM, Statistical GLCM and proposed Twin-tier with LWT. While comparing the Existing algorithm**,** the proposed provides the better results. The existing algorithm (GLCM, Statistical GLCM) values start from 79 to 84 and 88 to 84 but proposed Twin-tiers with LWT starts from 91 to 98 provide the great results.

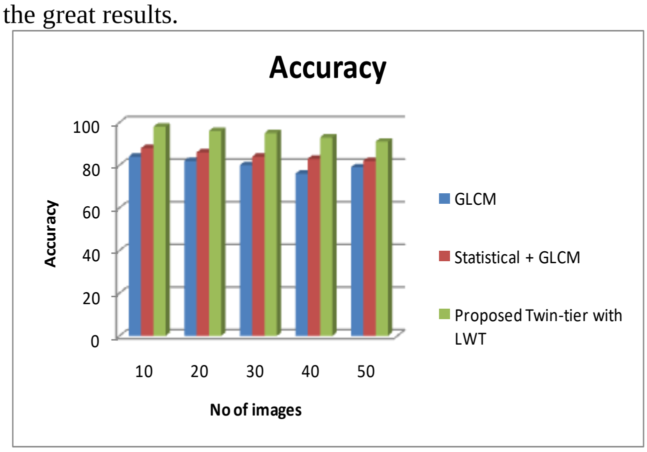

Figure 4. Comparision chart of Accuracy

The Figure 4 shows the comparison chart of Accuracy demonstrates the existing GLCM, Statistical GLCM and proposed algorithm. The proposed Twin-tier with LWT is better than the existing algorithm. The existing algorithm (GLCM, Statistical GLCM) values start from 79 to 84 and 88 to 84 but proposed Twin-tiers with LWT starts from 91 to 98 provide the great results.

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Sensitivity

Values	GLCM	Statistical + GLCM	Proposed Twin-tier with LWT
TP	75.4	78.4	83.3
TN	81.1	83.3	89.1
FP	84.2	89.6	94.7
FN	91.4	94.5	98.5

Table 2. Comparison of Sensitivity

The Comparison table 2 of Sensitivity of Value explains the different values of existing algorithm GLCM, Statistical GLCM and proposed Twin-tier with LWT. While comparing the Existing algorithm**,** the proposed provides the better results. The existing algorithm (GLCM, Statistical GLCM) values start from 75.4 to 91.4 and 78.4 but proposed Twin-tier with LWT starts from 83.3 to 98.5 provide the great results.

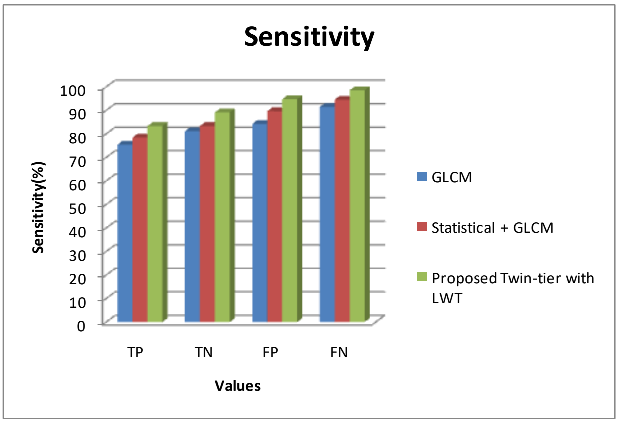

Figure 5. Comparison chart of Sensitivity

The Figure 5 shows the comparison chart of Sensitivity demonstrates the existing GLCM, Statistical GLCM and proposed Twin-tier with LWT. The proposed algorithm is better than the existing algorithm. The existing algorithm (GLCM, Statistical GLCM) values start from 75.4 to 91.4 and 78.4 but proposed Twin-tier with LWT starts from 83.3 to 98.5 provide the great results.

SPECIFICITY

Values	GLCM	Statistical + GLCM	Proposed Twin-tier with LWT
TP	53.2	57.4	67.8
TN	72.6	81.3	83.2
FP	55.2	65.9	86.4
FN	90.4	78.5	95.7

Table 2.Comparision of Specificity

The Comparison table 2 of Specificity of Value explains the different values of existing algorithm GLCM, Statistical GLCM and proposed Twin-tier with LWT. While comparing the Existing algorithm**,** the proposed Twin-tier with LWT provides the better results. The existing algorithm (GLCM, Statistical GLCM) values start from 53.2 to 90.4 and 57.4 to 78.5 but proposed Twin-tier with LWT starts from 67.8 to 95.7, provide the great results.

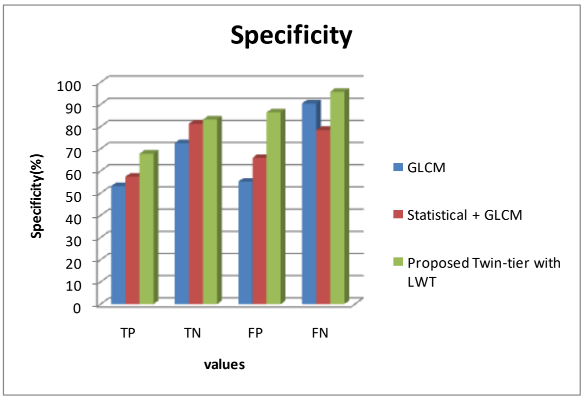

Figure 6.Comparision chart of Specificity

The Figure 6 shows the comparison chart of specificity values demonstrates the existing GLCM, Statistical GLCM and proposed Twin-tier with LWT. The proposed algorithm is better than the existing algorithm. The existing algorithm (GLCM, Statistical GLCM) values start from 53.2 to 90.4 and 57.4 to 78.5 but proposed Twin-tier with LWT starts from 67.8 to 95.7, provide the great results.

CONCLUSION

Feature extraction is a process of dimensionality reduction by which an initial set of raw data is reduced to more manageable groups for processing. The satellite images are applied with LWT and the surmised bands of the images are removed for additional handling. When the features of LWT applied images are separated, the feature vector is shaped by conceded the main request, GLCM and LWT applying image features. In Experiment result the proposed Twin-tier with LWT giving best result.

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