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AccuracyAssessment of Supervised and Unsupervised Image Classification of Fused Satellite Images

Ch Ramesh Babu
CSE,GCET,
Hyderabad,India

M .Seetha
Head,CSE,GNITS
Hyderabad, India

D.Srinivasa Rao
IT,VNRVJIET
Hyderabad,India

MHM Krishna Prasad
Professor,CSE,JNTUK
Kakinada, India

Abstract:Remote sensing techniques have been extensively utilized for recognition of land use and land cover structures. Land evidence can be definitely composed by classification of satellite images in the perspective of their practice. In this paper study area has been classified into five classes i.e. vegetation, agriculture, water body, open area and urban land by classification of fused images obtained from various fusion techniques. The spatial and spectral determinations of various satellite images make availableimprovedevidence with the encouragementof imageprocessing and image fusion of both multispectral and spatial images. The input images fused together are multispectral image and panchromatic images obtained from IRS-1D satellite utilizing LISS III. Matlab 10.0 software has been used for image processing, fusion and classification of the images. The Principal Component Analysis (PCA), wavelet transform, fuzzy and neuro fuzzy techniques arehave been used for image fusion. The resultant images have been classified using the supervised and unsupervised classification techniques;decision tree classifier and K-Meansalgorithms and evaluationconcerning them in standings of their accuracy.

Keywords:fusion,classification,accuracy,PCA,wavelet,neuro fuzzy

I. INTRODUCTION

Classification of satellite images is essential to identify the outline of satellite data. Nowadays, there may be existent various categories of classification procedures, but it is quite essential to progress their enactment in terms of accuracy percentage. So the projected method primary practice image fusion on multispectral image and its corresponding panchromatic image and combine these two images to acquire the more informative image than any input image utilizing different fusion techniques. Then feature abstraction, image classification and pattern appreciation is completed on that image. This fusion based classification technique is the simpler one which maintains the quality of output.

The objective of image fusion is to incorporate balancing multisensory and multitemporal evidence interested in one new image encompassing evidence, the eminence of which cannot be accomplished else. The word quality, its meaning and measurement depend on the particular application. The image fusion procedures are approximatelycategorized as spatial and transform domain approaches. The spatial fusion procedures are caused with spatial falsification and noise in the output fused image. To incredulous that transform domain image fusion methods such as discrete wavelet transform, contourlet and curvelet are materialized as dynamicinvestigationprovince for image fusion process [1].Alogo classification scheme based on the presence of logo images is projected. The projected classification scheme explores thepractice of overallappearances of logo images for cataloguing. Color, texture, and shape of a logo exclusivelydesignate the universalfeatures of logo images. The numerousarrangements of these features are utilized for classification purpose. Thegroupingcomprisessolitary with particular feature or with image fusion of twostructures or fusion of all three features measured at a time correspondingly. Additional, the system catalogues the logo image into: a logo image with fully text or with fully symbols or containing both symbols and texts. The K-Nearest Neighbour (K-NN) classifier is utilized for classification purpose and the investigationaloutcomesdemonstrated that the furthermostauspicious results are obtained for fusion of features[2].Comparison ofnumerous image fusion procedures have remained deliberated and their precisions have been assessed ontheir respective image classification process. LISS III multispectral data and panchromatic data have been utilized in this paper to establish the improvement and accuracy evaluation of fused imageabove the original images obtained from sensors by expending ERDAS image processing software[3].A proposed method emphases on two foremost concerns; primary one is the influence of grouping of multi-sensor images on the supervised learning classification accuracy expending Segment Fusion (SF). The subsequent matter efforts to commence the learning of supervised machine learningclassification procedure of remote sensing images by using classifiers have been assessed on their respected classification to select the finest procedure for classification of remote sensing images. QuickBird multispectral (MS) and panchromatic (PAN) images have been utilized in this method to establish the improvement and accuracy evaluation of fused image in excess of the original images using ALwassaiProcess software.According to investigational outcome of this work, that the assessmentoutcomesdesignate the supervised classification outcomes of fusion image, whichproducedhealthier than the MS image. Euclidean classifier based results arehealthy and deliversimprovedoutcomesover the other classifiers, in spite

of the popular confidence that the maximum-likelihood classifier is the greatestperfect classifier [4].The proposed workexamines the inspirations of the multispectral (MS) image which is fused with the panchromatic (PAN) image using various fusion approaches, onthe thematic accuracy and the consequential clusters of supervised and unsupervised classification correspondingly. Fused images remained then classified by utilizing thesupervised classification methodologies of maximum likelihood classifier (MLC) and the unsupervised methods of ISODATA clustering algorithm. By means of the classified outcome of the MS image as a standard, the integrative investigation of the overall accuracy designated a convincedgrade ofenhancement in the classification of fused images. The consequence of numerous resolutions for imagefusion is also accessible. The strength and restrictions of image fusion approach for image classification are in conclusionmentioned [5]. Unsupervised image Image classification of fused images are assessed through kappa and overall accuracy and results are explored [6].

II. IMAGE FUSION USING WAVELET TRANSFORM

The input images are decomposed into rows and columns by low-pass (L) and high-pass (H) filtering andsucceeding down specimen at respective level to get an estimate (LL) and detail (LH, HL and HH)coefficients. Scaling determination is connected with smooth filters or low pass filters and wavelet utility withhigh-pass filtering.Wavelet renovatesmake available anoutline in which an image is disintegrated, with each levelconforming to a cruderdetermination band[7].Image fusion process founded on wavelet disintegration, i.e. a multiresolution image fusion methodology. Image fusion can be done with the equivalent or dissimilar determination level, i.e. range sensing, visual CCD, infrared, thermal or medical[8]

III. PRINCIPAL COMPONENT ANALYSIS BASED IMAGE FUSION

The source images A(x, y) and B(x, y) are organized in two column vectors and their experiential means are subtracted. The consequential vector has a dimension of n x 2, where n is length of the each image vector.Calculate the eigenvector and eigenvalues for this subsequent vector are calculated and the eigenvectors conforming to the superior eigenvalue attained.The regularized components P1 and P2 are calculated from the attained eigenvector.The output fused image is given by equation,If(x,y)=P1A(x,y)+P2B(x,y) [9].

IV. IMAGE FUSION BASED ON FUZZY LOGIC

Fuzzification is to convert input image from gray-level to the membership plane and also decode the image information. In order to obtain measurable output defuzzification is utilized to produce used image with fuzzy procedures. Membership modification is explored between fuzzification and defuzzification process to change the worth of membership by employing like-minded fuzzy logic procedures [10].

V. NEURO FUZZY BASEDIMAGE FUSION

Fuzzy logic approach and neural networks are converged to instrument the image fusion practice using neuro fuzzy. The neuro fuzzy fusion procedure continually utilized for image fusion, where fused image attained from the fusion technique is utilized as one of the input images in subsequent iteration ahead. Various categories of image fusion procedures are discovered and determined that fuzzy and neuro fuzzy based iterative image fusion techniques outclasses wavelet transform and PCA based image fusion approaches with accurate membership functions and compatible fuzzy rules [11].

VI. PIXEL-BASED IMAGE CLASSIFICATION OF FUSED IMAGES

Pixel-based image classification is the technique in the image processing branch. Both supervised classification and unsupervised classification methods are founded on the single pixel, where the completedetermination of traditional satellite image classification procedure is to classifytotally image pixels into land cover groups or different themes. In common, multi-spectral image information is exploited to accomplish the image cataloging process and the supernaturalevidence for each image pixel is utilized as the support of classification. Satellite image classification procedure involves feature extraction method and also the satellite images in supernatural bands will be utilized for image classification of multi-spectral satellite images.Mean, Euclidean distance, rgb and slope features are examined in feature extraction process for the satellite image classification. The essentials of input image features are limitedmagnitudes of the image like luminance, spectral value etc.

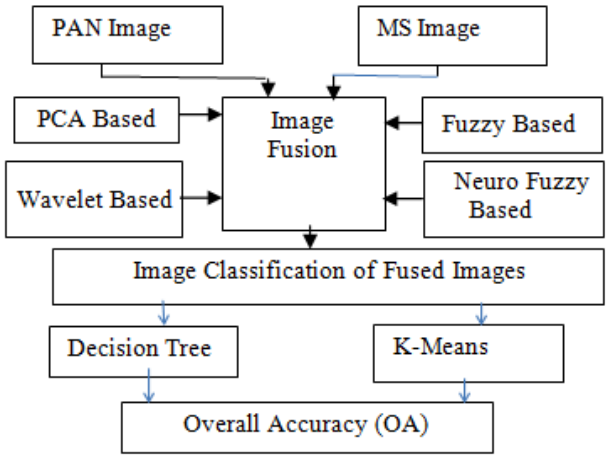


Figure 1.The organization of the proposed method

A. Decision Tree Classifier (DTC)

A DT classifier is a categorized organization where individual level, a test isutilized to one or more characteristic values that could require one of two conclusions. The result may be a leaf, which assigns a class, or a conclusion node, which stipulates a additional test on the featureprinciples and customs a subdivision or sub-tree of the hierarchy. Image classification is accomplished by

stirring down the tree up to a leaf is extended. The technique for building a DT as précised is as follows [12]:

- If there are *k* classes or groups denoted {C_1, C_2,..., C_k}, and a training set, *T*, then
- If *T* encompasses one or more items which all fit in to a single class C_j, then the DT is a leaf detecting class C_j.
- If *T* comprises no items, the DT is a leaf resoluted from evidenceadded than *T*. If *T* enclosesitems that fit in to a combination of classes, earlier a test is selected, grounded on a particulartrait, that has one or more conjointlyeliteconclusions {O_1, O_2,..., O_n}. *T* is subdivided into subgroupsT_1, T_2,..., T_n, where $T_i$comprises all the items in *T* that ought to result$O_i$of the preferred test. The similartechnique is utilized recursively to separatesubgroup of training items to build the DT.

B. K-Means Clustering

The K-Means clustering method utilized in this paper containing subsequent stages.

a. In order to denoteprimarycluster centroids locate k points with in the space denoted by the elements that are being grouped.

b. Assign each element in to the cluster group that has the neighboring centroid point.
c. Recompute the places of the k centroid points when total elements have been allocated.
d. Repeat above exploit steps 2 and 3 till the no centroid facts have the movement added to build a split up the items into numerous cluster clusters from whichever the metricquantity to be lessenedmight be calculated.

C. Image Data

NRSA, Hyderabad, INDIA used IRS-1D, LISS III sensors in order to obtain images in the multispectral mode. The features of IRS 1D LISS III
image data features are summarized in Table.1

Table 1. IRS-1D LISS-III image data characteristics

(a)Satellite/ Sensor	**IRS 1D LISS 3**
Image pixel resolution(spatial resolution at lowest point)	23.5 meters
Swath	127 kms (for bands 2, 3, 4)134 kms (for band 5 – MIR)
Repetitively	25 days
Spectral Bands	0.51 – 0.58 microns (B2) 0.61 – 0.67 microns (B3) 0.76 – 0.85 microns (B4) 1.550 – 1.700 microns (B5)

VII. EXPERIMENTAL RESULTS

IRS 1D satellite and LISS-III sensor images attained from NRSA Hyderabad, India are acquiesced as input images for pixel-based image classification procedure to obtain classified images. Classified images attained from the classification method were reliant on on the class of the classifier utilized for image classification. Classification accuracy evaluationfactor, overall accuracy isdemonstrated in the table to endorseconnotation of the classified fused images attained from different fusion methods, PCA, wavelet transform, fuzzy and neuro fuzzy. Fused images acquired from variousimage fusion practices are classified through decision tree classifier and K-Means procedure and alsoevaluated through overall accuracy.Fused images attained from fuzzy, neuro fuzzy techniques and alsofuzzy, neuro fuzzy based iterative fused images accomplishedglowingequated to classifying PCA, wavelet based fused images and classifying satellite images as well.

Ex.1 Ex.2 Ex.3

Figure 2. Input images for classification

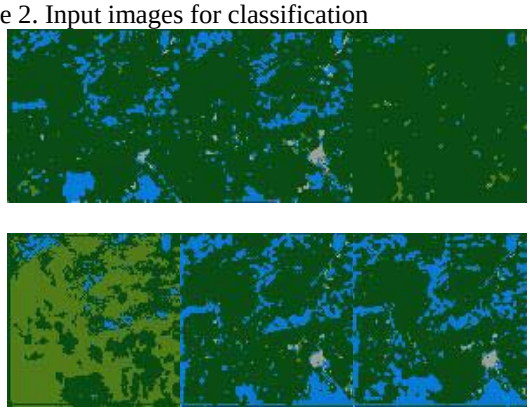


Figure 3. DTC based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.1

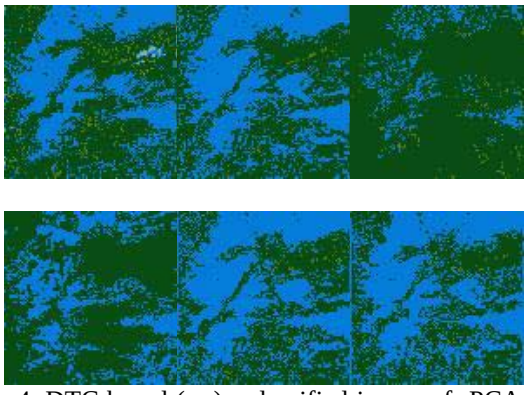


Figure 4. DTC based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.2

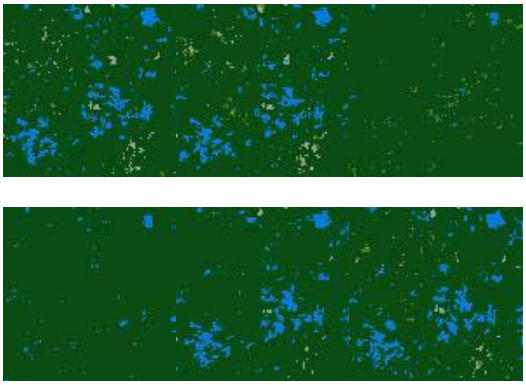


Figure 5. DTC based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.3

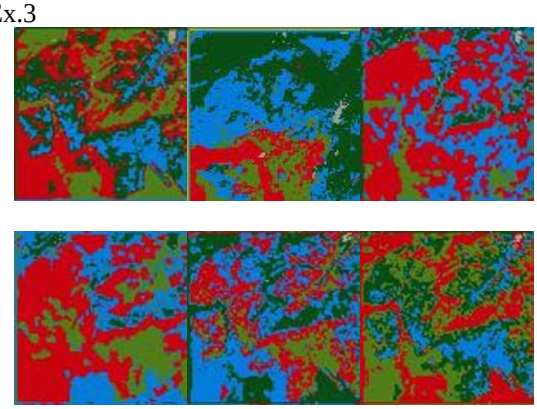
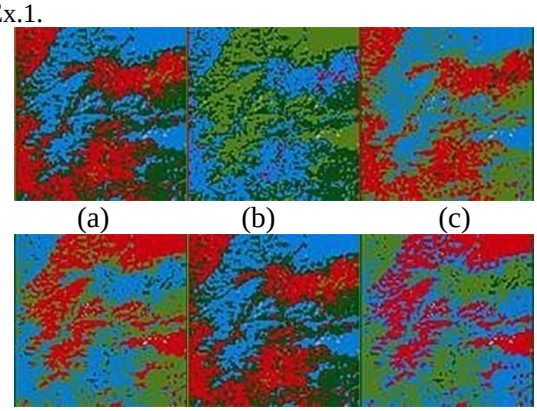


Figure 6. K-Means based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.1.



(a) (b) (c)

Figure 7. K-Means based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.2.

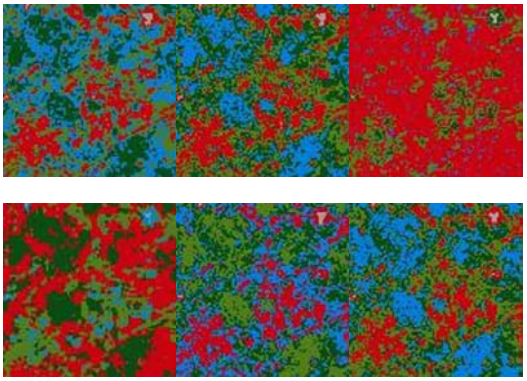


Figure 8. K-Means based (a) classified image of PCA based fused image , (b) classified image of fused image from wavelet transform, (c) classified image of fused image from fuzzy logic, (d) classified image of iteratively fused image from fuzzy logic (e) classified image of fused image from neuro fuzzy logic and (f) classified image of iteratively fused image from neuro fuzzy logic respectively for Ex.3.

Table 2. Overall accuracy of classified images obtained from DTC and K-Means algorithms

Image	Ex(1) OA from DTC	Ex(2) OA from DTC	Ex(3) OA from DTC	Ex(1) OA from K-means	Ex(2) OA from K-means	Ex(2) OA from K-means
Without fusion	31	36	26	46	53	38
PCAbased fused	46	41	36	62	73	48
wavelet based fused	42	26	32	71	64	53
Fuzzy based fused	61	66	65	67	68	63
Iterative fuzzy based fused	74	71	66	88	70	60
Neuro fuzzy based fused	71	63	63	66	89	63
Iterative neuro fuzzy based fused	82	69	68	83	86	65

VIII. CONCLUSIONS

Image fusion method is to congregate two or more satellite images into a one fused image comprises spectral and spatial evidence as well. Fused images required in numerous applications, image analysis, image interpretation, computer vision, classification, image recognition, remote sensing, medical imaging, biometrics, video supervision. Numerous fusion methods: PCA, wavelet based fusion, fuzzy and neuro fuzzy based image fusion approaches are implemented here. In this paper DTC and K-Means algorithm is used for the execution of image classification of fused images attained from above cited fusion practices. Fuzzy based and also neuro fuzzy logic based fused images

are accomplishedhealthy in recollecting quality and as well as in classified accuracy likened with quality and classification accuracy of fused images obtained from PCA, wavelet methods. In agreement to appraise classified image OA is explored. The investigationaloutcomesgained from the DTC and K-Means clustering algorithm for image classification of fused images are compared. Investigationaloutcomescalculated from classifiersclearlydisplays that the classification of fused images attained from fuzzy, neuro fuzzy express too advancement on the eminence of the fused image along with conservingadditional spatial and spectral evidence. Due to the dormant of the fuzzy and neuro fuzzy based image fusion approaches, it is obvious that the DTC and K-means aproaches for classification of fused images progresses accuracy associated to image classification without fusion process and it also can be additionally compared with other supervised classification approaches. By selecting more precise rules for DTC,classification accuracy may be improved. By enlightening image contented through iterative fusion practice, classification of fused images progresses the accuracy of the classification.

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