A REVIEW OF HARD CLASSIFICATION AND SOFT CLASSIFICATION APPROACHES IN REMOTE SENSING DATA

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Abstract- **Hard classification and Soft classification approaches are now emerging as famous techniques in the process of designing real world applications. The development of suitable algorithm for image classification and assessment of accuracy has lead to significant confidence in extraction information of thematic maps . Remote sensing images contain a mixture of pure and mixed pixels. In digital image classification, a pixel is frequently considered as a unit belonging to a single land cover class. However, due to limited image resolution, pixels often represent ground areas, which comprise of two or more discrete land cover classes. For this reason, it has been proposed that fuzziness should be accommodated in the classification procedure so that pixels may have multiple or partial class membership. In this case, a measure of the strength of membership for each class is output by the classifier, resulting in a soft classification technique**.

This paper focus on review of hard classification soft classification approaches in Remote Sensing Data.

keywords- Remote Sensing, Hard classification approaches, Soft classification approaches, Maximum likelihood , fuzzy means.

I. Introduction

Remote sensing fraternity has used digital image classification for many applications, such as resource utilization, environmental impact analysis, and other socio-economic applications.Remote Sensing (RS) can be defined as the science of classification of earth layer characteristics and inference of their graphical and physical properties using electromagnetic emission as a standard of communication. Classification of remotely sensed data into thematic maps remains a challenge due to many factors, such as, selection of sensed data, features types present, image processing and classification approaches. The term classification is defined by Chambers Twentieth Century Dictionary as the "act of forming into a class as per a rank or order of person or things".

In Remote Sensing, basically two classification methods are used-

1.Soft Classification-Soft classification provides more information and potentially more accurate result, especially for coarse spatial resolution

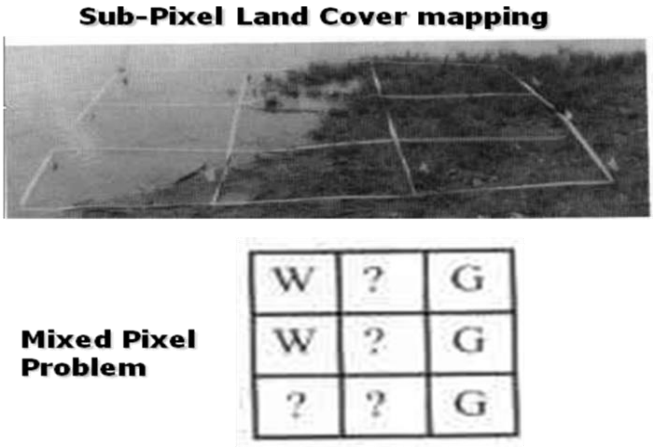
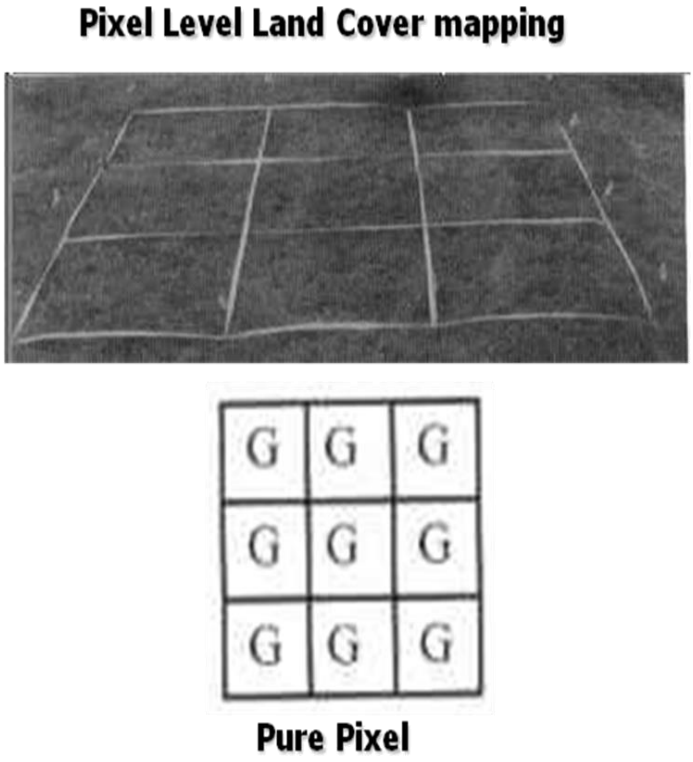


Fig.(1) Soft Classification mapping

2. Hard Classification-It make a definitive decision about the land cover class that each pixel is allocated to a single class.



fig(2) Hard classification mapping

II-Literature Review- The information about Land Cover is extracted from satellite remote sensing data[2] through image classification[1]. We can classify pixels according to its belongingness of feature There are generally two type of classification exist depending upon assigning pixel to only a pure single class or pixel can belongs to more than one class. The earlier approach is called hard classification and later approach is called soft classification. The extraction of land cover from remote sensing Images [22],[23] has traditionally been viewed as a classification problem where each pixel in the image is allocated to one of the possible classes. The information about Land Cover is extracted from satellite remote sensing data through image classification. We can classify pixels according to its belongingness of feature. There are generally two type of classification exist depending upon assigning pixel to only a pure single class or pixel can belongs to more than one class. The earlier approach is called hard classification and later approach is called soft classification. However ,the pixel belonging or but contain two or more classes in a single pixel area [3][4].The standard use of hard and pure classification methods that allocate single class but in term of mixed data it gives may provide erroneous results [3][4]. For assessing the accuracy of soft classification output mixed pixels have been incorporated at the testing stage.

General Review-

In hard classification, class is assigned to pixel is crisp i.e. pixel belongs to one of the class from all classes. The classified pixel is either completely belongs to a class or not. This is called hard classification (Ghosh, 2013). Although in real world the pixel has some spatial resolution and can cover a mixture of two or more class features on ground. The pure pixels are rare. Most likely, boundaries of classes have the mix pixel. Therefore the soft classification approach was developed[5][4].Soft classification is used to produce class proportions within a pixel ill order to increase the classification accuracy [2][4] and to produce meaningful and appropriate land cover composition [8][28] .One of the most popular fuzzy clustering [15] methods are the fuzzy c-means (FCM) [5] which is an unsupervised classifier that in an iterative process assigns class membership values to pixels of an image by minimizing an objective

function. Although, a few studies on the use of FCM have been reported, the major limitations of FCM are the probabilistic sum to one constraint. Therefore, besides using this classifier, another fuzzy set clustering method, namely possibilistic c-means (PCM) (Krishnaparam and Keller, 1993, 1996), which relaxes this constraint so as to be robust to the noise (i.e. Pixels with a high degree of class mixtures) present in the dataset, has also been implemented[4].

Remote sensing images contain a mixture of pure and mixed pixels. In digital image classification, a pixel is frequently considered as a unit belonging to a single land cover class.

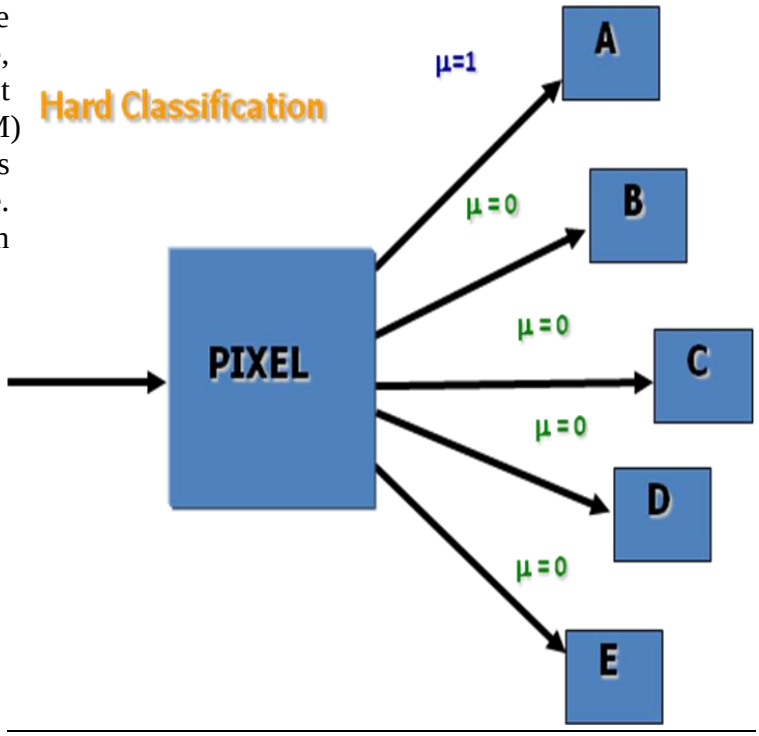
Types of Classification Techniques with their classifiers-

III.1 Hard classification Approaches Recent advances in supervised image classification have shown that conventional 'hard' classification techniques, which allocate each pixel to a specific class, are often inappropriate for applications where mixed pixels are abundant in the image (Foody et al. 1996). . The conventional hard classification methods, which assume that the pixels are pure, force the mixed pixels to be allocated to one and only one class. This may result into a loss of pertinent information present in a pixel. Mixed pixels may thus be treated as error, noise or uncertainty in class allocation for hard classification methods. The conventional use of hard classification methods that allocate one class to a pixel may tend to over- and under estimate the actual aerial extends of the classes on ground and thus may provide erroneous results (Foody, 2002). Different statistical algorithms in past have been used for allocating mixed pixels.

Hard Classification techniques can be further classified into two main types :-

1. Maximum Like Hood Classifier-
2. K-Mean Classifier
3. Minimum Distance-to-mean Classifier

Mixed pixels are assigned to the class with the highest proportion of coverage to yield a hard classification. Due to which a considerable amount of information is lost(11). To overcome this loss, soft classification was introduced.

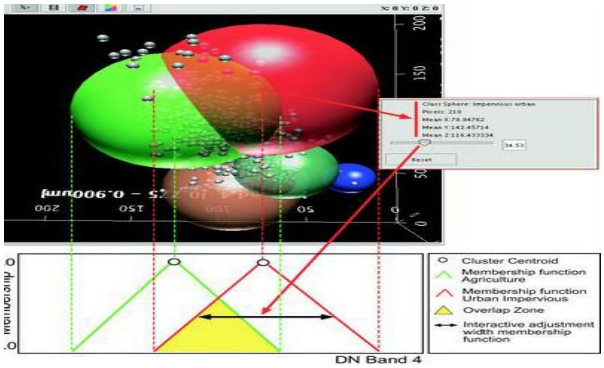


Fig(3)- pixel diagram of hard classification approaches

Hard classifiers-

Hard classifiers make a definitive decision about the land cover class that each pixel is allocated to a single class. maximum likelihood, minimum distance, artificial neural network, decision tree, and support vector machine are basically hard classifiers.Basically hard classification techniques are of two types-

1. Linear mixture modeling
2. Fuzzy classification



Fig(4) hard classifiers

II. SOFT CLASSIFICATION APPROACHES-

The extraction of land cover from remote sensing Images [22],[23] has traditionally been viewed as a classification problem where each pixel in the image is allocated to one of the possible classes. So remotely sensed data of the earth may be analysed sensing has thus become an important data source for providing effective land use land cover information particular at regional to global scales. Digital image classification is usually performed to retrieve this information using a range of statistical pattern recognition or classification technique (supervised and unsupervised) such as maximum like hood classifier, k-mean classifier, the minimum distance to mean classifier etc.. There classifiers allocate each pixel of the remote sensing image to a single land use land cover class.

1) *Artificial Neural Network:* Until recently, supervised classification of space-borne remotely sensed data has been achieved traditionally with Maximum Likelihood (ML) approach .

2) *FCM Fuzzy c- Mean(PCM) Clustering* FCM-isFCM is a method of clustering which allows one piece data to belong to two or more clusters that may be employed to partition pixels of remote sensing images into different class membership values [1][40]. The objective function FCM is

$$j_m(U,V)=\sum_{i=1}^{N}\sum_{j=1}^{C}(\mu_{ij})^m \| x_i-v_j \|_A^2 \quad [9][10] \quad (1)$$

Subject to constraints

$$\sum_{j=1}^{c}\mu_{ij}=1 \quad \text{For all I}$$

$$\sum_{j=1}^{c}\mu_{ij}>0 \quad \text{For all j} \quad (2)$$

$$0\le\mu_{ij}\le 1 \quad \text{For all i,j}$$

Where xi is the vector denoting spectral response I (i.e. a vector of spectral response of a pixel), V is the collection of vector of cluster centres, and vj, µij are class membership values of a pixel (members of fuzzy c-partition matrix),c and n are number of cluster and pixels respectively, m is a weighting exponent($1<m<\infty$) , $\| x_i-v_j \|_A^2$ is the squared distance (dij) between xi and vj , and is given by ,

$$d_{ij}^2=\| x_i-v_j \|_A^2=(x_i-v_j)^T A(x_i-v_j) \quad [9][3] \quad (3)$$

3) Possibilistics C-Mean (PCM) Clustering

The formulation of PCM is based on a modified FCM objective function, whereby an additional term called is regularizing term is also included. PCM is also an iterative process where the class membership values are obtained by minimizing the generalized least- square error objective function [5][40], given by,

$$j_m(U,V)=\sum_{i=1}^{N}\sum_{j=1}^{C}(\mu_{ij})^m \| x_i-v_j \|_A^2 + \sum_{i=1}^{c}(1-\mu_{ij})^m$$

[5][13] (4)

Subject to constraints

$$\max_j \mu_{ij}>0 \quad \text{for all i}$$

$$\sum_{i=1}^{N}\mu_{ij}>0 \text{ for all j} \quad (5)$$

$$0\le\mu_{ij}\le 1 \quad \text{For all i,j} \quad [7][9]$$

where ηj is the suitable positive number..

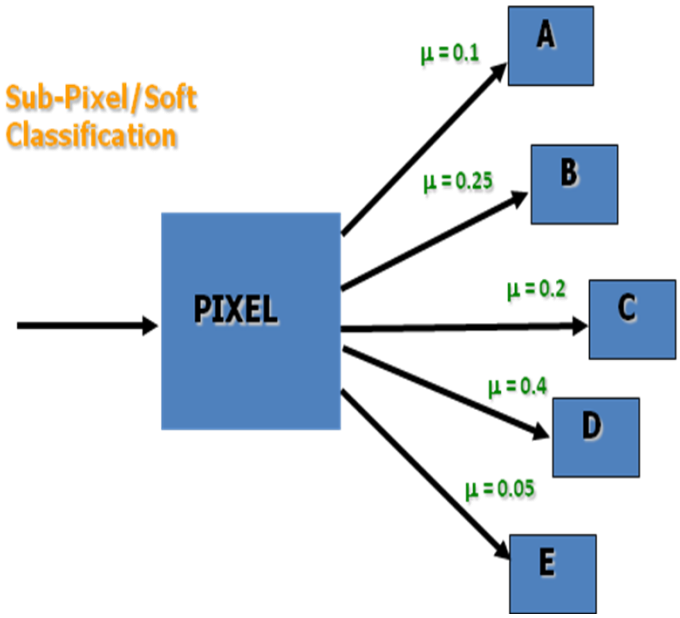
and, η j depends on the shape and the average size of the cluster j and its value may be computed as;

$$\eta=K\frac{\sum_{i=1}^{N}\mu_{ij}^m d_{ij}^2}{\sum_{i=1}^{N}\mu_{ij}^m} \quad [7][9] \quad (6)$$

Where K is a constant and is generally kept as 1. The class memberships, μ_{ij} are

$$\mu_{ij} = \frac{1}{1+\left(\frac{d_{ij}^2}{\eta_j}\right)^{\frac{1}{(m-1)}}}$$

$$\mu_{ij} = \frac{1}{1+\left(\frac{d_{ij}^2}{\eta_j}\right)^{\frac{1}{(m-1)}}} \qquad [5][13]$$



FIG(5)- SOFT CLASSIFICATION APPROACHES

IV. DISCUSSION AND CONCLUSION

The expected outcomes from this research work would be as follows:

In this paper is focused on soft classification approaches and uncertainty problem for classification and introduce a new entropy(without reference) based criterion.

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