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Review Article

Comparison of Feature Extraction and Pixel Based Approaches for Satellite Images Classification: A Review

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ABSTRACT

An overall performance comparison was delineated in this paper between the two most common classification techniques: Pixel based and Feature Extraction of remote sensing. Feature Extraction image analysis had been commonly used in a high resolution Satellite image as a standard paradigm used to extract meaningful information for updating GIS data. In finding solutions for many applications, all techniques have their advantages and disadvantages. In remote sensing, the study of image classification is a major challenge in producing LU/LC thematic maps with higher accuracies. However, the Pixel based classification method works only on spectral feature and ignores spatial feature, but Feature Extraction classification can work on spectral and spatial features. Feature Extraction often has characteristic features that can differentiate classes properly, such as mean, standard deviation.). This paper focused on literature review on satellite images classification techniques and its methods as well as topics that related on it.

1. Introduction

The process of classification of satellite images includes grouping image Pixel values into meaningful categories. Methods for classifying satellite images can be divided into three groups. (1) Manual, (2) hybrid, and (3). Automatic. All strategies have benefits and drawbacks of their own. The majority of the classification methods for satellite images come into the third group. The classification of satellite images requires the selection of the most suitable classification method based on the requirements. Figure (1) illustrates the hierarchy of classification methods for satellite images.

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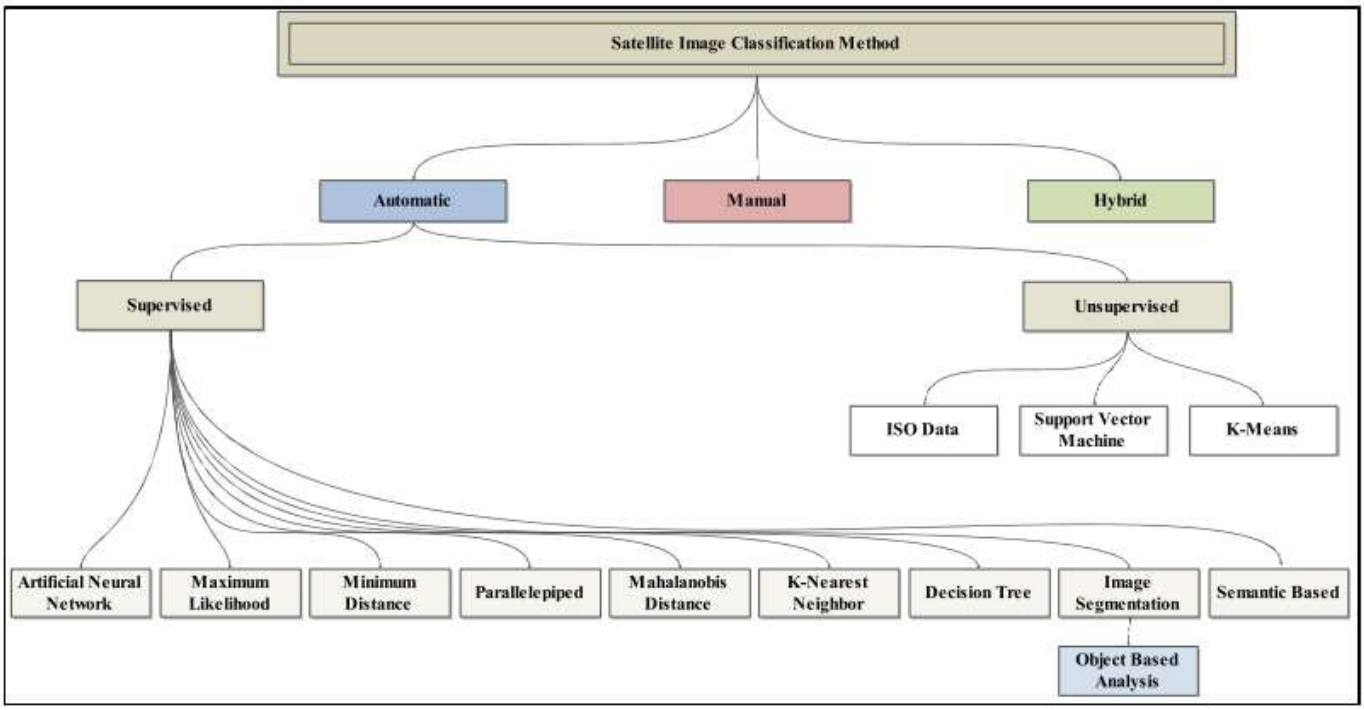

Figure.1. Satellite image classifications methods hierarchy. (Abburu & Babu Golla, 2015)

The automated method of classification of satellite images further categorised into two groups (1) supervised (2) unsupervised methods of classification. The current research study is a satellite image analysis with supervised classification methods and techniques based on MLC and SVM.

This paper also compares different researchers and comparative findings on methods of classification of satellite images. (Abburu & Babu Golla, 2015)

In general, there are two types of classification techniques: parametric and non-parametric algorithms. Parametric classification algorithms assume that the data for each class is normally distributed. The MLC is the most commonly used parametric classification algorithm, which generates decision surfaces according to covariance and the mean of each class. Non-parametric methodologies, on the other hand, such as SVM classification, do not make any Supposition about the statistical nature of data and are a new technique to add to the category of image processing techniques. (Taati et al., 2015).

The most widely used maximum likelihood algorithm (MLC), which assigns each Pixel to a class based on the probability that it belongs to the class, is one example of a classification algorithm. However, such suggestions about normal distribution may be limited and may not provide satisfactory results in some conditions. There were also classification algorithms that used non-parametric techniques, like(SVM), with no assumptions about probability distribution aiming to find the best separating boundaries between classes and pixels. (Jonsson, 2015).

2. Review on Classifications Image and Its Methods

(Xiaoxia et al., 2005) researched in a small area of Shanghai city in China. Using QuickBird data was conducted to compare the Feature Extraction and Pixel based classification techniques. The Feature Extraction technique segmented image data into homogeneous areas using suitable parameters at some stage. The nearest neighbour classifier was used to classify the segments. Maximum likelihood classification was used to identify the imagery in Pixel based classification. Classification and accuracy evaluation results indicate that the Feature Extraction approach generated more reliable and satisfying results. The overall accuracy of Pixel based classification has been increased from 63% to 83%.

(Yu et al., 2010) used RS and GIS techniques, the remotely sensed images used are QuickBird images. An automated method for the detection of shifts had been suggested. The suggested approach's testing was performed using multi-temporal sets of data matching to the geographic location of Guangdong Chinese province. A Feature Extraction SVM classification is used in the study. To create image objects, pixel merge segmentation, a mechanism utilizing spectral data and region size is used. Samples are automatically determined from RS data and historical LU vector data. The remote sensing images are then classified using an object-based SVM. GIS-derived object boundaries are important for calculating the percentage of each class in each region, So if compared the ratio of in each class to the historical class land, these regions are defined as shifted if the class percentage is high and significantly different than that of historical land. The test regions' findings are monitored. Finally, experimental results corroborated the proposed procedure's benefits and viability.

(Uca Avci et al., 2011) investigated a suitable technique for general land cover mapping. The tests were carried out on SPOT 5 multispectral data from Istanbul, Turkey. Iso data and MLC techniques of Pixel based compared with Feature Extraction and nearest neighbor approaches of Feature Extraction. The findings showed that condition-based approach efficiency is higher than the others. The advantage of condition-based categorization over other approaches is considered to be the use of direct specifications for object criteria in class definitions. Overall, iso data classifications had an accuracy of 75%; maximum likelihood classifications had an accuracy of 82 %. Feature Extraction classifications had an accuracy of 88 %, and nearest neighbor classifications had an accuracy of 85%.

(Tsai et al., 2011) studied the map and quantified the number of buildings newly constructed throughout 2002 and 2010 in Accra, Ghana. Using QuickBird Very high-resolution satellite images. Two semi-automated feature detection approaches were analysed: first, Post-classification comparison, and second, bi temporal layer stack of classification. Bi temporal layer stack technique provided better results than the post-classification comparison technique due to less uncertainty with maximizing variations between buildings and adjacent features and materials. Thanks to its ability to delineate individual buildings of different sizes more accurately, the spectral/spatial contextual approach (Feature Analyst) outperformed the true object-based feature delineation approach (ENVI Feature Extraction). For identifying and enumerating new building objects, semi-automated, object-based detection followed by manual editing seems to be a secure and successful solution.

(Abd, 2013) applied hyperspectral satellite imagery and Google Earth provided for the analysis. To create the thematic map of the UPM University campus located in West Malaysia, Selangor state. Land use/cover, the region was divided into nine classes (Clearwater, Lake, Soil, Roads, Building R- roof, Building Roof, Building B-roof, Grass, Tree) using two classification strategies: SVM for Feature Extraction classification and MLC for pixel classification. For the entire duration of the study. The findings showed that SVM is more reliable than Maximum likelihood MLC, with an overall accuracy of 98.23 % for SVM and 90.48 % for MLC, respectively.

(Abd & Alnajjar, 2013) used satellite imagery to described LU/LC change of vegetation and urban area for South Of Johor in Malaysia. Landsat TM for the year 1995 and Landsat ETM+ for the year 2011were used. Supervised Classification and MLC have been achieved to categorise the images in different land cover classes. The study area is categorised into five classes: urban area, vegetative, water bodies, barren land unknown (cloud); analysis of shift identification indicates that the built-up area has been increased by 3%, while the vegetative area has been reduced by 12%. The accuracy obtained is around 90.11% and 94.14%, respectively.

(Byun et al., 2013) showed that an effective segmentation technique for high-resolution pan-sharpened imagery using GeoEye-1 image as well as QuickBird image respectively. The images are of dense urban areas in Hobart, Australia as well as Daejeon, Korea, respectively. That takes into account both spatial and spectral data. First, researchers perform multispectral nonlinear edge, keeping smoothing and isolate the multispectral edge, which is used for seed selection and image

segmentation. Automatically chooses the initial seeds. Following the automatic selection of considerable seeds, image segmentation is accomplished using an adjusted seeded region growing technique. Based on visual evaluation and quantifiable comparison evaluation, experimental findings on two multispectral satellite data demonstrate that the proposed method outperforms prior segmentation strategies.

(Jonsson, 2015) used high spatial resolution from the SPOT5 satellite to evaluate the classification approach that is best fit to keep up to date with new land use in the Amazonas, Brazil. There are three approaches put to the test; 2 are Pixel based, and one is Feature Extraction. Concerning the former, they are SVM with Radial Basis Function (RBF) kernel in addition to MLC. Also, the latter has been segmented with the Multi-Resolution Segmentation (MRS), also k-NN. Each of the three methods will generate two categorised maps: one with the three original wavebands (green, red, and NIR) and another with a six-dimensional feature space that includes the three original wavebands and three texture derivations. Just two met the appropriate overall accuracy requirement of 85 %. Both were SVM (86.8 %) and kNN (86.2 %), the latter of which included texture analysis None of the classifications consisting solely of the three initial bands met this limit. The contrast texture derivation from the green and near-infrared bands and an entropy texture derivation from the red band were the three most appropriate texture derivations. When these three texture derivatives were combined with the initial bands, the categories became much more distinct. The texture analyses with GLCM separated classes more in the feature space than when just utilising original red, green, and NIR bands.

(Aburas et al., 2015) applied Two Landsat satellite image TM to extract NDVI values between 1990 and 2010. The study aimed to detect the LU/LC change in Seremban city, which is the largest district and the capital of the Negeri Sembilan State. MLC was utilised for classification. Four classes of (LU/LC) namely built-up area, barren land, water body, and vegetation. Defining the NDVI index using the Natural Breaks (Jenks) approach, The NDVI values are computed first. Results showed that region lacking vegetation increased from 3.55 % to 7.25 % in 2010, such as water sources, built-up areas, and desert fields. The dense vegetation area also declined from 78.57 % to 65.44 %, reflecting the need for new urban strategies to protect vegetation regions throughout urban and economic development. Accuracy assessment, according to classifications, is 87% and 88%, respectively. Kappa values of 0.85 and 0.87 were obtained for 1990and 2010 NDVI categorised maps, respectively.

(Taati et al., 2015) researched to generate LU classification using an MLC and SVM classification in the Qazvin region, Iran, using the Landsat 5 satellite TM image. The required corrections were implemented to the images in the pre-processing phase. The overall accuracy and index of kappa were used to check the efficacy of the two algorithms. The assessment outcome confirmed that SVM, with an overall accuracy of 86.67 % with a kappa index of 0.82, has greater precision than MLC in LU mapping.

(Karim et al., 2017) studied the combined effects of SURF with FAST and BRISK individually and found that it produced very promising performance, increasing number of features and much less computational time. To assess the speed of each Feature Extraction method and total computational time is determined. Feature Extraction methods such as local binary patterns, scale-invariant feature transformation, speed-up robust features (SURF), oriented gradient histogram, accelerated segment test (FAST) features and binary robust invariant scalable keypoints (BRISK). To compare the efficiency of each method, the features extracted are counted in shadow regions and pre-processed shadow regions. Finally, feature matching is done for all methods.

(Kaplan & Avdan, 2017) applied an approach combining a Pixel based index, and a Feature Extraction technique has been operated in a satellite image from Sentinel-2 with a resolution of ten m. the approach uses image segmentation. It also makes use of indices like (NDWI), which are used to extract water bodies. Two study areas, one mountainous and the other urban in Macedonia were chosen because they have distinct characteristics. The outcomes of the NDWI have been enhanced by a kappa coefficient of more than 0.5. The overall accuracy of the Feature Extraction categorisation was greater than 90% in the first

region, with a kappa coefficient of 0.88, but the kappa coefficient was 0.9 in the second area.

(Miranda et al., 2018) indicated that classify LC in satellite images high-resolution using the supervised technique. The land cover map of Indonesia's central java region. Sentinel-2 has obtained the satellite image, which was collected through USGS. For Supervised Classification, in addition, Arc GIS 10.5 was used to Categorised Image object. To create a land cover map in the four groups (Urban, Bare Land, Water and Forest), describe the main groups in the Mapping of the RSNI-1 National Standardization Body of Indonesia. This research established a supervised classification with MLC that the land cover classification was correctly assigned to 4 categories and with Overall accuracy is equal to 1 while the kappa index is equal to 0.48966. The result indicated that the evaluation had a low kappa accuracy value but a high overall accuracy value. The high accuracy value was obtained due to a complete supervised experiment conducted during the classification stage.

(Kumar et al., 2018) showed that Feature Extraction image classification methods are being used to produce high quality GIS-compatible urban land use maps when using high-resolution satellite data sets. High-resolution ResourceSat-2 LISS-4 and Cartosat-1 pan-sharpened images were used to construct a broad level urban Land Use / Land Cover (LU/LC) map on the study area attempting to cover parts of East Delhi City utilising Feature Extraction Image Analysis. Algorithms and rule sets for feature classification were developed using spectral indices, geometric parameters, and statistical textural techniques. The land use and land cover map of the research were successfully managed, consisting of four major LU/LC groups and focusing on the differentiation of barren and built-up areas. The overall accuracy of the data collected is calculated to be about 70%.

(Roy et al., 2018) studied the output of per-pixel classification comparatively to Feature Extraction image analysis for mapping mango orchards in Uttar Pradesh's Sitapur district (UP). High-resolution IRS-Resourcesat 2 - LISS IV imagery was used. The Supervised Maximum Likelihood algorithm was used for Pixel based classification, and the Segmentation Lambda Schedule was used for Feature Extraction classification. Following the collection of ground truth data, an accuracy analysis showed 65 % and 92 %, respectively, which increased to 96 % after visual editing of the latter. According to the findings of the study, Feature Extraction classification is the state-of-the-art for high-accuracy mapping of orchards.

3. Review on Feature Extraction and Pixel Based Analysis Comparison

(Whiteside & Ahmad, 2005) searched that compares the Feature Extraction method and a supervised Pixel based method for mapping LC in the Northern Territory's tropical of Australia. Feature Extraction method involved segmenting image data in multi-scale objects. Objects were given class rules utilizing spectral signatures, shape as well as contextual relationships. That rules then were used as a foundation for imaging's fuzzy identification. The supervised grouping included choosing training areas and classifying using the maximum probability algorithm. A comparison of results reveals greater overall Feature Extraction classification accuracy over the Pixel based classification, 78% versus 69.1%, respectively. The Kappa statistic for the Feature Extraction classification was 0.7389, while the Kappa statistic for the Pixel based classification was 0.6476.

(Jing Qian, 2007) aimed to compare the traditional and Feature Extraction classifications of remote sensing data in an arid environment. The search tested and compared Pixel based image classifiers such as the Maximum Likelihood algorithm and a Feature Extraction image classifier utilizing a Landsat ETM+ image to determine the most suitable arid zone image classification technique. Each technique was evaluated for accuracy utilizing reference data sets derived from high-resolution satellite data, aerial photographs, and field observations. The finding showed that the Feature Extraction technique obtained 89 % overall accuracy for a kappa index of 0.87, compared to 71 % for a kappa index of 0.66 for the Pixel based approach.

(Araya&Hergarten, 2008)Comparing the outcomes of two classification processing methodologies using Landsat ETM+ data Extraction of features and Pixel based mapping of Asmara, Eritrea's capital, as well as its nearby

suburbs. The maximum likelihood methodology was used for Pixel based technique besides the Bhattacharyya distance technique for Feature Extraction technique. Both of which are included in the ArcGIS as well as SPRING software. The classification accuracy of Pixel based and Feature Extraction methods is 78 % and 85 %, respectively. Kappa indexes for Pixel based as well as Feature Extraction methods were 0.74 and 0.82, respectively. Even though Pixel based technique is often used, the examination and visual interpretation of the findings demonstrate the advantages of the Feature Extraction technique in this case study.

(Mostafa et al., 2014) indicated that data classifications were carried by using a high-resolution satellite image from the IKONOS satellite. The approach compares two classification methods by putting them on four different test areas with different planning requirements. The study area is located at Assiut governorate, Egypt. The conventional Pixel based image analysis is the first method, and the Feature Extraction image processing is the second. For Pixel based image analysis and classification, the software ERDAS V.9.2 was used. eCognition Developer software V.8.0 was used to perform object-oriented image classification. The overall accuracy and kappa coefficient from the confusion matrices were used to determine each method's accuracy. The findings of this study revealed that object-based image analysis has more advantages than Pixel based image analysis. Furthermore, it has been discovered that the more planned an area is, the more accurate the results.

(Aryaguna & Danoedoro, 2016)Studied comparative the effectiveness of Pixel based and Feature Extraction identification for vegetation maps definition Tidar forest in the middle of Magelang city using a Worldview-2 high-resolution image. Many methods, such as Pixel based and Feature Extraction classification, can be used to classify flower composition. Salt and paper occur due to classification, which is issue when dealing with high spatial resolution image data using Pixel based techniques. The findings indicate that the most reliable classification approach is Pixel based classification using the majority of 5x5 kernel windows than other classification methods. The image Worldview-2 has the highest accuracy of 73.32 %. In the Tidar forest, Pixel based vegetation composition mapping is more accurate than Feature Extraction vegetation composition mapping.

(Sertel & Alganci, 2016) showed that The impact of forest fire in the region was determined by comparing pre and post situation in Izmir, Turkey. SPOT-6 images are defined depending on Pixel and Feature Extraction classification algorithms to reliably distinguish the boundaries of burned areas. The current findings demonstrate that relying solely on normalised difference vegetation index (NDVI) thresholds to identify burn marks is inadequate for Feature Extraction classification. However, developing a rule set that involved mean brightness numbers of near-infrared and red bands and mean NDVI values for all segments significantly enhanced classification accuracy. According to the assessment findings, A map of the burned area was created using a Feature Extraction with a kappa value of 0.9322 and a Pixel based method with a kappa value of 0.7433.

(Adam et al., 2016) studied the differentiation between Pixel based and Feature Extraction techniques to mapping LU/LC in Sudan's semi-arid areas. The study was conducted in North Kordofan State's gum arabic belt. The research used ASTER. Segmentation through colour and homogeneity identification. For each class, land use cover groups were extracted using nearest neighbour algorithms with membership function parameters (fuzzy logic). Pixel based and Feature Extraction methods' overall accuracy and Kappa indexes were 72.92 %, 54.17%, and 0.6259, 0.3810, respectively. Pixel based technique conducted considerably better than Feature Extraction technique in semi-arid land classified in Arabic gum belt.

(DERVİSOGLU et al., 2020) researched that Wetlands greatly benefit from remote sensing concepts and techniques, according to studies. The object was to determine the coastline of the wetlands. Sentinel-2 satellite data is used to investigate Duden Lake's coastline throughout all four seasons using Pixel based and Feature Extraction techniques. The techniques are investigated and assessed for their applicability in evaluating the shallow wetland coastline. The classification accuracy of Pixel based and feature extraction images is assessed. The accuracy

evaluation applied to the classification results was greater than 90% in each method.

4. **Conculsion**

The chapter presented the main principles and Reviews on classifications techineques for the purpose of the comparison between feature and pixel-based image analysis. All the algorithms have a way in which they work, although they possess certain weaknesses and strengths. Performance measures were also discussed, as they are important in the purpose of the experiment. It was however important to discuss factors which could impact on image classification, as a presentation of data quality was done.

To improve the assessment of LU/LC changes, remote sensing methodologies have been implemented that employ satellite imagery to accurately observe, identify, and map LU/LC changes. Today, two standard methods for image analysis are Pixel based and Feature Extraction. A literature review shows different results, and current research does not demonstrate whether Feature Extraction analysis and its theoretical benefits can be applied to a particular form of imagery to produce more reliable results. Recent research has been motivated by this ongoing debate. These methods have both advantages and disadvantages in mapping and analysing changes in a satellite image. Each technique's performance is compared in this study to decide which approach is superior for this form of application. This information is critical for strategic planning managers and future research into Baghdad's grassland quality and modelling changes in agricultural land use.

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