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Modified Morphological Profiles Based Classification from Very High Resolution Data

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ABSTRACT

Remote sensing optical images of very high resolution data can provide a precise and comprehensive representation of the surveyed scene. The significant task is to extract the features and to observe automatically. In this paper, Modified Morphological Profile (MMP) method is proposed. A limitation of the originally proposed MPs is that the profiles were only based on single shaped structuring elements (SEs), suggesting that such MPs may not be suitable for detecting different shapes in images. To better fit several shapes in a given image, a modified approach based on mathematical morphology is proposed to extract structural information from high resolution images and consequently yield new versions of MPs. It calculates the profile based on square, diamond and line shaped structuring elements are applied to extract the different types of features. The very high resolution data of Madurai city, South India acquired by World View 2 Sensor (1.85 m) proved the usefulness of this method than conventional method. The accuracy of classification maps is obtained using ground truth data

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INTRODUCTION

Remote sensing passive imaging sensors detect the electromagnetic energy radiated and reflected by the earth surface. With the constant increase in geometrical resolution of earth observation sensors faced in the last decades, the spatial information provides increasing contribute to the understanding of remote sensing imagery, since it characterizes the sensed landscape in a complementary way with respect to the spectral signatures of the land covers. In the past, the processing of low resolution images was mainly performed with pixel-based approaches due to their direct application to the image. Although, the results produced can be satisfactory for low resolutions, since a low correlation is experienced between neighboring pixels, the performances of such approaches drastically reduce when applied to VHR images. From a general survey of techniques modelling the spatial information in remote sensing, one can notice that there are different approaches for extracting the spatial information Furthermore, when dealing with VHR images, the interpretation of the scene can largely benefit from the analysis of the spatial domain.one of the possible approaches is to use mathematical morphology which can characterize the objects using shape as well as structures. Feature extraction can be defined as the set of vectors that represent an observation by reducing the dimensionality. The development of feature extraction methods has been one of the most important problems in the field of pattern analysis and has been studied extensively. The 4 point and 8 point connectivity operations are used to understand the structure or form of an image in mathematical morphology. Robust algorithms are developed and implemented for feature extraction of high resolution satellite data. The paper is ordered as follows. In section 2 and 3 the study area and the proposed methodology are discussed. In section 4, experimental results are given and discussed before to conclude the paper with final remarks in section 5.

I. Study area:

In this project we have chosen the study area as Madurai city. Madurai is the second largest city in the Indian state of Tamil Nadu and one of the oldest continuously inhabited cities. It is known as the Athens of the East, one of the ancient historic cities in the world. The municipal corporation of Madurai has an area of 52 km^2, The archaeological findings clearly suggest that the city is more than 2500 years old. It is approximately 101 meters above the sea level. Geographic location of our study area

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Longitude 78 6' 42.34" E - 78 7' 17.07" E
Latitude 9 55' 3.46" N -9 54'33.33"N

The image has taken by World View-2 satellite sensor which was launched at Sep,2008 with the Resolution of 0.46 meter for panchromatic and 1.85 meter for multispectral images. In this work, the worldview-2 MSS (Multispectral data) of Madurai city in the year of January, 2010 is considered here.

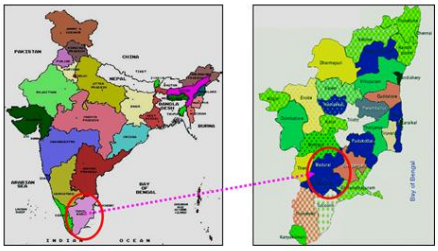

Fig. 1: study area.

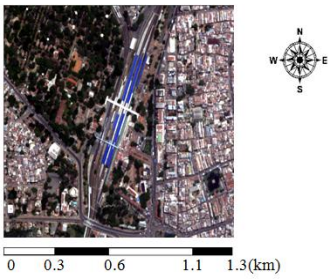

Fig. 2: Subset Image of World View-2 Sensor.

II. proposed methodology:

The steps involved in our research are categorized into three stages: Feature extraction, Classification and Accuracy Assessment. Feature Extraction stage involves the computation of different feature extraction profiles (morphological profiles) using square, disk, diamond, line shaped structuring element. After extracting different features the classification is performed using K-means Classifiers. Finally the classified result is verified with the ground truth data with the help of confusion matrix calculated using ENVI.

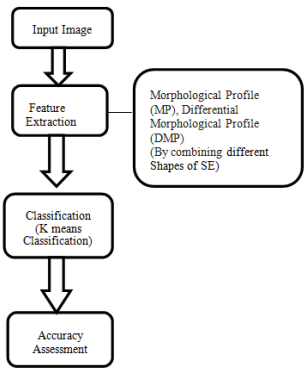

Fig. 3: Proposed Methodology.

A. Morphological Profile (MP) and Differential Morphological Profile (DMP) based Feature Extraction:

Morphological Profiles (MPs) are effective tool in extracting spatial features from the image in order to describe the objects in the scene. MP performs a multiscale decomposition of an image based on a simplification of the scene through the suppression of progressively larger details. The MP is defined by the composition of opening and closing by reconstruction (morphological operators particularly suitable for the analysis of high resolution data) with different sizes of structuring elements. A morphological profile is generated by geodesic operators, simply the concatenation of closing and opening profiles. For an input image f using n different sizes of structuring element MP can produce 2n+1 profile. (n from opening profile and n from closing profile and original image)

$$\Pi(f)=\left\{\Pi_i:\left\langle\begin{matrix}\Pi_i=\Pi_{\phi_\lambda},with\lambda=(n-i+1)\forall i\in[1,n]\\ \Pi_i=\Pi_{\gamma_\lambda},with\lambda=(i-n-1)\forall i\in[n+1,2n+1]\end{matrix}\right\rangle\right\} \quad (1)$$

From the concept of the MP, the derivative of the morphological profile (DMP) is defined. DMP contains the same information as the MP, but it can be useful for visual inspection of the scene. Since, it shows the differences between adjacent levels of the MP profile by enhancing the residual between subsequent filtering. From the DMP, it is possible to extract the morphological characteristic of the image that is defined for each pixel.

The differential morphological profile (DMP) $\Delta(x)$ can be written as the vector.

$$\Delta(f)=\left\{\Delta_i:\left\langle\begin{matrix}\Delta_i=\Delta_{\phi_\lambda},with\lambda=(n-i+1)\forall i\in[1,n]\\ \Delta_i=\Delta_{\gamma_\lambda},with\lambda=(i-n)\forall i\in[n+1,2n]\end{matrix}\right\rangle\right\} \quad (2)$$

RESULTS AND DISCUSSIONS

This chapter shows the various results of morphological profiles (MP , DMP) using different types of structuring elements and the classification results obtained by the various profiles using k-means Classifier. Finally the error matrix is calculated to validate various classification results. In order to create the profile For the Very High Resolution Image, a 7-D morphological profile was generated using a squared-SE with size of 5 , disk based structuring element of sizes 5 and the line shaped structuring element of size 5 and 90 degree orientation. These values were chosen for our study area. From the MP's 6-Dimensional differential Morphological Profile were also calculated. Since, they are able to model the size of the heterogeneous objects in the data. After extracting features from the images k-means clustering algorithm is applied to classify the data. Finally the classified data are verified with ground truth data to promote the significance of this method. In addition to that this same work result can also be verified with the conventional fixed shapes structuring element

morphological profiles. The differently shaped structuring element based morphological profile provides better accuracy than the conventional morphological profiles.

Results for DMP of various structuring elements:

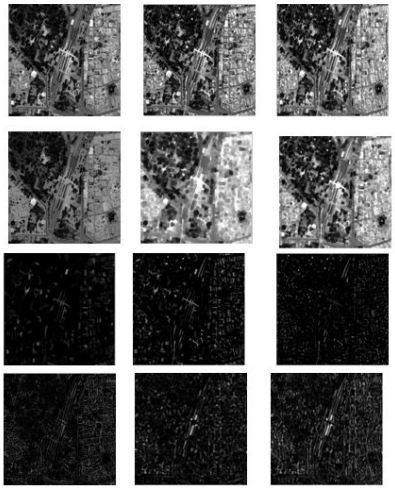

Fig. 4: Morphological profiles built on the World View-2 Image (a) First Row reports Opening by reconstruction ourput of square shaped, disk shaped and line shaped structuring element respectively. (b) Second Row reports Closing by reconstruction ourput of square shaped, disk shaped and line shaped structuring element respectively. (c) Third Row reports DMP ourput of square shaped, disk shaped and line shaped structuring element respectively. (c) Fourth Row reports DMP ourput of square shaped, disk shaped and line shaped structuring element .

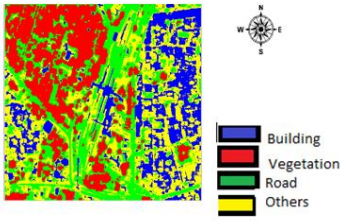

Fig. 5: Classification results for DMP with square shaped SE.

III. Conclusion:

In this work modified morphological profiles have been opposeded for the classification of high resolution satellite data. The motivation of this work relies on the need to improve the capability of modeling conventional morphological profiles and their derivatives. Since from the origin of morphological profiles ,none of the work has dealt with the different types of structuring element into simple categorization. This approach allows one to analyze the original image in a multi-level fashion by the application of a sequence of morphological opening and closing operators. The proposed technique was applied to multispectral images acquired by World View-2 satellite of Madurai city of South India. The morphological profiles, based on differently shaped structuring element provides better accuracy than classical methods by checking their accuracy using ground truth data. Finally it has been inferred that DMP with differently shaped SE produces the better accuracy (85%) than DMP square shaped SE (77%) .

Table 1: Confusion matrix result for DMP, DMAP with Area, DMAP with Inertia.

Class	Modified Morphological Profile Method						Morphological Profile with square shape					
	B (%)	V (%)	R (%)	O (%)	UA (%)	PA (%)	B (%)	V (%)	R (%)	O (%)	UA (%)	PA (%)
B	90	4	4	2	90	84	80	6	8	6	80	73
V	2	92	2	4	92	86	2	88	4	6	88	82
R	6	4	86	4	86	84	6	10	72	12	72	79
O	10	8	10	72	72	86	22	4	8	66	66	73

B-Building V-Vegetation R-Road O-Others UA- User Accuracy PA-Producer Accuracy

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