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Proposed Algorithm for Hybrid Satellite Image Classification

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Abstract

The satellite image classification system intends to distinguish between the classes being present in the image. It is highly challenging because the coverage area of the satellite is large such that the classes appear so small, this makes the process of object distinguish complex. Additionally, the classification accuracy is an important factor, which the classification system must pass through . This work presents a satellite image classification system which can classify between the vegetation, soil and water bodies ,etc. Satellite image classification needs selection of appropriate classification method based on the requirements .In this paper the Support Vector Machine (SVM) and (K-means) are applied on classification of high resolution and low resolution satellite images. Several different performance measures ,including time ,accuracy, sensitivity and simple contextual information were evaluated. Additionally , the image was segmented using k-means method in order to improve the classification accuracy ,sensitivity and reduce of time. The Support Vector Machine was flexible and powerful but still not perfectly suited for high resolution images. Classifying such images requires contextual information to be taken into consideration and the SVM could not efficiently learn correct context from training examples. Without including the contextual information obtained from the use of k-means. The proposed model can be used to obtain the appropriate classification of satellite to show the layers of the earth covering buildings ,roads, agricultural , desert lands, water, and vehicles, etc. We note that the time does not exceed 32 seconds for the number of images used within our database.

Keywords: satellite images, classification ,k-means ,support vector machine classifier.

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الملخص

ينوي نظام تصنيف صور الأقمار الصناعية التمييز بين الطبقات الموجودة في الصورة. إنه أمر صعب للغاية نظرًا لأن مساحة تغطية القمر الصناعي كبيرة للغاية بحيث تبدو الطبقات صغيرة جدًا ، مما يجعل عملية التمييز بين الكائنات معقدة. بالإضافة إلى ذلك ، فإن دقة التصنيف هي عامل مهم ، يجب أن يمر به نظام التصنيف. يقدم هذا العمل نظامًا لتصنيف صور الأقمار الصناعية والذي يمكن تصنيفه بين الغطاء النباتي والتربة والمياه. يحتاج تصنيف صور الأقمار الصناعية إلى اختيار طريقة التصنيف المناسبة بناءً على المتطلبات. في هذه الورقة ، يتم تطبيق support vector machine (SVM) و (K _means) على تصنيف صور الأقمار الصناعية ذات الدقة العالية والمنخفضة الدقة. تم تقييم العديد من مقاييس الأداء المختلفة ، بما في ذلك الوقت والدقة والحساسية والمعلومات السياقية البسيطة. بالإضافة إلى ذلك ، تم تجزئة الصورة باستخدام طريقة k_means لتحسين دقة التصنيف والحساسية وتقليل الوقت. كانت support vector machine مرنة وقوية ولكنها لا تزال غير مناسبة تمامًا للصور عالية الدقة. يتطلب تصنيف مثل هذه الصور أن تؤخذ المعلومات السياقية بعين الاعتبار ، ولا يمكن لـ SVM تعلم السياق الصحيح بكفاءة من أمثلة التدريب. دون تضمين المعلومات السياقية التي تم الحصول عليها من استخدامk_ means. يمكن استخدام النموذج المقترح للحصول على التصنيف المناسب للقمر الصناعي لإظهار طبقات الأرض التي تغطي المباني والطرق والأراضي الزراعية والصحراوية والمياه والمركبات ، إلخ. نلاحظ أن الوقت لا يتجاوز 32 ثانية للرقم الصور المستخدمة في قاعدة البيانات الخاصة بنا.

كلمات البحث: صور الأقمار الصناعية ، التصنيف ، K_means, مصنف support vector machine.

1-Introduction

Satellite image classification is a process of grouping pixels into meaningful classes[1]. It is a multi-step workflow, satellite image classification can also be referred as extracting information from satellite images. Satellite image classification is not complex, but the analyst has to take many decisions and choices in satellite image classification process. Satellite image classification involves in interpretation of remote sensing images, spatial data mining, studying various vegetation types such as agriculture and foresters and studying urban and to determine various land uses in an area[2].

Image classification is an important part of the remote sensing ,image analysis and pattern recognition. In some instances, the classification itself may be the object of the analysis .For example, classification of land use from remotely sensed data produces a map like image as the final product of the analysis [3].The image classification therefore forms an important tool for examination of the digital images. The methods of classification of satellite images can be categorized over a

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wide range into three classes :Automatic ,manual and hybrid. The two general approaches which are used most often are :supervised and unsupervised classification [4].

2-Literature Review

This section presents the related review of literature with respect to satellite image classification:

.In (2011), Dai D and Yang W.[5]:A satellite image classification system that is based on Two-layer Sparse Coding (TSC) is presented. The TSC identifies the original neighbors of the images without any training process. The satellite images are classified on the basis of TS coding coefficients .**In (2011), Gordo O., and others[6]:** The work proposed introduces a rule based system for satellite image classification, which is based on fuzzy logic. Additionally ,genetic algorithm is employed to choose the optimal set of fuzzy rules to make the process simpler. The accuracy rates of this work is claimed to be better**. In (2013), Xu K., and others[7]:** An efficient unsupervised classification scheme is proposed for high resolution satellite images .This work can provide accurate segmentation and the number of segments are automatically set. **In(2013), Shabnam Jabari and Yun Zhang,.[8]:** Introduced supervised satellite image classification method to classify very high resolution satellite images into specific classes using fuzzy logic .This method classifies into five major classes: shadow, vegetation, road, building and bare land .This method uses image segmentation and fuzzy techniques for satellite image classification .It applies two levels of segmentation, first level segmentation identifies and classifies shadow ,vegetation and road. Second level segmentation identifies buildings. Further it uses contextual check to classify unclassified segments and regions .Fuzzy techniques are used to improve the classification accuracy at the borders of objects. **In (2015),Banerjee B., and others[9]:**an unsupervised land cover classification scheme for multispectral satellite images is presented. The proposed scheme utilizes the concept of self-learning and cluster ensembles. The cluster ensembles deal with the iterative expectation-maximization (EM)

algorithm, which generates the cluster attributes. The classifier being employed in this work is maximum likelihood classifier and is trained by the cluster attributes formed by EM algorithm. This classifier does not require any supervision .**In (2016), Papa JP, and others[10]:**An unsupervised land cover classification system is proposed. This approach employs genetic algorithm with several met heuristic algorithms. This work concludes that one in four satellite images is correctly classified.

In (2016), Karalas K .,and others[11]: A multi-label classification scheme for satellite imagery is presented. In order to prove its capability, the same work is applied over hyper spectral satellite images. **In (2017) Maggiori E., and others[12]:** Convolutional Neural Network (CNN) based satellite image classification system. This work proposes a two-step training process, in which the initial step may involve several irrelevant data and so, the next step refines the data. The classification process is achieved by multi scale neuron module**. In(2017) , Xia J., and others[13]:** A new ensemble based technique is proposed for image classification. The technique is named as 'rotation random forest' ,which is made possible by Kernel Principal Component Analysis (KPCA).The initial feature set is decomposed into several feature subsets, followed by which the KPCA is applied over each and every subset. The KPCA extracts statistical features and are clubbed together to train the Random Forest.

3-Image Classification Methods

The classification technique of remotely sensed data are used to assign corresponding levels with respect to group with homogeneous characteristics[14], with the aim of categorize multiple objects from each other within the image. The level is called class. Classification will be executed on the base of spectral or spectrally defined features, such as density, texture ,etc. in feature space. It can be said that classification divides the feature space into several classes based on a decision rule[15-16].Classification methods divide into three approaches :Automated , manual and hybrid. As shown in figure 1.

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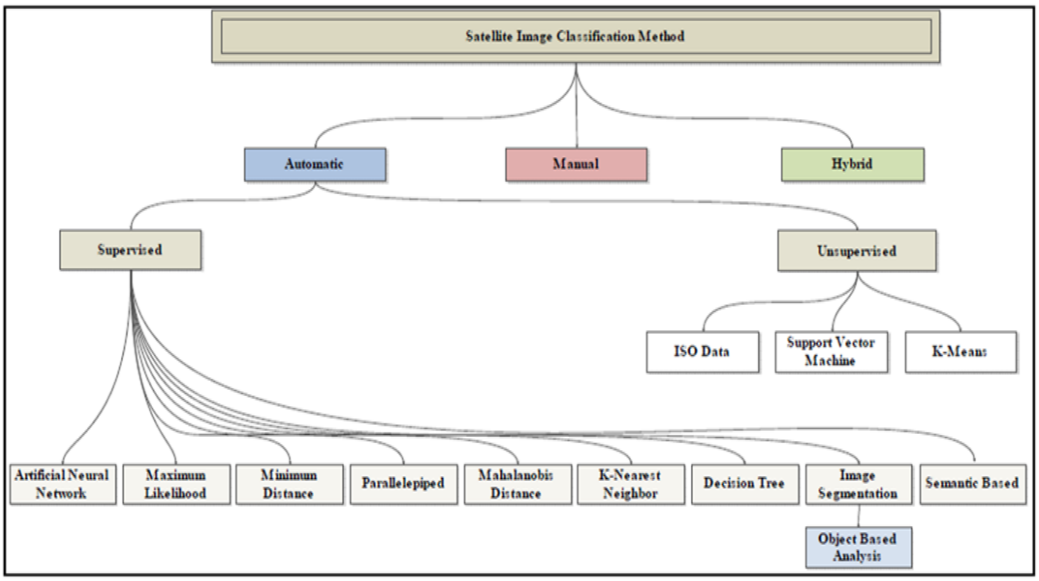

Figure 1: Block diagram of satellite image classification methods hierarchy[4].

Automated satellite image classification methods includes algorithms that implemented systematically the entire satellite image to group pixels into special categories. Where the majority of the classification methods fall under this category. Automated satellite image classification method further classified into two categories: supervised and unsupervised classification methods[17]. Supervised classification technique need input from an Analyst . The input from analyst is called as training set. Training sample is the most important factor in the supervised satellite image classification techniques. Accuracy of the techniques highly depends on the samples taken for training. Training samples are two types , one used for classification and another for supervising classification accuracy. Training set is provided before classification is activated . Main supervised classification techniques uses the following statistical techniques: Artificial Neural Network (ANN) ,Binary Decision Tree (BDT),Image Segmentation[18]. Unsupervised classification technique uses clustering mechanisms to

group satellite image pixels into unlabeled clusters . The analyst assigns indication labels to the clusters /classes and product well classified satellite image .Most common unsupervised satellite image classification is ISODATA[19], support vector machine (SVM) and K-means[20]. The methods of classifying manual satellite images are powerful and efficient but consume more time, manual methods in which the analyst must be familiar with the area covered by the satellite image. Accuracy and efficiency of the classification, towards a branch of study [18]. Hybrid ways to classify satellite images are integrated between advantages of both automatic and manual methods. Hybrid approach uses automated satellite imagery classification methods to do the initial classification, there are other manual methods used to develop classification and error processing[18].

4-Satellite image

Satellite images are rich and plays a vital role in providing geographical information [19]. Satellite and remote sensing images provides quantitative and qualitative information that reduces complexity of field work and study time [20]. Satellite remote sensing technologies collects data/images at regular intervals. The volumes of data receive at datacenters is huge and it is growing exponentially as the technology is growing at rapid speed as timely and data volumes have been growing at an exponential rate [21]. There is a strong need of effective and efficient mechanisms to extract and interpret valuable information from massive satellite images. Satellite image classification is a powerful technique to extract information from huge number of satellite image. As shown in figure 2.

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Figure 2: Example on satellite image

5-Satellite Image Application

Satellite images have many applications in meteorology, oceanography, fishing, agriculture, biodiversity conservation, forestry, landscape, geology, cartography, regional planning, education, intelligence and warfare. Images can be in visible colors and in other spectra . There are also elevation maps, usually made by radar images. Interpretation and analysis of satellite imagery is conducted using specialized remote sensing applications[22].

6- Disadvantages Of Satellite Image[23]

Because the total area of the land on Earth is so large and because resolution is relatively high, satellite databases are huge and image processing (creating useful images from the raw data) is time-consuming. Depending on the sensor used, weather conditions can affect image quality: for example, it is difficult to obtain images for areas of frequent cloud cover such as mountain-tops. For such reasons, publicly available satellite image datasets are typically processed for visual or scientific commercial use by third parties.

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7-Research problem

The satellite image classification system intends to distinguish between the classes being presented in the image .It is highly challenging because the coverage area of the satellite is large such that the classes appear so small, this makes the process of class distinguish complex. The computer aided classification should satisfy two important goals, which are accuracy and processing speed.

8-Aims and Objectives

This research presents a satellite image classification system, which can classify between the vegetation, soil and water bodies. The objective of this work is to suggest a way to develop a hybrid classification of satellite images and to divide the work into two important stages, which are satellite image pre-processing, and classification. The image pre-processing phase and then classification of satellite image with using SVM and K-Means techniques.

9-Methods used in research

9.1-Satellite image classification using K-means

K-Means unsupervised classification (calculates initial class means evenly distributed in the data space then iteratively clusters the pixels into the nearest class using a MDC). Each iteration recalculates class means and reclassifies pixels with respect to the new means[23]. Iterative class splitting, merging, and deleting is done based on input threshold parameters. All pixels are classified to the nearest class unless a standard deviation or distance threshold is specified, in which case some pixels may be unclassified if they do not meet the selected criteria. This process continues until the number of pixels in each class changes by less than the selected pixel change threshold or the maximum number of iterations is reached[23].

9.2-Satellite image classification using Support Vector Machine(SVM)[24]

Support vector machines (SVMs, also support vector networks[25]) are supervised learning models with associated learning algorithms that analyze data

used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall .In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. When data are unlabeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The support vector clustering[26] algorithm created by Hava Siegelmann and Vladimir Vapnik, applies the statistics of support vectors, developed in the support vector machines algorithm, to categorize unlabeled data, and is one of the most widely used clustering algorithms in industrial applications.

10.The proposed algorithm

The proposed algorithm to distinguish satellite images consists of the following steps:

Input :satellite image;

Output :classified satellite images by soil , vegetation ,water bodies ,road ,etc.;

Begin

Step1. Read satellite image.

Step2.Preprocessing :Image resize and DE noise the image by median filter.

Step3.Convert RGB space to L A*B* space.*

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Step4.Classify the colors in 'A B*' space using K-means clustering.*

Step5.Label every pixel in the image using the results from K-means.

Step6.Using (pixel-labels) we can separate the classes in the image by color which leads to several images.

Step7.Display all the results.

Step8.Load the sample data(clusters output from the application algorithm K-means).

Step9.Creat data ,a two column matrix containing length and width.

Step10.From the species vector, create a new column vector to classify data.

Step11.Randomly select training and test sets.

Step12.Train an SVM classifier using a linear function .

Step13.Use the svmclassify function to classify the test set.

Step14.Give each class a certain color distinguish it from the other class.

Step15.Evaluate the performance of classifier of time and classification ratio for each category.

Step16.End.

With the combination of these two methods, we will have a proposed algorithm that developed hybrid satellite image classification approach.

The main intention of this research article is to present an accurate satellite image classification system, which relies on image pre-processing classification phases. The image pre-processing phase processes the satellite image so as to make it suitable for the forthcoming phases. This phase DE noises and improves the contrast of satellite images .The median filter technique are utilized to eliminate unwanted information and enhance the

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contrast of satellite images respectively. The first stage is preprocessing through which the satellite image is transferred to the class extraction stage using K-means cluster) where each category is assigned to represent a specific region. Then ,these categories are categorized from the previous stage using (Support Vector Machine) to give each class a specific color , to represent one image in the same way. the second stage is k-means divides the satellite images into the soil cluster, vegetation cluster, and water bodies cluster , with the knowledge gained in the training phase. The previous categories are categorized into specific areas and in a specific color ,where the speed ,accuracy and classification ratio of each category should be available in this work using SVM classifier as shown in figure 3.

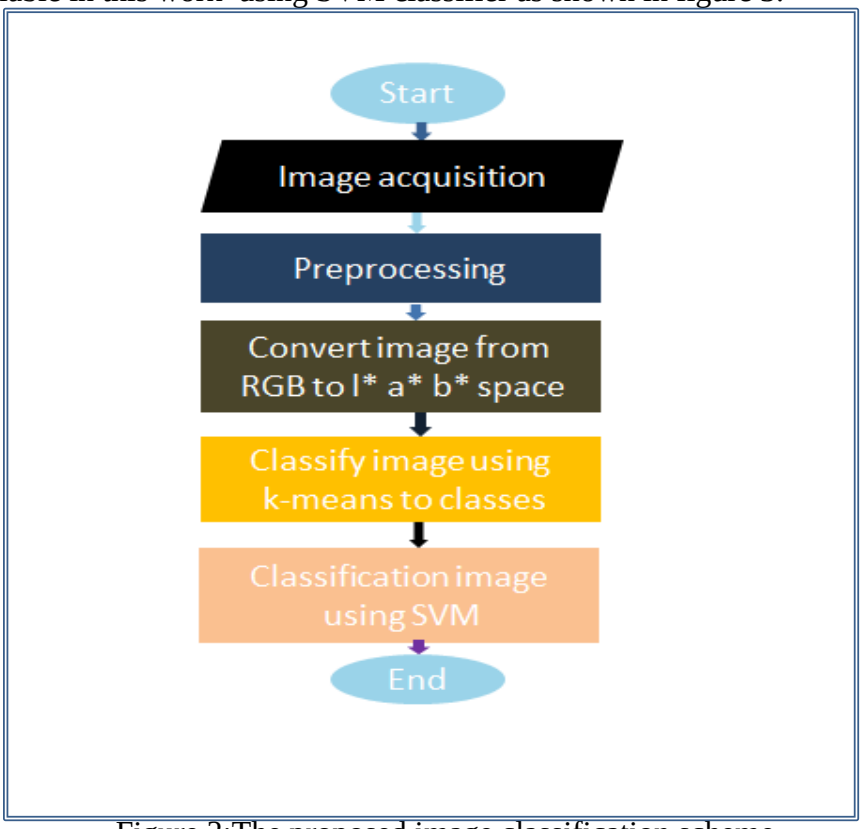

Figure 3:The proposed image classification scheme

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11.Results And Discussion

This work takes the images of the second from June for Iraq country into account for the purpose of image classification. The images being considered for this research lie between 29-37 latitude and lie between 44 - 47 longitudes. This section analyses the performance of the proposed approach by varying the feature extraction and classification techniques in terms of accuracy, sensitivity and specificity. The proposed approach is tested by considering the satellite images downloaded from Turkish MODIS site .The experimentation is done in the matlab environment. This work trains and tests the system with 50 from the images each respectively. The sample classification results are shown in the figure 4. The dimensions of each image are 2000 rows and 2000 columns and are classified with a time of (32.9078) second,(29.8091)second . The picture that we will take as an example where we applied the proposed method of classification on them, shown below in figure 4 and figure 5.

Figure 4: satellite image

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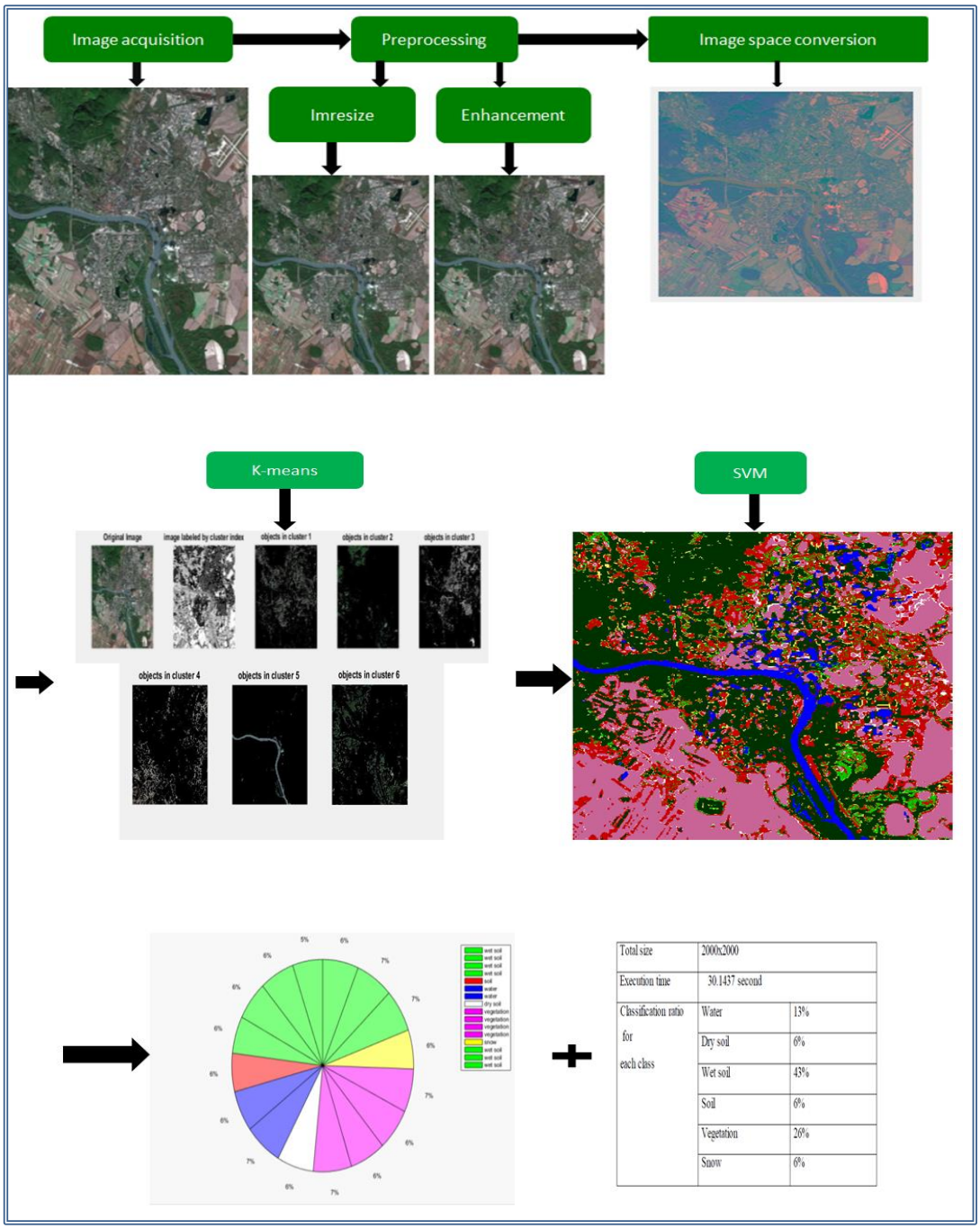

Total size	2000x2000	
Execution time	30.1437 second	
Classification ratio for each class	Water	13%
	Dry soil	6%
	Wet soil	43%
	Soil	6%
	Vegetation	26%
	Snow	6%

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Figure 5: Stages classification of satellite image

12.Comparison between the proposed model and the previous models

The proposed model will be compared with the previous models by adopting several measurements we have taken in the research namely, time ,accuracy and sensitivity. The proposed model shows the signification difference resulting from time reduction compared to the time used in the previously used models for both methods separately as well as accuracy and sensitivity ,as shown in table 1.

Table1 :Comparison between the proposed model and the previous models.

Techniques performance measures	Comparison varying classification techniques			
	K_NN	RVM	SVM	Proposed methods
Time				Not exceed 32 seconds
Accuracy	72	92	97	100
Sensitivity	68	86	98.7	100

13.Conclusions

In our study of the proposed work, we conclude the following:

1. The ability to distinguish objects in any satellite image through the proposed system.
2. To determine the classification ratio of each category in an image easily.

3. Speeding up the time of implementation of the classification of satellite images.

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