Images Classification and Feature Extraction by Using Unmanned Aerial Vehicles (UAV’s)

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Abstract

The classification method used in this research work is one in which a common set of features are used jointly in a single decision step. The classification analyses are chosen during experimental steps; planning the classification optimizes the data and enables conditions to be classified with the single run of the decision. This paper presents the classification of the terrain images; which are divided into patches of same size and each patch is classified as either possessing features of interest or possesses no features of interest at all. As the classification method used is a single decision step method; in order to have a good classifier performance, a number of experiments are performed on several images with varying conditions; each experiment on an image is done and considered independently. Experimental results are presented using real images, the result clearly identify the regions with man-made features. This technique for terrain classification is developed for air vehicles navigating in a terrain; this technique would assist the air vehicles in efficiently searching/navigating a terrain.

INTRODUCTION

Classification is based on the features that are extracted from terrain images; feature extraction from an image holds importance when it comes to computer vision or image processing; as extraction of information about image contents is the most primary objective that researchers have been paying attention to since almost last three decades. In the terrain images used in this project; the objects that are present in those images are processed for extraction of features are edge’s profiles; strength’s profiles and orientation profiles. In order to extract any information about the features a discrimination of the objects from each other is first to be made; and this essential task has been performed. This paper presents a novel idea on feature extraction; a research has been done on how to extract features of interest when given a single image.

IMAGES ACQUISITION

Image acquisition is one of the initial steps of the project where images are gathered through different sources, mainly through internet and Google-earth application [10]. The images selected for the purpose of research are satellite images; the Google-earth application was a source of getting satellite imagery at any height and for any terrain around the globe. The images selected for experiments are of places that had all sorts of different features in it, considering that proper research could be done and the results which would come would be realistic. Figure 1 shows one of the typical pictures used for performing experiments.

The Images are normally stored in compressed formats, typically to improve storage utilization or to save on bandwidth required to transmit it, now among them; the formats standardized by joint picture expert group (JPEG) are widely used on internet or image databases [6,8]. Although the format is a commonly used method of loss compression for photographic images, but suits well in this scenario; because the JPEG compression algorithm is at its best on photographs and paintings of realistic scenes with smooth variations of tone and color. Hence makes JPEG an accepted format for the images of this project and also as JPEG is also the most common format saved by digital cameras, which are widely in use.

Figure 1: One of the images used
features, i.e. green patches, soil patch, water, etc all comprise to be features known as natural features, while apart from natural features there are lots of houses built in this terrain, these are known to be manmade features. The objective of this project is now to extract features from the images and come up with a technique to distinguish areas which contain manmade features from the ones that consist of only natural features.

**PROCESS FLOW DIAGRAM**

Figure 2 shows the process flow diagram, this is the process flow diagram of the all the steps involved in edge detection, feature extraction and the outcomes of these processes are used in the final step for classification. All the processes are discussed in the sections to follow.

**RESULTS OF FEATURE EXTRACTION**

Figure 3 is one of the images that were used for experiments and is illustrated in this section to explain the phenomena developed for feature extraction. Its corresponding gray-scaled image and edge detected image using MATLAB’s function are displayed in figure 4.

Figure 4 shows the edge strengths of the input image; the input image is first converted into a gray-scale image; the conversion is made to make use of the intensity levels in the gray-scale image. The image is then divided into blocks of same size; each block is individually processed for edge detection. It can be observed in figure 5, it is divided into 100 blocks; the block division depends on few factors; which are discussed in section 5 of this paper.

The gray scaled converted image is divided into blocks and each block is considered as an individual image, the same method of edge detection is applied to compute edge strengths and orientations per block. The resulting edge orientations per block are shown in figure 6. The objective of dividing image into blocks is in order to process each block individually, each block is gone under some experiments and observations are made in each block; and based on the results of experiments and the observations the features are extracted from each block of the image.

Figure 5 and 6 are used in feature extraction, the process starts from the top left corner box in both the images and goes in a raster scan till the last bottom right block in both the images.
After the process of dividing the image into blocks of equal size, and finding strength and orientation per pixel for all the pixels. Through experiments and analytically; based on edges strengths and their orientations a methodology is built to extract features from terrain images, which are later used for classification, details on how features are extracted and the subsequent classification of terrain images is discussed in detail in the section 5 to follow.

CLASSIFICATION

On successfully processing of all the pixels in the image, for each block edge strength profiles and edge orientations profiles are generated by using proposed functions and methods. Features are extracted based on the edge information available on applying edge detection algorithm; the images are processed in order to extract only two types of features only, i.e. edge strengths profiles and edge orientations profiles. These two features make the basis for building a decision based classification method [17].

On performing a number of experiments and observing the results of the experiments a technique is developed using edge strengths and orientations profiles to identify blocks of images containing features of interest. The experiments performed were mainly on how to combine both the strength and orientation information together to develop a methodology which can be used to classify terrain images; each block of the image is classified as either possessing manmade features or possessing natural features. The focus is accordingly now how to make a decision based classification, using the features extracted.

The methodology developed through research and performing a number of experiments is one in which both the edges strengths and orientations are used according to their profiles/trends that were observed for manmade features and natural features. On performing different experiments it was observed to be useful; if the average of strengths in a block is taken, and that is assigned as the strength of the whole block, this mean value is used alongside with the extracted features corresponding to the orientations of the edges.

As grey level images are being used, the edge strengths are in grey levels from a minimum to the maximum present in the image; upon averaging them in each block the resulting block strengths of each block are shown in figure 7. Similarly figure 8 is the same representation in gray levels, the lowest intensity block is in black and the highest intensity block is in white.

On efficiently building edges strengths profiles, it is now to develop a methodology to extract features corresponding to the edges orientation (i.e. their profiles), which then both can be used together for classification. It was observed on performing numerous experiments that in order to differentiate between man-made features and natural features based on edges orientation, the orientation profiles showed completely different attributes for the two types of features. Figure 9 and 10 represent two cases of orientation’s profiles; figure 9 represents one of the block of image which completely
possesses man-made features, while figure 10 represents the block completely possessing natural features.

The orientations represent the direction of edges, it was observed through experiments that those blocks which possess natural features have straight orientations, and those straight orientations have much higher frequencies compared to the rest of the orientations. These orientations were found out to be either 0, 45, -45, 90, -90; as natural regions in an image normally a straight plane or are observed to be straight planes when 2D images are processed; hence when their orientations profiles are computed it is found to be these specific angles showing large peaks in the frequency profile graph. This is due to the fact that orientation per pixel are computed using the gradients in X and Y direction; Whenever the gradient in the X direction is equal to zero, the edge direction has to be equal to 90 degrees or 0 degrees, depending on what the value of the gradient in the y-direction is equal to. If Gy has a value of zero, the edge direction will equal 0 degrees. Otherwise the edge direction will equal 90 degrees; similar case is for 45 degrees as well [16].

The feature information that is extracted is utilized in a way such that the orientations pertaining to these 5 degrees are summed together and on the other hand the rest of the degrees are summed together as well, for regions that contain natural features these five degrees are of higher percentage as compared to cases when the regions contain man-made features; this is evident from the two cases presented in figures 9 and 10, the phenomena can be observed in the pie charts.

For the gray scale edge strength image, the intensity variance in blocks is a measure of contrast; hence the blocks overall edges strength is one of the condition for the decision based classification. If the variance is lower than a researched value, it means that the block does not possess features of interest (i.e. man-made features), thus, that block is classified as a block not possessing features of interest. The orientations profile on the other hand make up to be the second condition for the decision based classifications, the result of summation of orientations corresponding to five directions is used as the condition. These limits/conditions technique is the heart of the proposed technique and is the pioneer in classification, where if edges strength per block value is rated in the top 20%; then it satisfies one of the condition for being classified as a block possessing features of interest, and must fulfill the second condition; which is the percentage of the five orientations in a block must be greater than or 15%, then that block can be fully classified as possessing man-made features. The two numerical values are set after performing numerous experiments [14].

Figure 11 represents the classification of the terrain image; the blocks in black are represented by those regions which are not possessing features of interest, while the blocks in white are those regions clearly possessing features of interest (i.e. man-made features).

The values of edge strengths per block and the percentage of frequencies corresponding to five orientations define the basis of classification. After all pixels in the image have been processed, and for all the blocks the edge strength and orientation information has been extracted, the process of decision based classification can be initiated [15].
A. Block Size

Figure 11 and 12 are the classification of the same image, but have different division of blocks (i.e. block size), it can be observed by comparing the figures that in figure 3-12 the classification is much accurate and precise, this is due to the fact that the block size selected is reasonably well. Hence the block size should be selected with good care and considering all the parameters involve selection. The block size should not be very small nor should it be very large, in fact it should be moderate.

One of the parameter that should be considered is the height from which the input image has been captured, the block size should be larger for images taken close from the earth’s surface and should increase as further away from the surface it has been taken. Figures 13, 14 and 15 shows the effect of decreasing the block size for images that have been taken from a huge height, it should also be notices that the features are clear in the input image [18].

CONCLUSIONS

Wireless sensor networks are enabling technologies that once were not very practical, but with the development of new standards-based networks there has been a dramatic decrease in the power consumption of the WSNs, which has resulted in a widespread usage and deployment in a range of applications, the text to follow puts some light on WSN. This project is a phase of a bigger project with a bigger scope and hence the technique developed for classification is based on the thought of making it most useful for the project that would utilize this technique.

Images were a major requirement for this very project, considering the nature of the project it was not feasible to acquire real time images captured by imaging sensors installed on UAVs, therefore instead initially images were searched for
over the internet and finally over Google –earth application [10]. The images acquired were based on the facts; that they were best suited to serve the purpose of research and would resemble real time pictures taken by different types of UAVs.

One part of this project completes its task by successfully building a technique that would act as a backbone for the whole project when implemented; the technique build in this project is a researched methodology and classifies the terrain images efficiently. The classification technique proposed very accurately classifies areas of images possessing features of interest, as it is helpful to include positive (classifications that should be possible) and negative (classifications which should be impossible) controls in the experiment. These strengthen the interpretation that classifications are based on interesting activity patterns. The experimental results showed that using the decision-based method to classify terrain images provide accurate classification for the type of application.

REFERENCES