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Identification of Buildings and Roads Area in an Aerial Image by Applying Morphological Filters

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Abstract
Morphological filters erosion and dilation plays an important role for highlighting the buildings and roads areas in aerial images. These filters give better results for classification of particular building and road areas in Images which are our region of interest. Image processing is a dynamic field and in recent years it is applied in many areas like medical sciences, remote sensing, military defense system, physical sciences and aerospace for useful purposes. This research paper focuses the study of highly resoluted aerial image of populated area. By applying different image processing techniques on aerial images like red band extraction, edge detection, enhanced gray level, texture features, red band replacement, binary threshold and finding the objects and classes of the image. By considering a particular range of buildings and roads objects then reconstruct the subjected images. At the end these buildings and road areas are highlighted by applying morphological filter erosion and dilation. We have taken the aerial image of Lahore Canal bank Road by Google earth and implemented all the above discussed techniques on it. The implemented techniques highlighted the building and road areas with red color.
Key Words: Aerial Image, Objects, Edge Detection, Morphological Operators.

INTRODUCTION

In recent years image processing is emerging field .It is observed that this field is applied in medical sciences, physical sciences, GIS, Military defense system and space technology, urban cities planning, traffic control system etc. Aerial image needs particular processing for information refinement. The image which is taken from certain height is not so good quality and does not give the appropriate result [1]. Actually image which is taken from height also containing some irrelevant data so it is necessary to extract the desired segments of the image so there must be applied some image preprocessing techniques. Complex aerial images containing buildings, roads, forest, sensitive defense areas, apparently it looks very difficult to classify these areas. All these areas are interconnected through edges. Whenever we cannot identify the actual edges of these areas then we are not able to segment these desired areas [5]. Now a days recent development of urban cities planning, road paths, play grounds and parks all are planned to fulfill the needs of future on the basis of satellite imagery [12]. It clearly shows the pressure of population on particular area, bridges requirement through cities connections and different encroachment which are being done by population in building construction. It is also observed that natural disaster like Flood areas and earth quick and mining areas where human access is not so easy through aerial or satellite imagery we can take the help. There are different factors affecting the satellite imagery like resolution [2], image geometry, image shadow, feature like color, shape, size, texture etc. Aerial image of Lahore Pakistan is being considered for this research experiment .It shows some areas which are highly populated have problem of traffic flows. How these highly populated areas and roads are highlighted. At first applying preprocessing techniques like histogram equalization methods and then applying edge detection method (*Cany)* is applied on this image and better image is obtained. After apply the color contrast and different color band are replaced, then texture base analysis is applied and the most important object of images are identified through supervised class selection method. Objects of big range size are considered and very small range size objects are ignored. By applying morphological operator erosion and dilation for highlighting edges are identified and labeled the building areas and roads [4]. Segmentation is applied; it is a process in which a complex image is decomposed in to several sub images [3]. In a heterogeneous large image we have to identify the homogenous small images. Actually these homogenous images are our region of interest in our subjected large image and all these regions are mutually interlinked to each other's. So it is not so easy to extract small images in a complex large aerial image and how can we identified the particular edges of buildings, roads, play grounds bridges etc. so before segmented the image, First we have to apply some operations on that image so that we can accurately identified our regions of interest.

MATERIALS AND METHODS

The objective of this research is to find out the buildings and roads in the highly complex city aerial image. We have taken the image of Lahore city Canal Road. First activity is to get the edges or boundaries of buildings and roads. For aerial image, there is no easy way to find out the edges of connected shapes then we first extract Red Band of image and then enhanced the Contrast of the image [6]. After Contrast enhancement, then applied edge detection filtering methods (Difference) and find out the edges of the complex images like buildings , roads, trees and vehicles etc. After finding the edges then enhanced the gray level Then calculated the texture features and find out the second order probability matrix [7].Calculate the texture features of image like entropy, mean, variance, correlation, angular moment, inverse difference moment, sum of entropy, sum of variance. Then Red Band is replaced on the original color image (RGB) [10]. Apply the binary threshold and find out the objects in the image [9]. It is observed that some objects have gape and not completed the whole edges so applied the morphological operator dilation and erosion three times respectively to fill these gape in edges and showing better solid edges of the shapes which is desired. Then highlighted these edges of particular shapes with Red Band, we have mostly focus the large areas of buildings and roads and moving vehicles on the roads. Extraction process of buildings and roads of aerial image is shown in figure1. We have implemented all these techniques in C#.NET IDE environment with Windows XP operating system support.

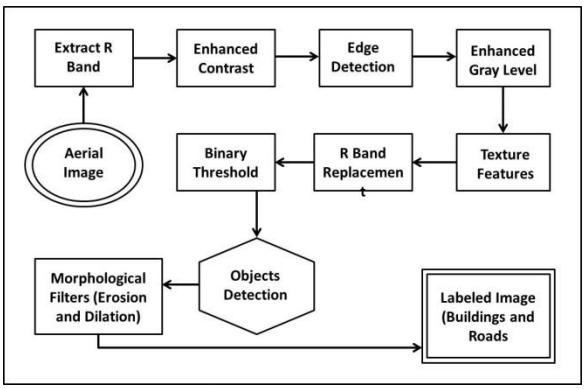

Figure 1. Framework of Aerial image Labeling

Edge Detection

It is very difficult to find out the edges in Aerial images due to the heterogeneous environment. Before applying the edge detection filter first extract the Red band of color image and then enhanced the contrast and by applying the edge filter of *Canny.*it gives better result. Canny edge detector required three parameters for applying on any image [9] i.e. Variance, low threshold and high threshold.

Object Detection Algorithm

Most common image extraction technique is based on pixel base analysis. Aerial image composition is very complex because these images not only contain the actual information but also some extra information which is by default considered as noise. So in aerial image analysis this traditional approach is not feasible for classification of complex image. In this research we are using the object base image segmentation because here pixel as itself consider as object [12] and trained the algorithm of supervised range of objects .these objects are then classified into different classes. Each class has its own characteristics which shows that how many objects contains an image like building, play grounds, fields, roads, trees, vehicles etc.

After getting the objects then identified that some objects range have large size like buildings and roads as compared to vehicles which have small range size. We particularly classified the region of interest and the highlighted these region with Red Band Replacement of original (RGB) color.

Figure 2. Original Aerial image of Lahore City

Figure 3. Red Band Extracted image

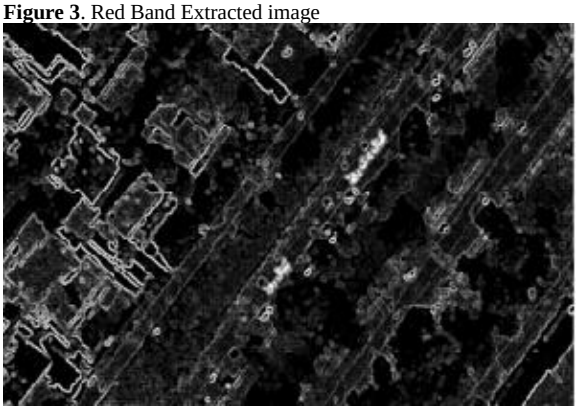

Figure 4. Canny edge detection filter

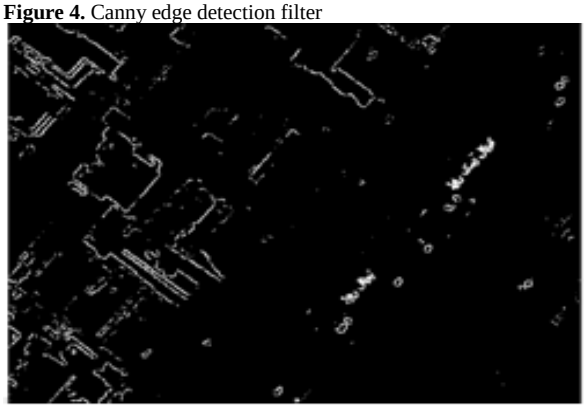

Figure 5. Object detection

Table1. Object detection

Total objects= 796	Objects Size(Classes)	Objects individual Values
	1 pixels objects	167
	2 to 10 pixels objects	411
	11 to 20 pixels objects	97
	21 to 50 pixels objects	80
	51 to 100 pixels objects	28
	101 to 200 pixels objects	11
	201 to 500 pixels objects	2
	501 to 1000 pixels objects	0
	1001 to 2000 pixels objects	0
	2001 to 5000 pixels objects	0

RESULTS AND DISCUSSIONS

Texture Features

Mostly image is recognized through color, shape, size, compactness but another important feature is texture, It not defined but perceive, Texture base analysis of aerial image is calculated in dimensions of 0^0, 45^0, 90^0, 135^0 degree and generate the matrix of second order probability statistics. For texture feature actually need the distance and it shows that which pair of pixels needs the co-occurrence matrix. As distance increases it is coarse texture and as distance decreases then texture would be fine.

It is observed that after preprocessing and finding the objects in an image then the last approach is how to label the image. Identified Objects are lying in desired region but exist small gapes between the edges of the boundaries. By filling these gapes, we have applied morphological operator dilation and erosion to fill these gaps and making the solid shapes of required region [5].

Table2. Texture Feature Extraction angle 0^0 and angle 45^0

Angle=0^0 Distance=1	Parameters Name	Parameters Value
	Angular Second Moment	0.000484593266462168
	Contrast	212.664448401319
	Coorelation	0.955975011692l5
	Variance	2415.26978853846
	Inverse Difference Moment	0.270964005403l8
	Sum Average	181.207101438136
	Sum Variance	41385.1470756686
	Sum Entropy	2.49858913411615
	Entropy	3.742949654380l1
	Difference Variance	193.551912874634
	Difference Entropy	1.32976143047858

Angle = 45^0, Distance = 1	Parameters Name	Parameters Value
	Angular Second Moment	0.00025609033208566l4
	Contrast	391.566177492866
	Coorelation	0.918143209574969
	Variance	2391.77577974761
	Inverse Difference Moment	0.14896872958722l
	Sum Average	180.886681510856
	Sum Variance	40997.5727303439
	Sum Entropy	2.49936192550463
	Entropy	3.897819888823
	Difference Variance	362.39830298734

Table3. Texture Feature Extraction angle 90^0 and angle 135

Angle = 90^0, Distance = 1	Parameters Name	Parameters Value
	Angular Second Moment	0.000518252731032934
	Contrast	223.938985100389
	Coorelation	0.953485720917161
	Variance	2407.20687835852
	Inverse Difference Moment	0.28283378688719
	Sum Average	181.103799464178
	Sum Variance	41304.4592014141
	Sum Entropy	2.49929035793964
	Entropy	3.71693881900328
	Difference Variance	205.923383215626
	Difference Entropy	1.30672505057457

Angle = 135^0, Distance = 1	Parameters Name	Parameters Value
	Angular Second Moment	0.000248602237077891
	Contrast	405.920252051769
	Coorelation	0.915142445306302
	Variance	2391.7743889569
	Inverse Difference Moment	0.146346490162895
	Sum Average	180.886672955127
	Sum Variance	40983.2824149138
	Sum Entropy	2.49915906713707
	Entropy	3.91952481442556
	Difference Variance	374.963485884969
	Difference Entropy	1.48011535620795

Morphological filter

Morphological filter work on binary, gray level and color images. Morphological operation on multicolor image (RGB) treated as each individual band as gray level and shown adjacent object brighter due to these filter. Morphological filter apply on the shapes of Edges, which are not showing clearly any shapes and these weak edges may confuse the classification. Then by applying dilation filter, it expands boundaries edges and gapes are reduced then these edges may come closer to each other and become the connected edges [7] [3].

By equation:

I_k= Dilate (I_{k-1} , S) $\cap$ B_0 Where I= Image

$Image_k$ is region after convergence change the boundary and S is the structuring element and B_0 is the negation of the boundary of the image

Erosion filter then compressed or shrink the edges and by replacing the Red band in image highlighted the desired region of interest. The erosion of *X* by *B* is also given by the expression

$X \ominus B = \cap_{b \in B} X_{-b}$.

By Binary image definition, the position where the structure fits and here B_x mean B describes with x.

X is the image and B is the structural element,

$\in_B (X) = \{x \backslash B_x \subseteq X\}$

Where $x \in X \forall x_1, x_2, x_3 \ldots\ldots \in X$

Before applying morphological filter Red channel is replaced on the original image as shown in figure 6.This shows the false color composite image classification [12]. As earlier objects are identified then by replacing the Red Band in that image which is shown in figure 7.

After applying the dilation and erosion filter thrice a time for the weak connected edages then they become the strong edges and become the solid shapes and fill the Red color which is shown in figure 8**.**

Figure 6. Red Channel Replaced

Figure 7. Buildings and Roads Object Highlighted

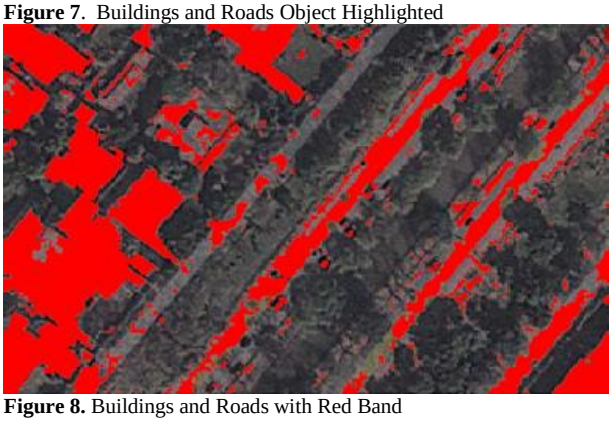

Figure 8. Buildings and Roads with Red Band

CONCLUSION AND FUTURE WORK

This research focuses the segmentation of multiband aerial image and we have highlighted the buildings, roads and vehicles on roads in this aerial image. Morphological filter dilation and erosion are implemented on segmented aerial image which gives the result in the form of highlighted region of Red Band. By applying different preprocessing methods like edge detection, enhanced the contrast, sharpening the image, objects detection and binary threshold gives better results. Texture feature gives the second order probability statistics. By implementing the morphological filter dilation and erosion highlighted the region of interest in the form of Red Color in the subjected image. For future work on this research to applying different artificial neural network techniques to train and test the image which gives better result for further exploration.

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