

Adapted Normalized Graph Cut Segmentation with Boundary Fuzzy Classifier Object Indexing on Road Satellite Images

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Abstract: Image segmentation is an essential component of the remote sensing, image inspection, classification and pattern identification. The road satellite image categorization points a momentous tool for the assessment of images. In the present work, the researchers have evaluated the computer vision techniques for instance segmentation and knowledge based techniques for categorization of high-resolution descriptions. For sorting of the road satellite images, the technique named Adapted normalized Graph cut Segmentation with Boundary Fuzzy classifier object Indexing (AGSBFI) is introduced. Initially, the road satellite image is segmented to have inverse determination of shapes using adapted normalized graph cut segmentation method. The features of the segmented area are extracted and then classification of unknown boundary is carried out using boundary fuzzy classifier. Finally the classified images are then recognized based on the location using the arbitrary object indexing scheme. Performance of AGBSFI technique is measured in terms of classification efficiency and objects recognition accuracy with better results. AGBSFI considers the problem of inverse determination of unknown shape, boundary and location in the existing method. An analytical and empirical result shows the better object recognition accuracy with inverse determination of shape, boundary and location of road satellite images.

Keywords: Image segmentation, boundary fuzzy classifier, adapted normalized graph cuts, arbitrary object indexing, categorization, road satellite images.

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1. Introduction

Segmentation and classification of patterns is an important area in a variety of fields including artificial intelligence, computer vision and image examination. In such problems, if a priori probabilities and the conditional probability density of all classes are unknown, then it produces worst results. Chosh *et al.* [6] proposes a fuzzy set-based classifier with a superior learning and generalization ability. The proposed classifier exploits the feature-wise degree of belonging of a pattern to all classes, generalization in the justification process and the combined class-wise contribution of features effectively.

Oikonomopoulos *et al.* [11] address the trouble of localization and recognition of human activities in unsegmented image sequences. The chief contribution of this method is the use of an implicit representation of the spatiotemporal shape of the activity which relies on the spatiotemporal localization of characteristic ensembles of feature descriptors. Confirmation for spatiotemporal localization of activity is accumulated in a probabilistic spatiotemporal voting scheme. The limited nature of the proposed voting framework allows us to deal with multiple activities taking place as well as with activities in the presence of confusion and occlusion.

Image segmentation using the road satellite images is a fundamental research area undertaken for the

inverse determination of unknown shapes. Graph-based segmentation is one of the normally used techniques in imaging analysis. The graph cut model is a famous framework for determining the shapes in minimal computation cost. The graph cut method is aimed to minimize the computation cost of the road satellite image equivalent to all required labelling for the object and background seeds. The adaptive normalized graph cut is a universal criterion for segmenting graph used in image data rather than focusing on local features and consistencies for inverse determination of unknown shapes.

The objective of this study is to improve the shape determination of the interactive segmentation. The proposed adaptive normalized graph cut segmentation is based on dense shape. The segmentation by adaptive normalized graph cuts is an iterative process. After the segmentation, the user involvement is condensed and the performance of the graph cuts algorithm is improved at the initial iteration.

The second iteration follows a boundary fuzzy classifier for the classification of the road satellite images. The concept of assurance is defined as the degree of how well an input pattern of segmentation is assigned to a class label by a boundary fuzzy based classifier. The focus is on the minimum assurance of classification among given segmented patterns for the inverse determination of unknown boundary. It is

expected that a boundary fuzzy based classifier with high generality ability has a large minimum assurance of classification. It discusses the relationship between the minimum assurance of classification and the classification boundaries using fuzzy classifier in road satellite data.

The final iteration of process includes the arbitrary object indexing for recognizing the unknown location in the road satellite images. The arbitrary object indexing method determines the set of features from the various set of road image classifiers. The features of the arbitrary indexing uses the classification images for the inverse determination. Once the inverse determination is found, the index tables are created by discretizing the vector space of the inverse determination. The Indexing scheme uses the arbitrary apex effect. It defines the arbitrary density function of these angles and the ratios of the distance are used to determine the exact location.

We provide here an overview of Adapted normalized Graph cut Segmentation with Boundary Fuzzy classifier object Indexing (AGSBFI). The rest of this paper is arranged as follows: Section 3 introduces architecture diagram of the proposed scheme. Sections 3.1, 3.2 and 3.2 describes about proposed method; section 4 shows the evolution and experimental evaluation; section 5 evaluated the results and discuss about it. Section 6 describes conclusions and prospect.

2. Literature Review

Image segmentation is constantly an necessary but demanding problem in computer vision. The simplest approach to image segmentation may be clustering of pixels. Baldevbhai and Anand [2] deal with the problem of image segmentation under the paradigm of clustering. A vigorous clustering algorithm is proposed and utilized to do clustering on the $L^*a^*b^*$ color feature space of pixels. An enhanced median filter algorithm is implemented by Gupta [7] for de-noising of extremely corrupted images and edge preservation. Mean, Median and improved mean filter is used for the noise detection.

Pg *et al.* [13] presents an iterated region merging-based graph cuts algorithm with is oval addition of the standard graph cuts algorithm. Graph cuts addresses segmentation in an optimization framework and finds a globally optimal solution to a broad class of computation cost functions. Bae and Tai [1] focus on the Piecewise Constant Level Set Method (PCLSM) applied to the multiphase Mumford-Shah model for image segmentation. Danek *et al.* [4] present a two stage graph cut based model for segmentation of touching cell nuclei in fluorescence microscopy images.

Li *et al.* [10] propose a new object-oriented method for the high spatial resolution remote sensing images classification including spectral statistics, image segmentation, feature space optimization and fuzzy classification. The experiments results demonstrate that the object-oriented method has the benefit of high

precision, rarely exists incorrectly and good quality of classification image.

Image classification is an subject that utilizes image processing, pattern recognition and classification methods. Regular medical image classification is a progressive area in image classification and it is predictable to be more developed in the future. Hosseini and Zekri [8] of the Adaptive Neuro-Fuzzy Inference System (ANFIS) as a classifier in medical image classification. ANFIS is a Fuzzy Inference System (FIS) implemented in the framework of an adaptive fuzzy neural network. It combines the explicit knowledge representation of an FIS with the learning power of artificial neural networks.

Clustering of mathematical data forms the basis of numerous classification and system modeling algorithms. The purpose of clustering is to distinguish natural groupings of data from a large data set to create a concise representation of a system's behavior. Padmavathi *et al.* [12] propose fuzzy c means clustering method with threshold for underwater image segmentation. It focuses on contrast of fuzzy c means clustering algorithms with proposed method for underwater images. Saeedi *et al.* [14] propose a new method for textual areas removal of an image using a fuzzy classifier and dual-tree discrete wavelet transform. It extensive our text extraction scheme for classification of document images into text, background and picture components.

In the field of pattern classification, it often encounters problems that class-to-class misclassification costs are not the similar. Jahromi *et al.* [9] use rule weight as a simple mechanism to tune the rule-base. It attempts to reduce the total cost of the classifier to train data. Choi *et al.* [3] introduces the new color Face Recognition (FR) method that makes effectual use of boosting learning as color-component feature selection framework.

Elragal [5] discusses a method for improving accuracy of fuzzy-rule-based classifiers using Particle Swarm Optimization (PSO). Two different fuzzy classifiers are measured and optimized. The first classifier is based on mamdani FIS and second classifier is based on takagi-sugeno FIS.

To enhance the segmentation effect and classification accuracy of road satellite images, devised a new technique named as AGBFBI is presented.

3. AGBFBI

The road images are examined and the process follows the three different phases. The initial phase is segmentation for inverse determination of shapes followed by classification for the determination of boundary and finally includes the recognition of road images using indexing for establishing the exact location.

The initial phase includes the segmentation using the adaptive normalized graph cuts based on the divisions for inverse determination of shapes. The adaptive normalized cut is a universal measure for

segmenting graph used in road image data rather than focusing on confined attributes and consistencies. This method is used as a criterion to measure total dissimilarity between various groups of road images and total similarity within the groups.

The second phase contains a classification of the segmented road images using the boundary fuzzy classifier for inverse determination of the boundary. The boundary fuzzy classifiers are used in building of the classification method to achieve high simplification ability. The boundary fuzzy classifier undertakes abundant computational experiments in order to show its generalization ability in road images. Classification assurance represents how well an input segmented road image is classified by a boundary fuzzy classifier. The fuzzy conjecture process assigns an input road image to the class with the maximum product of the compatibility and the certainty factor.

The final phase follows an arbitrary object indexing for the recognition of images and determining the location. The object i.e., the road images are indexed and the exact location are analyzed using the arbitrary object indexing. The index table contains all the information of indexing corresponding to the constant vector. The architecture diagram of AGSBFI technique as shown in Figure 1.

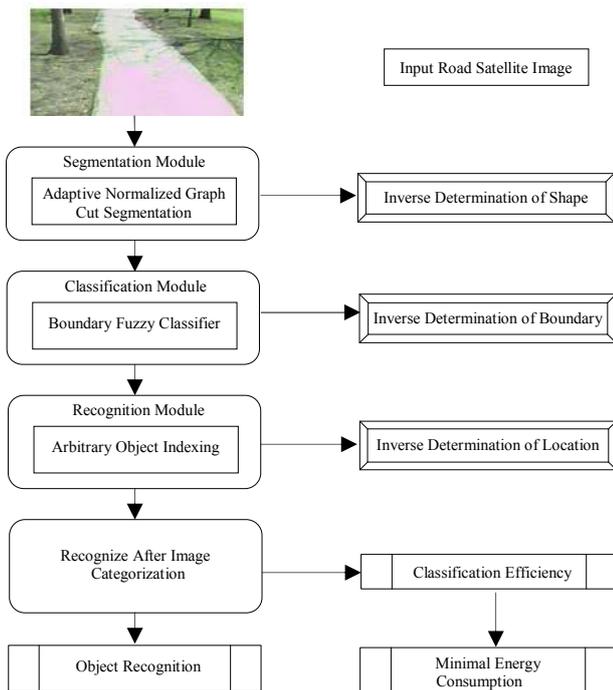


Figure 1. AGNS (Procedure).

The Figure 1 is observed and then the AGSBFI scheme is efficiently designed for the segmenting, classifying and recognizing the road satellite images. The set of road satellite images are taken from FRIDA and CMU/VASC Image database.

3.1. ANGS (Angs) Procedure

Road image segmentation using the adaptive normalized graph cuts uses the set of pixels ‘ P ’ and a set of tag ‘ T ’. The goal is to find a tagging $f: P \rightarrow T$ to

minimize the computation and find the shape efficiently.

$$R(f) = \sum_{p \in P} E_p(f_p) + \lambda \sum_{p, q \in N} W_{p, q}(f_p, f_q) \quad (1)$$

Where N the region system, $E_p(f_p)$ The consequence of assigning tag $f_p \in T$ to p , $W_{p, q}(f_p, f_q)$ is the consequence of tagging the pair p and q with tags $f_p, f_q \in T$ to determine the shape after segmentation. Equation 1 uses adaptive normalized graph cuts if and only if the pair wise interfaces probable $W_{p, q}$ satisfies.

$$W_{p, q}(0, 0) + W_{p, q}(1, 1) \leq W_{p, q}(0, 1) + W_{p, q}(1, 0) \quad (2)$$

The minimum $R(f)$ can be computed efficiently with adapted normalized graph cuts by determining the shapes. The Equation 1 is called as statistics term. The statistics term assumes that the entity consequence for assigning pixel ‘ P ’ to ‘‘item’’ and ‘‘backdrop’’, correspondingly. The subsequent quantity in Equation 1 is called the smooth term to identify the shape. The smooth term comprises the ‘‘boundary’’ properties of segmentation. $W_{p, q}$ should be interpreted as a consequence for a discontinuity between p and q .

Naturally, $W_{p, q}(f_p, f_q) = V_{p, q} K(f_p \neq f_q)$, where $K(\cdot)$ is 1 if $f_p \neq f_q$ and otherwise. Normally, $V_{p, q}$ is large when pixels ‘ p ’ and ‘ q ’ are similar and $V_{p, q}$ is close to zero when the two are very different.

$$\exp(-(K_p - K_q)^2 / 2\sigma^2 \text{dist}(p, q)) \quad (3)$$

Parameter $\lambda \geq 0$ in Equation 1 load the relative importance between the local and boundary terms to determine the shapes to select proper parameter λ .

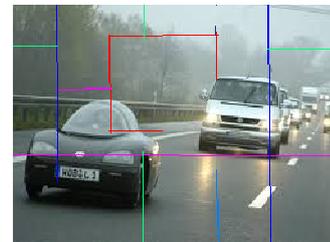


Figure 2. Angs example model.

The above Figure 2 describes the segmentation of the road images using the ANG cuts. This models are defined by the response of strain and attributes maps. A strain is a square template defined by an array of dimensional load vectors. An attribute map is an array whose entries are dimension attributes vectors computed from a dense grid of locations in a road image to determine the unknown shape.

3.2. Boundary Fuzzy Classifier for Classification

In a classification of road images with m dimensionality and N classes of segmentation, n tagged form, $y_p = \{y_{p1}, y_{p2}, y_{p3}, \dots, y_{pn}\}$, $p = 1, 2, 3, \dots, n$ are given as training samples of road images. Assuming that without loss of generality, each attribute of y_p is normalized to a unit interval. From the training

samples we generate boundary fuzzy classifier. F_q : If y_l is B_{q1} and y_m is B_{qm} then class C_q with CF_q .

Where $q=1, 2, 3, \dots, N$, F_q is the tag of the q^{th} boundary fuzzy if-then rule, $B_q=(B_{q1}, \dots, B_{qn})$ represents a set of precursor boundary fuzzy sets, C_q a the consequent class, CF_q is the assurance of the rule F_q and M is the total number of generated boundary fuzzy if-then rules. The square membership functions as precursor boundary fuzzy sets are used as shown in Figure 3.

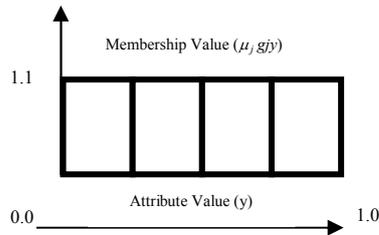


Figure 3. Square boundary fuzzy set model.

The square membership function divides the attribute axis into four fuzzy sets. Suppose the attribute axis is divided into I fuzzy sets. The membership function of the j^{th} fuzzy set is defined as follows:

$$\mu_j(y) = \max\{1 - (y - y_{j-1})/w, 0\}, j=1, \dots, I \tag{4}$$

Where $y_j = j-1/I-1, j=1, \dots, I$ and $w=1/I-1$. Let us denote the compatibility of a training pattern y_p with a boundary fuzzy if-then rule F_q as $\mu_{Bq}(y_p)$. The compatibility $\mu_{Bq}(y_p)$ in classifying the boundary is calculated as follows:

$$\mu_{Bq}(y_p) = \prod_{i=1}^m \mu_{B_{qi}}(y_{pi}), q=1, 2, \dots, M \tag{5}$$

Where $\mu_{B_{qi}}(y_{pi})$ compatibility of y_{pi} with the boundary fuzzy set B_{qi} and y_{pi} - k^{th} attribute value of y_p .

The number of boundary fuzzy rules in road images to be generated is I_n . That is, the number of rules increases exponentially for the separation number and the dimensionality for determining the boundary of road images.

3.3. Arbitrary Object Indexing Method

The set of road images are segmented and categorized using the boundary fuzzy classifier, then categorize image groups are indexed into the table using the arbitrary object indexing to determine the exact location of images. The set of categorize road images is matched with the indexing table group to obtain the definite association. This method uses the arbitrary apex effect to strongly denote the location of the road image attribute value. The arbitrary apex effect is a strong location of images with the varying angles and ratio of the length in road images.

Consider the groups of road images that are predictable on image plane with I_1, I_2 and I_3 are the road images of the group and J_1, J_2, J_3 are image points. Let α be the angle of I_1, I_2, I_3 and β be the angle of J_1, J_2, J_3 and segment length for the location of road images follows, the angle formed from the

point and the image and ratio of length to find the location denoted by $a1/a2$ and $b1/b2$. The apex effect varies not only with the ratio but also with α . The probabilistic apex effect is used to create a system to determine the location using the indexing table and image groups as shown in Figure 4.



Figure 4. Image group model.

The performance of the image group arbitrary indexing of road images is estimated for various arbitrary thresholds. The above image group is used to isolate the image plane, image point and group. The arbitrary object indexing system recognizes the road images after the categorization efficiently.

3.4. AGSBFI Algorithm Technique

Algorithm 1: AGSBFI technique.

Input: Road satellite image.

Output: Object recognition accuracy.

Begin

Step 1: Segment the road satellite image.

Step 2: Apply adaptive normalized graph cut segmentation.

Step 3: Obtain inverse determination of shape.

Step 4: Classify segmented road images.

Step 5: Apply boundary fuzzy classifier.

Step 6: Obtain inverse determination of boundary.

Step 7: Recognize the classified road images.

Step 8: Apply arbitrary object indexing.

Step 9: Obtain inverse determination of location.

End

The above algorithm follows the process of segmentation, classification and recognition of road images. The segmentation is done using the ANG cut to determine the shape. Secondary, the classification is performed using the boundary fuzzy classifier to determine boundary. Finally, the recognition of road images after categorization using arbitrary object indexing to obtain the exact location.

4. Experimental Evaluation

AGSBFI technique is implemented using MATLAB. For the efficient object recognition, the road images are used. FRIDA and FRIDA2 databases of numerical images are easily used to assess in a systematic way. The performance of visibility and contrast restoration algorithms of FRIDA comprises 90 synthetic images of 18 urban road scenes. FRIDA2 comprises 330 synthetic images of 66 diverse road scenes. The view point is congested to the one of the vehicle's driver. To each image without fog are associated 4 foggy images and a depth map.

CMU/VASC Image database of apr10_87_bright contains the 35 frame of a bright road scene and aug 10_87_dark1 describes the 35 frame of a dark road scene for experimental evaluation. The performance of the AGSBFI technique is measured in terms of:

- Classification Efficiency.
- Object Recognition Accuracy.
- Computation Cost For Segmentation.

5. Results and Discussion

This work efficiently evaluated the classification effectiveness and accuracy of the proposed system using the fuzzy classifier and indexing method. The below table and graph describes the performance of proposed AGSBFI technique are compared with the existing segmentation and classification of multi Spectral satellite image using modified Graph-cut and Fuzzy Classifier technique (SCGFC) and Novel Fuzzy (NF) based method.

- *Classification Efficiency*: It is defined as the efficient way of categorizing the similar group of satellite road images. At testing time, a number of fuzzy classifiers used in order to make the final prediction of boundary.

$$\text{Classification Efficiency} = \left(\frac{\text{No. of classified road images}}{\text{No. of unclassified road images}} \right) * 100. \quad (6)$$

Table 1. Segmented images vs. classification efficiency.

Segmented Images	Classification Efficiency		
	Proposed GSBFI Method	SCGFC Method	NF based Odel
10	0.98	0.75	0.52
20	0.97	0.78	0.53
30	0.95	0.79	0.55
40	0.95	0.79	0.56
50	0.94	0.80	0.57
60	0.92	0.82	0.58
70	0.93	0.83	0.60

The classification efficiency is calculated based on the road images segmented by implementing AGSBFI technique. The above table describes the classification efficiency on AGSBFI technique, SCGFC method and NF based method.

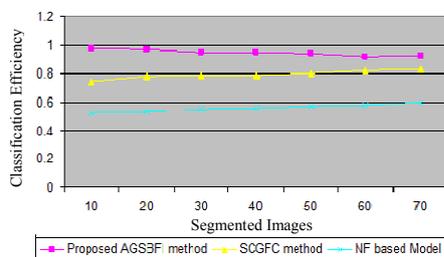


Figure 5. Segmented images vs. classification efficiency.

Figure 5 describes the classification efficiency for determining the boundary using the boundary fuzzy classifier. The segmented road images are classified efficiently using the if-then rule in the fuzzy classifier of the AGSBFI method. The experiment are conducted with the help of CMU/VASC Image database of apr10_87_bright to evaluate the performance of the

AGSBFI method with the existing SCGFC method and NF based method. The outcome of the classification efficiency is approximately 90-95% higher when compared to all other methods in CMU/VASC Image database.

- *Object Recognition Accuracy*: Accuracy is defined as the degree of actuality in object recognition. Object recognition accuracy is dependent on how data is collected and is usually judged by comparing numerous measurements from the same or different sources.

$$\text{Accuracy} = \frac{\text{No. of correctly classified road images}}{\text{Total no. of road images for recognition}}. \quad (7)$$

Table 2. Output pixel size vs. object recognition accuracy.

Pixel in Size	Computation Cost for Segmentation (J)		
	Proposed AGSBFI Method	SCGFC Method	NF based Model
50	2.5	10.5	12.1
100	5.2	12	15.5
150	6.9	15.9	18.7
200	8.1	16.5	21.9
250	12.5	19.8	25
300	15.6	22.3	28.5
350	18.8	23.6	29.6
400	20.4	26.5	33.3

Figure 6 described the object recognition accuracy based on the output pixel size after classification. The outcome of AGSBFI technique are compared with the existing SCGFC and NF based method for object Recognition Accuracy is shown in table.

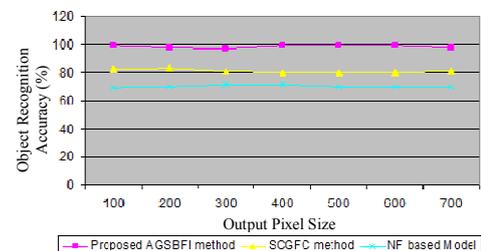


Figure 6. Output pixel size vs. object recognition accuracy.

Figure 6 describes the object recognition accuracy using the FRIDA dataset. As, this dataset describes the accuracy after categorization of the road images from the set of images in AGSBFI technique. It uses the arbitrary indexing scheme to exactly determine the location of image from the image plane. The existing model produces the less accuracy from the set of recognized road images, thus showing the quality less images with the noisy environment. The variance in object recognition accuracy is approximately 15-20% high in the proposed AGSBFI technique.

- *Computation Cost for Segmentation*: It is defined as the overhead for computing the segmentation process in the road images. It is measured in terms of CPU cycles.

$$\text{Computation cost} = Ts2$$

Where T = total no. of segmentation of images and s represents the instruction per second for segmentation.

Table 3. Pixel in size vs. computation cost for segmentation.

Output Pixel Size	Object Recognition Accuracy (%)		
	Proposed AGSBFI Method	SCGFC Method	NF based Model
100	99	82	69
200	98	83	70
300	97	81	71
400	99	80	71
500	99	80	70
600	99	80	70
700	98	81	70

Figure 7 described the computation cost consumption while segmenting the input road images for the further process. The above table calculates the computation cost consumption while segmenting in AGSBFI technique, SCGFC and NF based method

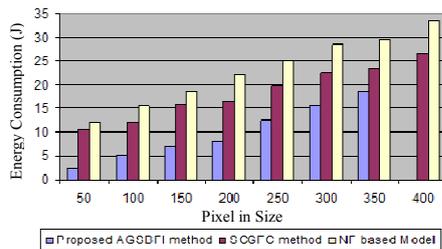


Figure 7. Pixel in size vs. computation cost consumption for segmentation.

The performance graph of the AGSBFI technique is shown in the Figure 5. The segmentation is performed using the graph cut technique division method to segment the road images efficiently. The division method applied in our CMU/VASC Image database of aug 10_87_dark1 road images is approximately 80-90 % outperforms the existing systems. ANG cut segmentation cuts the road images in less time, so the computation cost is minimal.

Finally, it is being observed that the AGSBFI technique eradicates the noise and recognize the road image pattern efficiently using the segmentation and classification. The experiments are conducted in FRIDA and CMU/VASC Image database to prove the result.

6. Conclusions

This work efficiently recognizes the road images after categorization using AGSBFI technique. At first, the road satellite image is segmented to have inverse determination of shapes with minimal computation cost consumption using ANG cut segmentation method. The features of the segmented area are extracted and then classification of unknown boundary is carried out efficiently using boundary fuzzy classifier. Finally, the classified images are then recognized based on the location using the arbitrary object indexing scheme for accurate object recognition. AGSBFI 80-90% it outperforms well by considering the problem of inverse determination of unknown shape, boundary and location in existing SCGFC method. Performance of AGSBFI technique in FRIDA dataset and CMU/VASC image database is measured

in terms of classification efficiency, objects recognition accuracy and computation cost consumption for segmentation by producing better results.

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