SPATIAL FEATURE EXTRACTIONS USING SUPERVISED FUZZY CLASSIFICATION

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ABSTRACT

This paper emphasis on spatial feature extractions and selection techniques adopted in content based image retrieval that uses the visual content of a still image to search for similar images in large scale image databases, according to a user's interest. The content based image retrieval problem is motivated by the need to search the exponentially increasing space of image databases efficiently and effectively. It is also possible to classify the remotely sensed image to represent the specific feature of the target images. In this paper, a priori knowledge about information for certain feature classes is used in order to classify image in fuzzy logic classification procedure. Here first we have to supervised image classification and then use the logic based on fuzzy logic. Based on similarities supervised membership function is used. Results of the procedure, based on pixel-by-pixel technique, were compared and certain encouraging conclusion remarks come out.

Key words: Spatial Feature Extractions, feature selection, Fuzzy Logic.

1. INTRODUCTION

1.1 About Feature Extraction

The increase in computing power and electronic storage capacity has lead to an exponential increase of digital content available to users in the form of images which form the bases of many applications [1]. Consequently, the search for the relevant information in the large space of image databases has become more challenging. How to manage appropriate extracted outcome is still difficult problem and it is a proper field to make experiment. A typical image retrieval system includes feature extraction usually in conjunction with feature selection [2]. We can depict any image as a collection of color, texture and shape features. While several image retrieval systems rely on only one feature for the extraction of relevant images, but exact collection of relevant features can yield better retrieval performance [3]. The process of determining the combination of features that is most representative of a particular query image is called feature selection.

In case of analyzing real-world maps, the images shown there may not distinctly identify accurate and comprehensible information; rather lots of knowledge may be embedded in the domain in a hidden and unexplored form.

1.2 Fuzzy Logic

The logic which works with approximation instead of exact and constant value is called fuzzy logic. The logic has been used from long back to solve various problem domains. The working value of fuzzy logic can be any value in between 0 and 1.Although the fuzzy logic is relatively young theory, the areas of applications are very wide: process control, management and decision making, operations research, economies and, for this paper the most important, pattern recognition and classification. An idea to solve the problem of image classification in fuzzy logic manner as well as comparison of the results of supervised and fuzzy classification was the main motivation of this work.

1.3 Algorithm

In this paper, *a priori* knowledge about information for certain feature classes is used in order to classify image in fuzzy logic manner. More specifically,

a) input (image channels) and output variables (feature classes) are introduced in the working environment.
b) Membership functions are defined using results from supervised classification.
c) Several Fuzzy Logic Toolboxes was used in definition of fuzzy logic inference rules,
d) These rules are examined by using simulation of classification procedure at random sample areas.
And at the end,
e) Image classification was conducted.

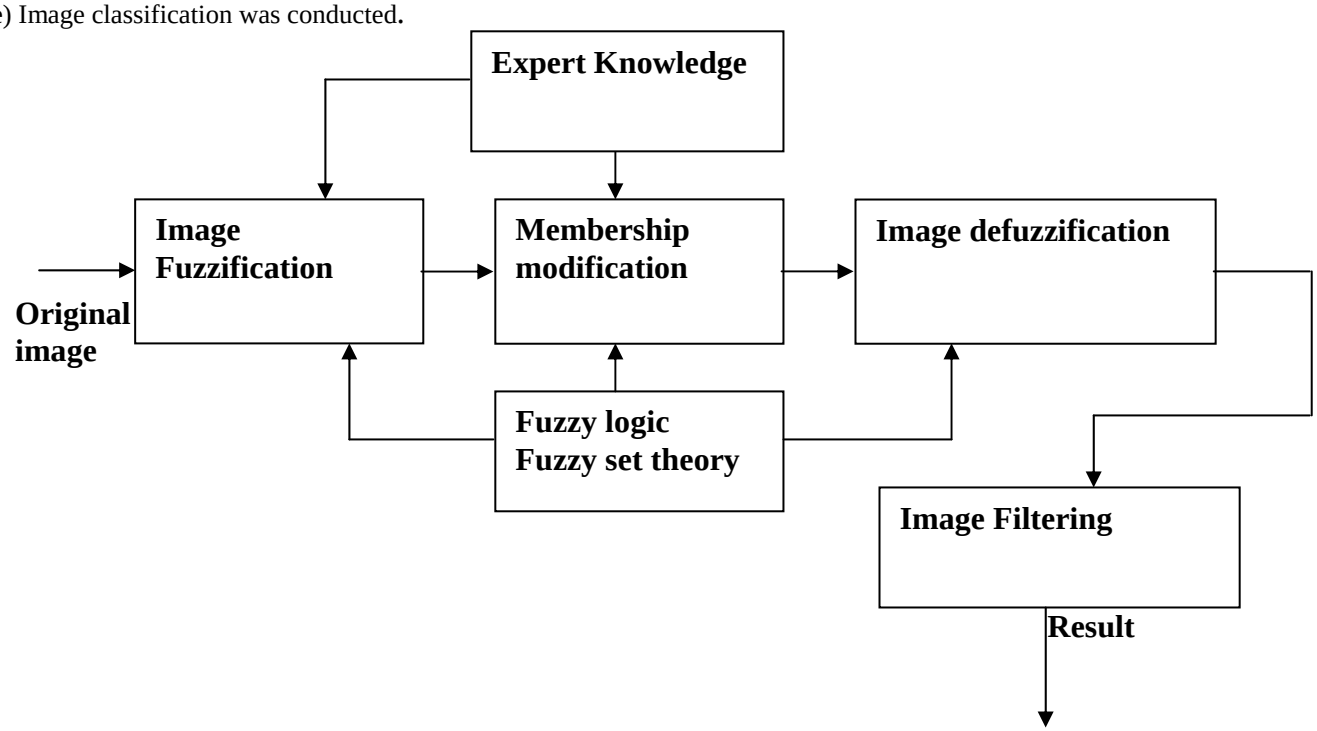

Figure 1: Procedure for Image Classification

2. SUPERVISED CLASSIFICATION

Supervised fuzzy classification means fuzzy logic classifies the knowledge discovery like a supervision of teacher to a student in their academic life.
The supervision is accomplished by using two steps:

1. The first step is to create signature files (training sites)
2. Classification itself.

The fuzzy logic can be used in the creation of the signatures files and also in the process of the classification itself, but is not necessary to be used in both stages.

2.1 *Defining the Training Areas*

The classified area will be determined within the specific image. Analyzing the image that is being considered, features are selected in terms of highways, settlements, forests and water. Since the feature classification showed that lake water and pond water are very poorly separated and considering that this classification cannot be improved by a different channel combination, those classes were merged into the one single class: water. The classification statistics gave a list of each of the classes, with the average values and standard deviations for each channel for the class selected. These data were used later in the definition of the membership function [6].

2.2 Classification Procedure

In the classification mechanism, the maximum similar classifier without NULL class was used. We implied a normal distribution and evaluates the variance and correlation of spectral response during the classification of the unknown pixel.

$$P(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/(2\sigma^2)}$$

P(x)=probability density function of normal distribution.
Where μ=Mean
σ^2=Variance.
The results of the image classification contains: number of classified pixels, average and complete correctness, and statistics for the each of the classes. If many of training areas pixels were classified into different classes, the training areas were not so well determined.

3 MEMBERSHIP FUNCTION

Membership function is the mathematical function which defines the degree of an element's membership in a fuzzy set. The membership degree is computed by using fuzzy membership functions like: piecewise linear functions, the Gaussian distribution function [9], the sigmoid curve and quadratic or cubic polynomial curve. The simulation on the training area can be done using statistical methods: minimum, maximum, mean, and standard deviation for each band independent and covariance matrix for all the three bands.

3.1 *Fuzzy logic Operators*

The foremost necessary step to understand between fuzzy set and probability is that they are not same, fuzzy set varies with probabilities. The methods that we have had used to manage fuzzy sets have slide similarities with probability theory. Fuzzy logic is a subclass of predicate logic, and there are similarities between fuzzy set and non fuzzy set operator. There will be same result after being applying fuzzy operator to non-fuzzy sets, predicate logic.

The functionalities of logic operators are depend on Boolean values that range from 0 (false) to 1 (true). After time being while logic operators are implement to non-fuzzy values, the non -fuzzy set produce the same output as the AND, OR, and NOT operator. Its also similar with three basic set operations- intersection, union, and complement [11].

3.2 If-Then Rules

The if-then rule is very effective to utilize fuzzy logic. Usually the knowledge involved in fuzzy logic can be express as rules in the form:

If x is P Then y is Q

Where x and y are fuzzy variables and P and Q are fuzzy values. The if-part of the rule "*x* is *P*" is called the premise, while the then-part of the rule "*y* is *Q*" is called the conclusion [12]. Statements in the premise (or consequent) parts of the rules may well involve fuzzy logical connectives such as ‘AND’ and ‘OR’. In the if-then rule, the word "is" gets used in two entirely different ways depending on whether it appears in the antecedent or the consequent part.

4. EXPERIMENTS WITH REAL-WORLD DATA

4.1. Input Data

For the procedures of image classification was used to gather images from “Google Earth” on the Bangladesh region (Chittagong zone). It uses this as a case study for implementing feature extraction. The collected images contain some common features such as roads, water, field, agriculture, buildings. The features will be separated based on the pixel intensity value selected for the individual features. It has been chosen as an application area because number of spatial features can be extracted from the map images of Forestry complex.

This image contains three channels recorded in three bands: the first band for green, the second for red and the third for blue. In the figure below, we present a fragment of this image and some statistics for the whole image.

Figure 2.: Forestry Complex Area

After performing thresholding based on color intensities defined for each and every feature, the features are higlighted with individual colors. Therefore, the highlighted feature area is clearly distinguished from the background. The thresholding process finally extract number of spatial features from the particular region such as road, water, field, building and forest.

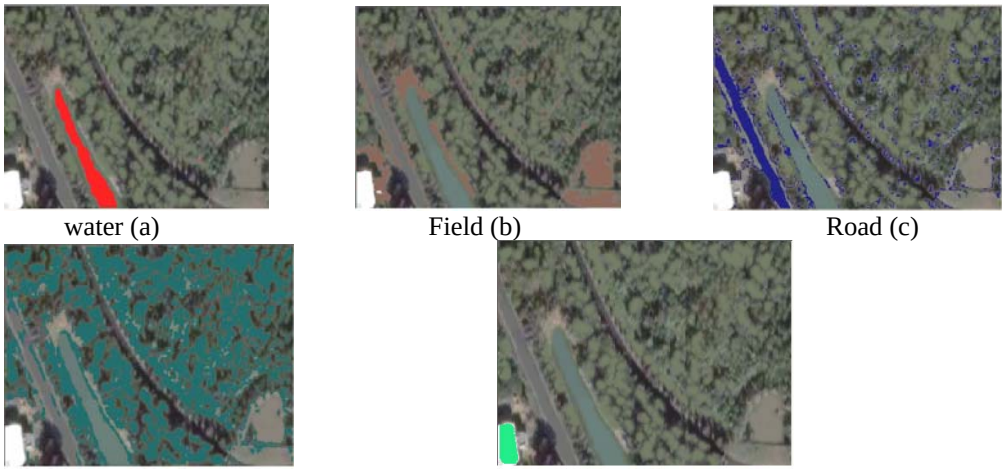

Figure 3.: Extracted Features from Foresty Area Image

The extracted features are further thresholded for seperating them from the background. This has been done by setting the background to all white form, thus displaying the particular feature are.
The seperated features are displayed below:

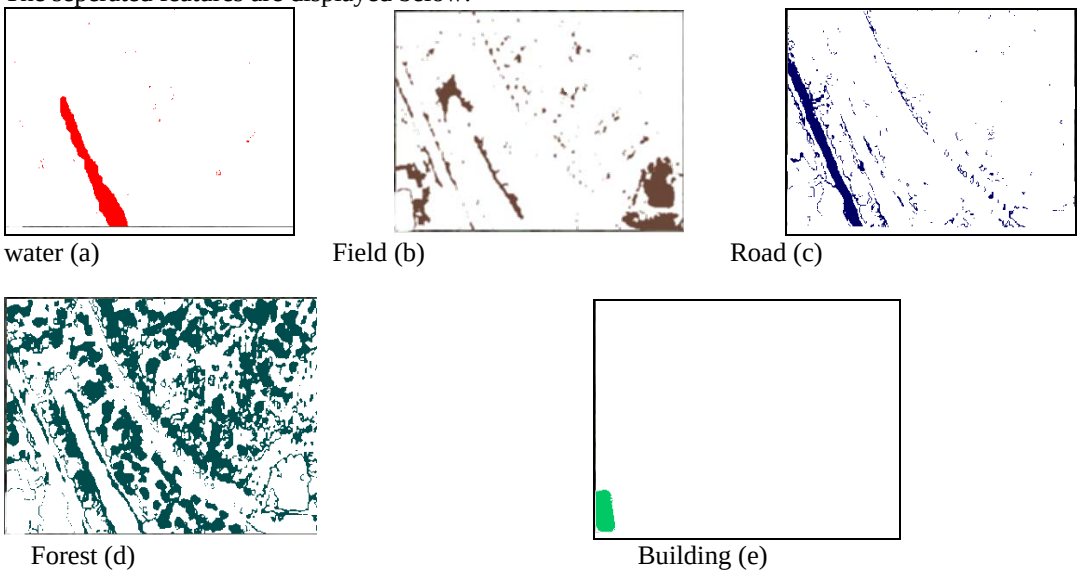

Figure 4.: Seperated Features from Foresty Area Image

5. RESULT EVALUATIONS

One way of the result evaluation was through the *accuracy assessment*. The classification results are compared to the raw image data and the report is created. This process is done during the *random sample selection.* The idea of the accuracy assessment is: point is highlighted in the sample list and observation was done where it is located on the image. This position should be compared to the class list and select the class that one believes it should belong. This idea was taken and applied in the fuzzy logic classification verification.

The following table shows the mean and s: standard deviation for the classified classes:

Channel	Mean	Standard Deviation
water (from 50 samples)		
Green	73.53	12.32
Red	52.47	9.53
Blue	67.64	14.71
Forest (from 75 samples)		
Green	143.12	22.12
Red	58.77	18.12
Blue	44.12	17.11
Agriculture (from 50 samples)		
Green	122.77	15.50
Red	62.47	13.53
Blue	65.45	17.31
Buildings (from 50 samples)		
Green	52.23	13.21
Red	39.12	8.56
Blue	44.12	10.11
Road (from 75 samples)		
Green	83.35	16.00
Red	29.37	9.12
Blue	41.12	12.19

Creation of the membership functions for the output variables is done in the similar manner. Since this is Sugeno-type inference, *constant* type of output variable fits the best to the given set of outputs (land classes). When the variables have been named and the membership functions have appropriate shapes and names, everything is ready for writing down the rules.

Class	Output variable
water	1
Forest	2
Agriculture	3
Buildings	4
Roads	5

Based on the descriptions of the input (green, red and blue channels) and output variables (water, agriculture, forest, buildings, roads), the rule statements can be constructed:
Rules for image classification procedure in verbose format are as follows:

IF (GREEN is a1) AND (RED is a1) AND (NIR is a1)
THEN (class is water)
IF (GREEN is a2) AND (RED is a2) AND (NIR is a2)
THEN (class is agriculture)
IF (GREEN is a3) AND (RED is a3) AND (NIR is a3)
THEN (class is forest)
IF (GREEN is a4) AND (RED is a4) AND (NIR is a4)
THEN (class is buildings)
IF (GREEN is a5) AND (RED is a5) AND (NIR is a5)
THEN (class is roads)

7. ACCURACY ASSESSMENTS

Idea for accuracy assessment of fuzzy logic classification results comes from the manner the maximum likelihood accuracy assessment was performed: select random sample areas with known classes and then let fuzzy logic 'say' what these samples are. With 100 random selected samples, results were as following:
Correctly classified samples: 84
Misclassified: 16
Accuracy: 86%

7. DISCUSSION AND CONCLUSION

This paper aimed for extracting the spatial features for providing a fundamental abstraction for modeling the structure of maps representing various raster images. The central part of this paper is an established procedure that is carried out for spatial feature extraction. As the work continues, it tries to implement every part of the procedure so as to establish its effectiveness and efficiency. It involved the use of supervised learning, assigning membership functions and discovery of pattern feature phases for successfully classifying an image. In the knowledge base, it must be well known whether selected sample forest area or water area.

The achievements of this project can be measured in terms of analyzing the applications of the system. The case studies that have been performed give some generalized outputs in case of extracting spatial features such as highways, buildings, water, agricultural fields, sea, sea-shore and forest. Moreover, the extracted patterns did not coincide with each other.

8.References

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