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A Review on Image Classification Approaches and Techniques

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ABSTRACT

Object Classification is an important task within the field of computer vision. Image classification refers to the labelling of images into one of a number of predefined categories. Classification includes image sensors, image pre-processing, object detection, object segmentation, feature extraction and object classification. Many classification techniques have been developed for image classification. In this survey various classification techniques are considered; Artificial Neural Network(ANN), Decision Tree(DT), Support Vector Machine(SVM) and Fuzzy Classification.

Keywords : Image Classification, Artificial Neural Network, Decision Tree, Support Vector Machine, Fuzzy Classifier.

I. INTRODUCTION

Classification between the objects is easy task for humans but it has proved to be a complex problem for machines. The raise of high-capacity computers, the availability of high quality and low-priced video cameras, and the increasing need for automatic video analysis has generated an interest in object classification algorithms. A simple classification system consists of a camera fixed high above the interested zone, where images are captured and consequently processed. Classification includes image sensors, image pre- processing, object detection, object segmentation, feature extraction and object classification. Classification system consists of database that contains predefined patterns that compares with detected object to classify in to proper category. Image classification is an important and challenging task in various application domains, including biomedical imaging, biometry, video-surveillance, vehicle navigation, industrial visual inspection, robot navigation, and remote sensing.

Classification process consists of following steps:

A. **Pre-processing** - atmospheric correction, noise removal, image transformation, main component analysis etc.
B. **Detection and extraction of an object**- Detection includes detection of position and other characteristics of moving object image obtained from camera. In addition, in extraction, from the detected object estimating the trajectory of the object in the image plane.
C. **Training:** Selection of the particular attribute which best describes the pattern.
D. **Classification of the object** : Object classification step categorizes detected objects into predefined classes by using suitable method that compares the image patterns with the target patterns

II. METHODS AND MATERIAL

2.1 Image Classification Approaches

Various image classification approaches are defined briefly:

1) On The Basis of Characteristic Used:

A. Shape-based:

This method make use of the objects' 2D spatial information. Common features used in shape-based classification schemes are the points (centroid, set of points),primitive geometric shapes (rectangle or ellipse), skeleton, silhouette and contour.

B. Motion-based:

This method use temporal tracked features of objects for the classification.

2) On The Basis of Training Sample Used

A. Supervised Classification

The process of using samples of known informational classes (training sets) to classify pixels of unknown identity. Example: minimum distance to means algorithm, parallelepiped algorithm, maximum likelihood algorithm

B. Unsupervised Classification**:**

In this type of classification is a method which examines a large number of unknown pixels and divides it into number of classes based on natural groupings present in the image values. Computer determines spectrally separable class and then defines their information value. No extensive prior knowledge is required. Example**:** K- means clustering algorithm.

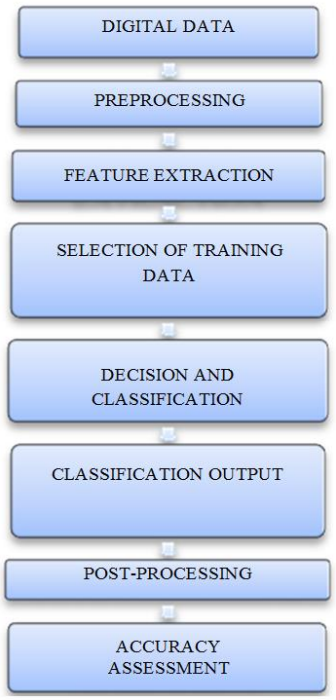

Figure 1. Steps for image classification

3) On The Basis Of Assumption Of Parameter on Data

A. Parametric classifier

The parameters like mean vector and covariance matrix are used. There is an assumption of Gaussian distribution. The parameters like mean vector and covariance matrix are frequently generated from training samples. Example: Maximum likelihood, linear discriminant analysis.

B. Non Parametric classifier

There is no assumption about the data. Non-parametric classifiers do not make use of statistical parameters to calculate class separation. Example: Artificial neural network, support vector machine, decision tree classifier, expert system.

4) On The Basis Of Pixel Information Used

A. Per pixel classifier

Conventional classifier generates a signature by using the combination of the spectra of all training-set pixels from a given feature. the contributions of all materials present in the training-set pixels is present in the resulting signature. It can be parametric or non-parametric the accuracy may not meet up because of the impact of the mixed pixel problem. Example: maximum likelihood, ANN, support vector machine and minimum distance.

B. Subpixel classifiers:

The spectral value of each pixel is assumed to be a linear or non-linear combination of defined pure materials called end members, providing proportional membership of each pixel to each end member. Subpixel classifier has the capability to handle the mixed pixel problem, suitable for medium and coarse spatial resolution images. Example: spectral mixture analysis, subpixel classifier, Fuzzy-set classifiers.

C. Per-field classifier:

The per-field classifier is intended to handle the problem of environmental heterogeneity, and also improves the classification accuracy. Generally used by GIS-based classification approaches.

D. Object-oriented classifiers:

Pixels of the image are united into objects and then classification is performed on the basis of objects. It involves 2 stages: image segmentation and image classification Image segmentation unites pixels into objects, and a classification is then implemented on the basis of objects. Example: e Cognition.

5) On The Basis Of Number Of Outputs For Each Spatial Element

A. Hard Classification

Also known as crisp classification In this each pixel is required or forced to show membership to a single class.eg maximum likelihood, minimum distance, artificial neural network, decision tree, and support vector machine.

B. Soft classification

Also known as fuzzy classification In this each pixel

may exhibit numerous and partial class membership. Produces more accurate result.

6) On The Basis of Spatial Information

A. Spectral Classifiers:

This image classification uses pure spectral information .Example: Maximum likelihood, minimum distance, artificial neural network.

B. Contextual Classifiers

This image classification uses the spatially neighboring pixel information. Example : frequency-based contextual classifier.

C. Spectral-contextual classifiers:

This classification uses both spectral and spatial information initial classification images are generated using parametric or non-parametric classifiers and then contextual classifiers are implemented in the classified images. Example: combination of parametric or non-parametric and contextual algorithms.

7) Multiple classifiers approach:

Different classifiers have their own advantages and disadvantages. In this approach different classifiers are combined. some of the method for combining multiple classifier are : Voting rules, Bayesian formalism, evidential reasoning, multiple neural network.

2.2 Image Classification Techniques

Table I. Different Techniques for Classification

Classification method	Description	Characteristics
Artificial Neural network	ANN is a type of artificial intelligence that imitates some functions of the person mind. ANN has a normal tendency for storing experiential knowledge. An ANN consists of a sequence of layers; each layer consists of a set of neurons. All neurons of every layer are linked by weighted connections to all neurons on the preceding and succeeding layers.	It uses Non-parametric approach. Performance and accuracy depends upon the network structure and number of inputs
Fuzzy Measure	In Fuzzy classification, various stochastic associations are determined to describe characteristics of an image. The various types of stochastic are combined (set of properties) in which the members of this set of properties are fuzzy in nature. It provides the opportunity to describe different categories of stochastic characteristics in the similar form.	It uses Stochastic approach. Performance and accuracy depends upon the threshold selection and fuzzy integral.
Decision tree	DT calculates class membership by repeatedly partitioning a dataset into uniform subsets Hierarchical classifier permits the acceptations and rejection of class labels at each intermediary stage. This method consists of 3 parts: Partitioning the nodes, find the terminal nodes and allocation of class label to terminal nodes	DT are based on hierarchical rule based method and use Non-parametric approach.
Support Vector Machine	A support vector machine builds a hyper plane or set of hyper planes in a high- or infinite-dimensional space, used for classification. Good separation is achieved by the hyper plane that has the largest distance to the nearest training data point of any class (functional margin), generally larger the margin lower the generalization error of the classifier.	SVM uses Non-parametric with binary classifier approach and can handle more input data very efficiently. Performance and accuracy depends upon the hyperplane selection and kernel parameter.

Table II. Advantages and Disadvantages of Different Classification Techniques

Decision tree	• Can handle non-parametric training data • Does not required an extensive design and training. • Provides hierarchical associations between input variables to forecast class membership and provides a set of rules n are easy to interpret. • Simple and computational efficiency is good.	• The usage of hyperplane decision boundaries parallel to the feature axes may restrict their use in
Support Vector Machine	• It gains flexibility in the choice of the form of the threshold. • Contains a non-linear transformation. • It provides a good generalization capability. • The problem of over fitting is eliminated. • Reduction in computational complexity. • Simple to manage decision rule complexity and Error frequency.	• Result transparency is low. • Training is time consuming. • Structure of algorithm is difficult to understand • Determination of optimal parameters is not easy when there is nonlinearly separable training data.
Fuzzy Measure	• Efficiently handles uncertainty. • properties are describe by identifying various stochastic relationships.	• Without priori knowledge output is not good precise solutions depends upo n direction of decision.

III. CONCLUSION

This paper attempts to study and provides a brief knowledge about the different image classification approaches and different classification methods. Most oz. common approaches for image classification can be categories as supervised and unsupervised, or parametric and nonparametric or object-oriented, subpixel, per-pixel and per field or spectral classifiers, contextual classifiers and spectral-contextual classifiers or hard and soft classification. This survey gives theoretical knowledge about different classification methods and provides the advantages and disadvantages of various classification methods.

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