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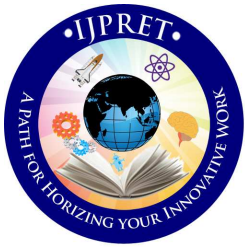

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FEATURE EXTRACTION OF DIGITAL AERIAL IMAGE: A REVIEW

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Abstract

Feature Extraction involves simplifying the amount of resources required to set the large set of data accurately. Feature extraction is important for a pattern recognition system. The input parameter vector is transformed into a feature vector or reduces its dimensionality [4]. When the input data to an algorithm is too large to be processed and notoriously redundant (e.g. the same measurement in both feet and meters) then it will be transformed into a reduced representation set of features (features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. Digital Aerial photography is used in land-use planning, archeology, movie production, cartography (particularly in photogrammetric surveys, which are often the basis for topographic maps), environmental studies, surveillance, commercial advertising. Orthophotos are commonly used in geographic information system such as are used by mapping agencies to create maps. [2] Large sets of orthophotos, typically derived from multiple sources are widely used in online map systems such as Google Maps. In this paper we have given the summary of various methods adopted to extract the features of digital aerial images.

INTRODUCTION

Digital Aerial Image refers to the photographs of the ground taken usually from an elevated position. These are the images in which the camera is not supported by a ground-based structure. Cameras may be hand held or mounted, and photographs may be taken by a photographer, triggered remotely or automatically. Features are represented in their true ground position, making direct measurement of distance, areas, angles, and positions possible.

Fig1: High resolution Digital Aerial Image for engineering planning.

A feature is defined as a function of one or more measurements, each of which specifies some quantifiable property of an object, and is computed such that it quantifies some significant characteristics of the object. Based upon a literature survey, the classification of the various features currently employed as follows:

1. General features: Application Independent features such as color, texture, and shape. [1]

2. Domain-specific features: Application dependent features such as human faces, fingerprints, and conceptual features. All features can be classified into low-level features and high-level features. [1]

Low-level features can be extracted directly from the original images, whereas high-level feature extraction must be based on low-level features.

Feature extraction is defined as locating those pixels in an image that have some distinctive characteristics. To initiate the process, the operator interprets the image and decides which features are to be measured and which algorithms are to be used for this task. The approximate location of a feature is pointed out to the algorithm. Feature extraction methods can be classified into three categories [1]:

1. Generic feature extraction: Here edges, lines, corners, and some individual features are extracted.

2. Structural feature extraction: The image is split into sub regions so as to make it more convenient to be studied.

3. Model-based feature extraction: Some application-dependent knowledge must be taken into account that means for a face, we know there must be two eyes, one nose, and one mouth, and the two eyes must be on two sides of the nose, respectively.

The rest of the paper is organized as follows.

In section 1, we start with definition, functionality, and classifications of low-level image features as well as conceptual features (high level features). In section 2, we present several approaches of feature extraction. In section 3, we concluded.

1. TYPES OF IMAGE FEATURES

1.1 Low level Image Features

Low-level image features includes edges, textures, and corner.

I. Edge Definition

An edge may be regarded as a boundary between two dissimilar regions in an image which may be different surfaces of the object. In practice, edges are defined as sets of points in the image which have a strong gradient magnitude. Locally, edges have a one dimensional structure.

10	9	11	200	198	196

Fig 2: Example of One-dimensional Gray-scale Image to Illustrate an Edge.

Edges are described using three essential parameters i.e. direction, strength and position. [1]

II. Texture Definition [1]

Texture refers to the visual patterns that have the property of homogeneity including cloud, trees, bricks, hair, fabrics etc. It contains important information about the structural arrangement of surfaces and their relationship to the surrounding environment.

III. Corner Definition

It is the feature formed at boundaries between only two image brightness regions, where the boundary curvature is extremely high.

Feature detection is a low-level image processing operation and usually performed as the first operation on an image, and examines every pixel to see if there is a feature present at that pixel.

IV. Common feature detectors

Feature detector	Edge	Corner
Canny	X	
Sobel	X	
Harris & Stephens/ Plessey	X	X
SUSAN	X	X
Shi &Tomasi		X
Level Curve Curvature		X
FAST		X
Laplasian Of Gaussian		X
Difference Of Gaussians		X
Determinant Of Hessian		X

1.2 High Level Image Features

The conceptual feature includes point pattern, shape and contours. These can directly serve for special applications.

I. Point Pattern [1]

Point sets with finite diameters are encountered in various pattern recognition and image processing problems. The points may be feature vectors in feature space, pixels in digital images, physical objects such as stars in the galaxy

II. Shape Description

The outer shape can be described via some statistical expression after locating edges and extracted meaningful regions:

i) Geometric descriptions:

Area (Number of points in region), Length, Perimeter, Principle axes of inertia, Elongation or eccentricity, Compactness and Moments of inertia.

ii) Topological descriptions:

a) Connectivity - The number of features in neighbor that adjoin the region.

b) Euler number [1]

II. Contour Descriptions

Contour lines are defined as lines linking points on a map which are the same height above a certain fixed level. Contour lines are abstract, and a large amount of relevant information can be derived from them. This includes:

a) The locations of high points.

b) The shape and slope of the ground

c) The position and nature of ridge lines.

Contour lines are used when maps are designed to show the physical nature of the land.

IV. Shape based Detectors

1) Thresholding 2) Template Matching 3) Hough Transform (Lines, Circles/ellipses, Arbitrary shapes)

Flexible methods for feature detection

- Deformable, parameterized shapes

- Active contours (snakes).[2]

1.3 Feature extraction in software

The feature extraction and dimension reduction is provided by many data analysis software packages. Some of the simpler feature extraction techniques via built-in commands are provided by common numerical programming environments such as MATLAB, SciLab, NumPy and The R Language. [2]

2. VARIOUS FEATURE EXTRACTION METHODS

In [3], straight line segments were used as Primitive features. To extract them, first Canny's edge detector was applied. Next, the thinning algorithm was applied to ensure the edge width of one pixel. A simple line growing algorithm was used to detect straight line segments that potentially represent object edges. The feature improvement module was also developed for reduction of noise and error.

In [4], two popular methods for feature extraction i.e. linear discriminates analysis (LDA) and principal component analysis (PCA) are explained. In this paper, the minimum classification error (MCE) training algorithm is investigated for feature extraction. A generalized MCE (GMCE) training algorithm is proposed to mend the shortcomings of the MCE training algorithm. LDA, PCA, MCE and GMCE algorithms extract features through linear transformation. In this paper, Support vector machine (SVM) is also investigated and compared to linear feature extraction algorithms.

In [5], local application of Hough transform combined with use of transformation matrix is used to obtain rapidity and accuracy.

Application of Hough transform minimizes influence of noise provoked by isolated pixels. This approach is adapted to features texture extraction (i.e. regularity and directionality) and video text localization.

In [6], the application of ant colony algorithm (ACA) is presented for edge extraction in city aerial image for building recognition. The overall idea of this work is clustering pixels by a character complex of gray value, gradient and neighborhood of each pixel. The result of ACA is compared with the results of Canny operator and the comparison indicated that ACA is efficient in

edge feature extraction, especially for the aerial images.

In [7], a method of gray-level projection called circular projection that is invariant to translations, scale changes and rotations is proposed. This method can reduce the problem of 2-D patterns into that of 1-D ones. The method is applied to feature extraction for road and river from high resolution aerial images. It is observed that the method combined with wavelet processing can provide reliable features for segmentation and recognition of roads and rivers.

In [8], the digital aerial image is first preprocessed by edge detection, principal component analysis and the texture filter of second-order probability statistics.

Secondly the gray image of the contrast texture through the sharpening window of 7×7 is obtainedthen taking the gray image as an independent band, a pseudo color composition with the band combination of contrast (R), the digital aerial image band (G) and the digital aerial image band (B) is processed. Finallymultiple segmentation and building extraction in towns and villages based on the pseudo color images were processed.

CONCLUSION

In this paper various feature extraction methods are summarized. The future work will focus on feature extraction of digital aerial images using edge detection algorithm.

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