Chapter 13

Feature Extraction Techniques: Fundamental Concepts and Survey

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ABSTRACT

The feature extraction is the process to represent raw image in a reduced form to facilitate decision making such as pattern detection, classification or recognition. Finding and extracting reliable and discriminative features is always a crucial step to complete the task of image recognition and computer vision. Furthermore, as the number of application demands increase, an extended study and investigation in the feature extraction field becomes very important. The goal of this chapter is to present an intensive survey of existing literatures on feature extraction techniques over the last years. All these techniques and algorithms have their advantages and limitations. Thus, in this chapter analysis of various techniques and transformations, submitted earlier in literature, for extracting various features from images will be discussed. Additionally, future research directions in the feature extraction area are provided.

INTRODUCTION

Feature is defined as a function of the basic measurement variables or attributes that specifies some quantifiable property of an object and is useful for classification and/or pattern recognition. Obtaining a good data representation is a very domain specific task and it is related to the available measurements. Various features currently employed can be classified into low-level features and high-level features. However, there is no clear guideline along which features should be classified as low- or high-level ones. Generally, quantitatively and qualitatively more complex processing is needed to derive high-level features from an image than low-level features. Low-level features are the fundamental features that can be extracted directly from an image without any object
description, while high-level features extraction concerns finding shapes and objects in computer images and it is based on low level features (Nixon & Aguado, 2013). The Low-level features can be categorized as follows: General features, Global features and Domain-specific features. General features are application independent features such as color, texture, and shape. These features, according to the abstraction level, can be further divided into: pixel-level features, which are the features calculated at each pixel (e.g. color, location, etc.) and local features, which are features computed over a subdivision of the image bands that are resulted from image segmentation or edge detection. The Global features are features that are calculated over the entire image or just regular sub-area of an image. The domain-specific features are application dependent features such as human faces, fingerprints, character recognition and conceptual features (Chora’s, 2007). Obviously, this classification is not that sharp, there exist overlaps between them. Also, it must be considered that for some applications such as computer vision applications, the feature used should be both expressive and meaningful (associated with significant scene elements) and detectable (the location algorithm must exist).

It’s worth be noted that, the lower the abstraction level of the features employed, the easier to locate them in the image, yet the more difficult to use them for understanding the meaning of that image, and vice versa (Lei, Hendriks & Reinders, 2009). Figure 1 shows the categorization of feature extraction methods.

Human expertise, which is often required to convert “raw” data into a set of useful features, can be escorted by automatic feature extraction methods. Feature extraction is the process of transforming raw data into more informative signatures or characteristics of a system, which will most efficiently or meaningfully represent the information that is important for analysis and classification. In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (features vector). If the extracted features are carefully chosen it is expected that the features vector 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.

A good feature representation is essential to attain high performance in any pattern recognition or image processing tasks. However, manually defining a good feature set is often not feasible. The problem of feature extraction can be decomposed into two steps: feature construction and feature selection (Guyon, Gunn, Nikravesh & Zadeh, 2006). Researchers have been tackled both steps for many years, however there is still a great interest in feature extraction. A number of new applications (e.g. bioinformatics, combinatorial chemistry, text processing, decision making, pattern recognition, speech processing, image retrieval and vision) with very large input spaces critically need space dimensionality reduction for efficiency and efficacy analysis (Gale & Salankar, 2014; Shenbagavalli & Ramar, 2014; Arun, Emmanuel & Durairaj, 2013; Zhu, Xu, Lu, Wen, Fan & Li, 2014). Feature construction involves transforming a given set of input features to generate a new set of more powerful features, which can then be utilized for processing.

Furthermore, reducing the number of features as well as removing the irrelevant, redundant, or noisy data increases the efficiency and effectiveness of the implemented algorithms. Feature selection is the process of selecting a subset of the constructed features according to a certain criteria. This is an important and frequently used dimensionality reduction technique for various applications, e.g. data mining, face recognition.
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