Chapter 33
Local Phase Features in Chromatic Domain for Human Detection

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ABSTRACT

In this paper, a new descriptor based on phase congruency concept and LUV color space features is presented. Since the phase of the signal conveys more information regarding signal structure than the magnitude and the indispensable quality of the color in describing the world around us, the proposed descriptor can precisely identify and localize image features over the gradient based techniques, especially in the regions affected by illumination changes. The proposed features can be formed by extracting the phase congruency information for each pixel in the three-color image channels. The maximum phase congruency values are selected from the corresponding color channels. Histograms of the phase congruency values of the local regions in the image are computed with respect to its orientation. These histograms are concatenated to construct the proposed descriptor. Results of the experiments performed on the proposed descriptor show that it has better detection performance and lower error rates than a set of the state of the art feature extraction methodologies.

1. INTRODUCTION

Human detection is an active research area in the computer vision due to its importance in practical applications including automatic safety systems, person identification, road scene understanding, human computer interaction, robotics, and surveillance systems. The wide variability of the human body appearance such as scale variation, clothes, pose, as well as illumination changes, shadows, occlusion and complexity of the backgrounds make the human detection be one of the most difficult categories in object detection. In the last decade, variety of techniques and features were developed for Human

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detection. Some of these features are the Histogram of Oriented Gradient (HOG) (Dalal & Triggs, 2005), the Scale Invariant Feature Transform (SIFT) (Lowe, 2004), Edgelet (Wu & Nevatia, 2005), the Local Binary Pattern (LBP) (Ojala et al, 2002), Haar (Viola & Jones), and Shapelet (Sabzmeydani & Mori 2007). The histogram of oriented gradient developed by Dalal and Triggs in 2005 is considered as the most popular local feature used for depiction and detection of human beings. Most of the multi-feature algorithms developed to improve the performance of the human detection system were based on HOG features. Wojek and Schiele (2008) combined HOG, Haar and shapelet features. Zhang and Ram (2007) improved the detection of the IR images by the combination of the Edglets and HOG features. Wang et al (2009) connected HOG and LBP features to improve pedestrian detection performance. Dollar et al (2009) developed the integral channel features (ICF) that combined HOG, gradient magnitude and LUV color, etc. Histogram of Oriented Phase (HOP) (Ragb & Asari, 2016) is another single feature extraction algorithm that was developed for human detection tasks. This algorithm is a local phase based approach and shows a better detection performance over the HOG descriptor, especially on the images affected by the contrast and illumination changes (Ragb & Asari, 2016) that make this algorithm a relevant base for further human detection multi-feature techniques. HOP descriptor can capture and extract distinctive features from a gray-level image and describe the local structural appearance using the oriented phase congruency histograms. The main drawback of the HOP descriptor is that the light color changes are ignored since only the gray-scale intensities are used in the computation (Danni et al, 2010). Color provides powerful discriminating information, and it is generally acknowledged that both color and shape information are important cues for object detection and recognition (Slater & Healey, 1995), (Mel, 1997). In this paper we propose several color HOP descriptors by combining color information with the local HOP descriptor, such as HOP-RGB, HOP-HSV, HOP-LUV, HOP-Opponent, and HOP-YCbCr. The proposed color histogram of oriented phase descriptor is denoted as (CHOP). The framework of the human detection system based on CHOP descriptor is shown in Figure 1. For the RGB input image, the phase congruency magnitude and orientation of each pixel of the three image channels (R, G, B) are computed. The maximum values of the phase congruency in each corresponding pixel of the three channels are selected. The resulting phase congruency channel is divided into local regions (block). The histogram of oriented phase for each local region is computed and normalized. The histograms of the local regions are concatenated to construct the overall CHOP descriptor. The same is done for the other color spaces by transferring the RGB image into HSV, LUV, Opponent, and YCbCr using a physical model-based transformation. The dimensionality of the proposed CHOP vector space is reduced and the redundancy in the features is eliminated using the Principal Component Analysis (PCA) algorithm. The Support Vector Machine (SVM) classifier is used in the training of the proposed human detection system.

The remaining sections of this paper are organized as following: In section 2, we discuss the local energy and phase congruency computation. In Section 3, we describe how the color histogram of oriented phase (CHOP) descriptor is constructed. The dimensionality reduction based on principal component analysis (PCA) is discussed in section 4. The experimental results are explained in Section 5. Finally, the conclusion is presented in Section 6.

2. LOCAL ENERGY AND PHASE CONGRUENCY COMPUTATION

Module of local energy is an algorithm developed by Morrone and Owens (1987) and Morrone et al. (1986). This module postulates that the features are perceived at points where the Fourier components