Journal of Organizational and End User Computing
Volume 32 • Issue 2 • April-June 2020

A Machine Learning Method with Threshold Based Parallel Feature Fusion and Feature Selection for Automated Gait Recognition

Muhammad Sharif, Department of CS, COMSATS University Islamabad, Wah Campus, Wah Cantt, Pakistan
Muhammad Attique, Department of Computer Science, HITEC University, Museum Road Taxila, Pakistan
Muhammad Zeeshan Tahir, Department of CS, COMSATS University Islamabad, Wah Campus, Wah Cantt, Pakistan
Mussarat Yasmim, Department of CS, COMSATS University Islamabad, Wah Campus, Wah Cantt, Pakistan
Tanzila Saba, Artificial Intelligence & Data Analytics (AIDA) Lab, CCIS Prince Sultan University, Riyadh, Saudi Arabia
Urcun John Tanik, Texas A&M University-Commerce, Commerce, USA

ABSTRACT

Gait is a vital biometric process for human identification in the domain of machine learning. In this article, a new method is implemented for human gait recognition based on accurate segmentation and multi-level features extraction. Four major steps are performed including: a) enhancement of motion region in frame by the implementation of linear transformation with HSI color space; b) Region of Interest (ROI) detection based on parallel implementation of optical flow and background subtraction; c) shape and geometric features extraction and parallel fusion; d) Multi-class support vector machine (MSVM) utilization for recognition. The presented approach reduces error rate and increases the CCR. Extensive experiments are done on three data sets namely CASIA-A, CASIA-B and CASIA-C which present different variations in clothing and carrying conditions. The proposed method achieved maximum recognition results of 98.6% on CASIA-A, 93.5% on CASIA-B and 97.3% on CASIA-C, respectively.

KEYWORDS

Gait Recognition, Geometric Features, HOG Features, MSVM Classifier, Segmentation

INTRODUCTION

In the domain of computer vision, Human Gait Recognition (HGR) is an active research area due to its unobtrusiveness for identification and verification. In comparison with other biometric devices such as iris and face detection (Choudhury and Tjahjadi, 2015; Lishani, Boubchir et al., 2017; Dey, Ashour et al., 2018; Wang, Li et al., 2018), the gait offers an opportunity to recognize human even at a distance point by utilizing a video camera. Existing research in this area has explained that gait is likely to become a robust biometric for assistance in many applications such as surveillance in airports, bus stations, clinical analysis, banks surveillance systems and forensic applications (Aqmar, Fujihara et al., 2014; Yasmin, Sharif et al., 2016; Zeng and Wang, 2016).

Recently, several image processing and machine learning-based techniques are introduced for HGR. These techniques can be separated into two classes such as model based (MB) (Bashir, Xiang, & Gong, 2010) and model free (MF) (Zeng, Wang, & Li, 2014). The MB approach takes structural

DOI: 10.4018/JOEUC.2020040104

model of a human body in the absence of motion. Afterwards, parameters of these structural models are further applied as features like joint angles. The major advantage of this approach is to express high-level model of a human body but it is complex because of high cost and computational time. This approach also works better over the view invariant and cofactors like carrying, clothing and shadows which affects the recognition rate (Zeng, Wang et al., 2014, Arora, Hanmandlu et al., 2015). The model free class operates on silhouette images of a human body instead of a structural model. This approach is less sensitive for the quality of an image as compared to model-based class. Also, it has low computational time and cost. The major challenge of this approach is sensitivity because of several problems such as carrying, clothing and shadows (Piccardi 2004, Rida, Jiang et al., 2016; Wu, Huang et al., 2017).

A general gait recognition framework consists of several sub steps such as preprocessing, ROI detection, feature extraction and recognition. The preprocessing step has much importance for obtaining high recognition rate because the raw input videos have a complex background and low contrast. The low contrast videos affect ROI detection which later on degrades the recognition accuracy. Therefore, preprocessing is a major step for improving the contrast of input video and also removes extra noise such as change in background, variations and human change. In gait recognition, different segmentation methods have been introduced for ROI detection such as background subtraction, thresholding, watershed and few more (Piccardi, 2004; Gupta, Dixit et al., 2014). There are several types of features which exist in computer vision such as texture, color, geometric, shape, Gabor and wavelet transform. These features are high in number of dimensions; therefore, they reduce the accuracy. This kind of problem is resolved by several researchers by the implementation of reduction techniques. The major reduction techniques are Principal Component Analysis (PCA) (Ryu and Kamata, 2011), ICA, genetic algorithm and few more (Khan, Sharif et al., 2016). Finally, the reduced features are utilized by supervised learning methods as SVM, Fine K-Nearest Neighbor (FKNN), neural network, decision trees and regression models (Abdullah and El-Alfy, 2015; Khan, Sharif et al., 2016; Nida, Sharif et al., 2016). These methods perform significantly well when the extracted number of features is unique and have no redundancy between them. Therefore, classification accuracy fully depends on the extracted number of features.

In literature, numerous researchers introduced several methods for HGR. However, the performance of HGR is significantly affected due to several covariate aspects such as change in clothes, occlusion, view angle, time, carrying conditions and different variations (Al-Tayyan, Assaleh et al., 2017, Yu, Chen et al., 2017). In this article, several challenges are taken into account such as the presence of shadows, varying view point at different conditions, effects of occlusion, change in human angle, change in viewpoint and high dimension of extracted features. A new method is presented in this work which resolves the listed problems for HGR. The proposed method is based on three pipe line procedures: a) a preprocessing method is implemented for distinguishing the human from background, which is a combination of HSI color transformation and linear contrast enhancement; b) implementation of a uniform segmentation method and optimizing results by fusion of background subtraction; c) fused texture and shape features based on parallel method and selecting the best features using minimum distance values. The selected features are fed to Multi category AVM (MSVM) for recognition.

The contributions of this article are listed below:

1) In preprocessing, a hybrid technique is implemented for contrast enhancement based on HSI color transformation. The Hue channel is selected, and foreground contrast is increased by using a logarithmic function. Finally, the logarithmic image is optimized by performing linear contrast which efficiently distinguished background and foreground objects.
2) A uniform segmentation method is implemented for ROI detection which improves the segmentation performance by fusion of background subtraction. The fusion process is done by mutual information method.