Computers and Electrical Engineering 000 (2018) 1–13

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Research on hybrid information recognition algorithm and quality of golf swing☆

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ARTICLE INFO

Article history:
Received 8 August 2017
Revised 7 February 2018
Accepted 7 February 2018
Available online xxx

Keywords:
Hybrid information system
Golf gesture recognition
Static image
Video sequence

ABSTRACT

As is well known, the target recognition algorithm of hybrid information system has intrinsic disadvantages, such as high time complexity, high performance requirements of hardware and complex operations, in this paper, a fast golf gesture recognition algorithm of static image and video sequence is proposed for the field of sports auxiliary training. In static image recognition, a fast multi-scale aggregation channel feature is utilized to extract hybrid information, and the extraction speed can be improved through an approximate calculation method. An improved AdaBoost classifier is adopted to classify the information. On this basis, the aggregation of channel feature detector locates the prominence region of static image, and then scans the generated fractional sequence through the gesture detector as the feature data of golf gesture in the video sequence. Finally, the real-time judgment of feature data is carried out with a linear support vector machine, the rapid identification of golf swing gesture can therefore be obtained. The experimental results show that the recognition speed is over 30 fps and the accuracy is 97% on iPhone5s and later versions, which suggest the validity of algorithm in practical application.

1. Introduction

How to extract gesture features in static images and a video sequence has been a focused topic in the field of hybrid information system. The task of gesture recognition is whether to include the target gesture or to locate the time axis of the target. It is a basic function of various auxiliary training equipment. With the rapid development of sports and the continuous improvement of living standard in China, more and more people are engaged in golf sports. But golf enthusiasts are not only satisfied with participating in the movement, but also eager for achieving or simulating the professional movements through scientific training methods. However, the target recognition algorithm of hybrid information system suffers high time complexity and hardware requirements, thus reducing the training efficiency.

The high calculation complexity of the main target recognition algorithm leads to the heavy cost of time in feature extraction and classification training, and in return the feature extraction affects the accuracy and robustness of algorithm [1]. The commonly used feature descriptors have integral channel features [2], local binary patterns (LBP) features [3], gradient histogram features [4], Hall features [5], deep neural network [6], among others. Most of these features share the same limitations of not being able to describe the target comprehensively. Although the deep neural network has low requirement for feature engineering, the time complexity of network training remains high. Therefore, many researchers have proposed the

☆ Reviews processed and recommended for publication to the Editor-in-Chief by Guest Editor Dr. S. Liu.

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https://doi.org/10.1016/j.compeleceng.2018.02.013
0045-7906/

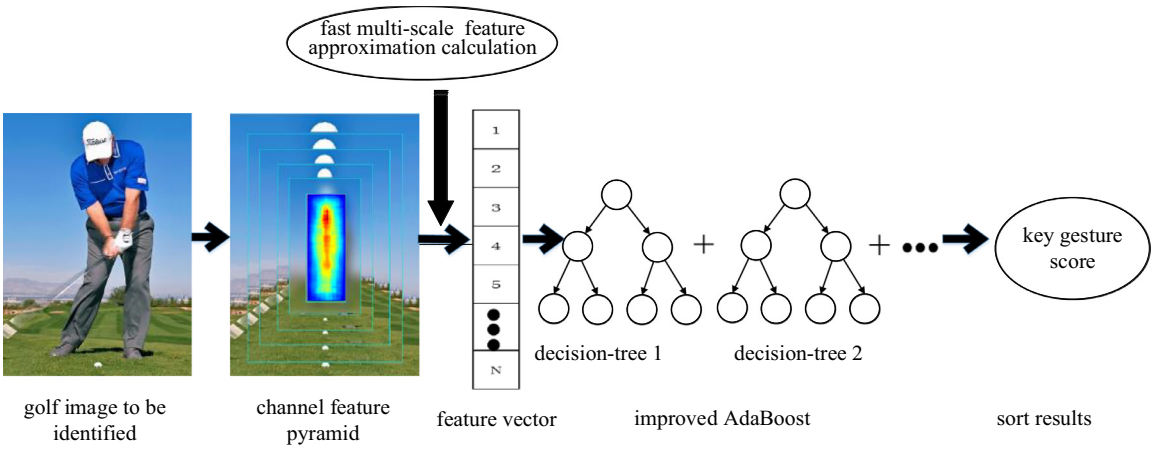

Fig. 1. Flowchart of fast golf gesture recognition algorithm.

concept of multi-feature fusion, aggregating the existing multi-channel feature to obtain a more descriptive feature. Dollar et al. improved the integral channel features and proposed Aggregate Channel Feature (ACF), which detected pedestrians in the open environment via Boosting. Nam et al. generalized the ACF and proposed filter channel feature [7,8], to include a variety of channel feature variants in a unified framework. Yang et al. were inspired by Convolutional Neural Network (CNN), and proposed Convolution Channel Feature (CCF) based on ACF [9], which can be used in the object detection tasks of computer vision, such as pedestrian detection, face detection and edge detection. Moreover, for the problem of slow training, Appel et al. proposed a fast algorithm to reduce features, and Oliveira et al. presented a target detection method based on CNN [10]. Wohler et al. introduced a target detection method based on Adaptive Delay Neural Network (ATDNN) [11]. Xie Lei used binocular camera to track golf swings, and used the binocular stereoscopic vision technology to achieve the three-dimensional reconstruction of the track [12].

Tackling the problem of high time cost in feature selection and extraction and classification training, this paper proposes a fast golf gesture recognition algorithm based on static image and video sequence, and verifying the algorithm effectiveness in practical applications through experiments.

The remainder of this paper is organized as follows: In the next section, the fast golf gesture recognition algorithm is introduced, by adopting the fast multi-scale feature approximation method and the improved AD-DWTAdaBoost. In Section 3, the training and testing phase of a fast golf gesture recognition algorithm based on video sequences is explained. The algorithm effectiveness is demonstrated through a series of experiments in Section 4.

2. A golf gesture recognition algorithm in fast static image

In order to recognize the golf gesture accurately, a real-time golf gesture detection algorithm based on multi-scale ACF is adopted. The algorithm mainly includes feature extraction and classification recognition. The flow of golf gesture recognition algorithm based on static image is shown in Fig. 1.

2.1. Feature extraction

2.1.1. Aggregate channel feature

Due to the high complexity of golf gesture in the image, the proposed algorithm utilizes the ACF with rich expression ability, consisting of 10 important feature channels. These 10 channels contain 6 gradient direction histogram channels, 3 LUV color space channels and 1 local normalized gradient magnitude channel. Compared with single channel features, the ACF can aggregate a variety of channel features in different dimensions, with the ability of fully depicting the target. It is important to note that ACF has strong performance of anti-noise, making it ideal for describing the common features of golf swing gesture in image effectively and accurately.

$$\mathrm{L1}-norm : \hat{v}_i \leftarrow \frac{v_i}{\|v\|_k + \varepsilon} \tag{1}$$

In Eq. (1), v_i is a vector that has not been normalized, $\|v\|_k$ represents k order norm, ε is a very small number, $\hat{vi}$ indicates a normalized value. Meanwhile, the direction of gradient histogram is quantized, and decomposed into feature with multiple channels. In order to improve the quantization speed, a fast quantization method is adopted, utilizing the two-dimensional gradient vector of pixel, the normalized vector calculate the inner product and the hash search method to search maximum value. Obviously, the interval corresponding to the maximum value is the one after the quantization

Please cite this article as: J. Li et al., Research on hybrid information recognition algorithm and quality of golf swing, Computers and Electrical Engineering (2018), https://doi.org/10.1016/j.compeleceng.2018.02.013