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DiveNet : Dive Action Localization and Physical Pose Parameter Extraction for High Performance Training

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ABSTRACT The tremendous progress of deep convolution neural networks has shown promising results on the classification of various sports activities. However, the accurate localization of a particular sports event or activity in a continuous video stream is still a challenging problem. The accurate detection of sports actions enables the comparison of different performances, objectively. In this work, we propose the DiveNet action localization module to detect the springboard diving sports action in an unconstrained environment. We used Temporal Convolution Network (TCN) over a backbone feature extractor to localize diving actions, with low latency. We estimate the divers center of mass (COM) trajectory and the peak dive height using the temporal demarcations provided by the action localization step via the projectile motion formula. In addition, we train a DiveNet pose regression network, which extends the Unipose architecture with direct physical parameter estimation, i.e. COM and 2D joint keypoints. We propose a new homography computation method between the diving motion plane and the image-view for each dive. This enables the representation of physical parameters in metric scale, without any calibration. We release the first publicly available diving sports video dataset, recorded at 60 Hz with a static camera setup for different springboard heights. DiveNet action localization achieves an accuracy of 95% with a single frame latency (< 25 ms). The DiveNet pose regression model shows competitive results around 70% PCK on different diving pose datasets. We achieve COM accuracy of 6 pixels, dive peak height sensitivity of 20 cm and mean joint angle errors around 10 degrees.

INDEX TERMS deep learning; diving sports pose; action localization; sports analytics;

I. INTRODUCTION

THE body pose and motion analysis of sports athletes is an emerging research area in computer vision and deep learning [1]–[4]. The analysis of sports videos is a challenging task because the body postures and manoeuvres involved in sports such as diving, gymnastics and balance-beam are complex. In addition, monocular based human pose estimation often suffer from self-occlusion and motion blur due to high-speed nature of actions that are performed [5]–[7]. These problems often cause many markerless motion captures to provide inferior results [8]. Sports video analysis aims to provide objective measures to compare the athlete's performance, e.g. during training. For a given sports performance, video analysis can help to improve the athlete's technique with real-time feedback [9]–[13]. Thus, it assists

sport trainers in technique analysis, thereby increasing the overall efficiency of the coaching process [14]. Existing sports analysis is largely analyzed manually to observe the movement of the diver's body parts during training. The feedback provided after manual analysis is time-consuming, laborious and error-prone [15]. In recent years, alternative technologies are proposed [16], but they still have limitations in using them to provide accurate and robust results [15]. So far, existing analysis techniques often focused on diving classification are challenges due to high variability in the scenes. The variability occurs due to various factors such as people in the background, image resolution and different viewing positions [17].

Our work primarily focuses on competitive springboard diving training. Thus, we differ from recent works on diving

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