Detecting Clashes in Boxing

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Abstract. Sports video analysis is currently an important issue from the point of view of both statistics and live sports coverage. In the context of boxing, computer vision can be used, among other things, to present statistics and to indicate whether there is a contact between the boxers at a particular moment. In boxing, the situation where there is a contact between the boxers does not last long for most of the fight. In this paper, we proposed a solution by which contact between the boxers is detected. This is realised by detecting the boxers and then determining the Euclidean distance between them. The solution was tested on real data, video recorded by us during a boxing tournament. The results obtained show that it is possible to detect contact during boxing and thus skip the rest of the fight. We showed that the contact between boxers occurs in less than a half of the overall time of a fight.

Keywords: clash detection · video processing · combat sport analysis.

1 Introduction

These days computer vision plays a crucial role in the world of sports. Currently dozens of cameras in stadiums are tracking players and balls for game analysis. Computer vision provides knowledge that has a wide range of stakeholders. Beginning with spectators, television presenters, referees and ending with coaches who analyse entire games and the performance of individual players [3, 7, 10, 13].

Competitions in many sports are analysed by advanced and accurate systems every day. Image processing plays important role in these solutions. Computer vision is being used by modern systems to tracking cricket balls and generate a trajectory in 3D based on up to ten high speed cameras with mean error of 2.6 mm [9]. However, current research on combat sports video is very limited, mainly in boxing [5].

By this time scientific community has proposed several approaches to analyse combat sports like boxing. One of them basing on wearable sensors [4, 11, 12] that may be dangerous to players or banned by game regulations, as in NBA games [9]. Tag-based systems also have a problem of short battery life, which is up to 4 hours on some systems [9].

Instead of wearable devices and sensors approach it is possible to measure features of performance using computer vision. The mentioned method is called

as non-invasive approach to analyse pugilists in the ring. It is possible to track boxing gloves using footage from one static frontal view camera [10]. Methods using depth data are also used for tracking boxers and classifying punches; authors [1, 5] chose overhead camera position to reduce problem with occlusions (by another boxer or referee in boxing ring).

The purpose of this paper is to prepare a framework for detect clashes, which is based on frontal view cameras in each corners in a boxing ring. Collecting the relevant footage for this purpose was necessary. Therefore the authors were recording real boxing bouts and prepared the complete training set.

The remainder of the article is organized as follows. Section 1 contains an introduction to current computer vision responsibility in sports and a review of several approaches by other authors. Section 2 contains the proposed approach to detect clashes in boxing. Section 3 contains details of the data collection process and experiments results. The last Section 4 contains summary, conclusion of this paper and further works.

2 Clash Detecting

Boxing competitions characterizes with a lot of breaks between fights and rounds. When watching footage of the entire competition, it appears that for a long time nothing happens in the boxing ring. Clash detecting is the preprocessing step before detecting and classifying blows on the footage. For about 70% of the time (in the footage of the whole competition) boxers are not engaged in close-combats situation according to our observations. Clash detecting is designed to extract interesting parts of footage, where boxers are in close-combats situations. Filtered material is ready for detection and classification of boxer punches.

Boxing is a highly dynamic sport which requires high resolution and high frame rate cameras to capture the details. Using such high quality generates a huge video file which leads to the big computational complexity. An approach to clash detection that reduces the volume of data processed is extremely necessary.

Clash detecting framework based on the authors' approach for boxer detecting (See [8]). Boxer detecting based on person detection [2, 6] with color based approach to filter judge and people outside the boxing ring.

Euclidean measure from equation (1) is used to calculate distance between boxers in the ring. The algorithm detects a clash while distance between the detected boxers is close. A clash is a potential situations where blows could occur between boxers.

$$d\left(A,B\right)=\sqrt{\left(x_B-x_A\right)^2+\left(y_B-y_A\right)^2}, \tag{1}$$

where A and B are points in the coordinate system, x and y stand coordinate for values of the points.

3 Experiments

The necessary footage of the boxing bouts was recorded in Poland at the Silesian league games for juniors, cadets and seniors. For this purpose four GoPro Hero8 cameras with power banks and 128 GB memory cards were used. The cameras were mounted behind each corner on 1.8m high tripods and were recording video in full HD resolution at 50 frames per second. After the competition, which lasted four hours, each memory card was nearly full, totaling just under 500 GB of recorded footage.

A 12 minutes long footage containing 35,000 frames was selected for the experiments. Footage includes 3 rounds of one fight and one round of the next fight. Between rounds 3 and 4 several clashes were detected as shown in the Figure 1. Between fights competitions greet each other, thank each other and receive awards, therefore a few clashes can be detected in that time.

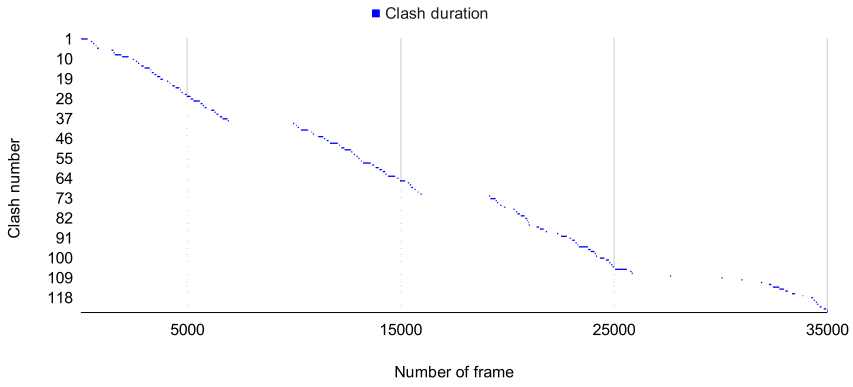

Fig. 1. Diagram of the detected clashes in the footage

The Figure 1 shows detected clashes in the video recording. In the selected footage clashes being were detected in 14,600 frames, which means that for 41% of the recording boxers are in close-combats situation. In this way, the remainder of 59% of the footage can be filtered out. Gaps on the graph represent breaks between rounds and situations where boxers are not close to each other.

4 Conclusion

The purpose of this paper was to propose the approach to detect clashes in boxing bouts footage. Important part of the work was providing a protocol of recording and collecting relevant footage of boxing fights. The authors set up a recording environment and chose special equipment for this purpose.

The experiments confirm that clash detection framework can be used in preprocessing part which allows to reduce large volume of data. In the future authors will synchronize the video from all cameras to reduce problem with occlusions.

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