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A Proposal of a Spike Event Classification Method Based on Ball Trajectory in a Volleyball Video

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Abstract

In this research, we propose a method for classifying a spike event in a volleyball game video. In our method, Person and ball detection and tracking are implemented with the YOLO and the ByteTrack. An action event such as a spike and toss is recognized by focusing on the changes in a player's bounding box of the tracking result. The spike event is classified from the action events with a trajectory of the ball movement. The precision and recall rates of our method are 95% and 93%, respectively, and it indicates an improvement of 8% over existing method.

Keywords: Computer Vision, VolleyBall, Sports Analysis, Spike Event Classification

1 Introduction

Analysis of a volleyball game serves as a tool for developing strategies against an opposing team and revisiting the performance of one's own team[1]. An analyst watches all match videos, and manually records the gameplay by tagging. The tagging process is used for scene segmentation and statistical analysis. Zhang *et al*. have proposed a study to detect play scenes with color similarity, and to eliminate extraneous scenes such as replays and intermissions from a broadcast sports video [2]. This method lacks the capability to detect specific play events, indicating a need for improvement within the field. The integration of a clustering approach for play events may advance event detection and enhance the overall efficiency of game analysis.

In relation to detecting play events, a spike event classification method has been proposed by Hsu *et al.*, and it detects the spike events from within the play scenes. The method utilizes frame-to-frame differencing near the net [3]. This method encountered an issue with false detection as it misidentified the movements of the serving player, the referee, the spectator, and a decoy player mimicking the spike event as actual one. Therefore, we propose a spike event classification method with the ball's trajectory to avoid false detection of decoys and other events.

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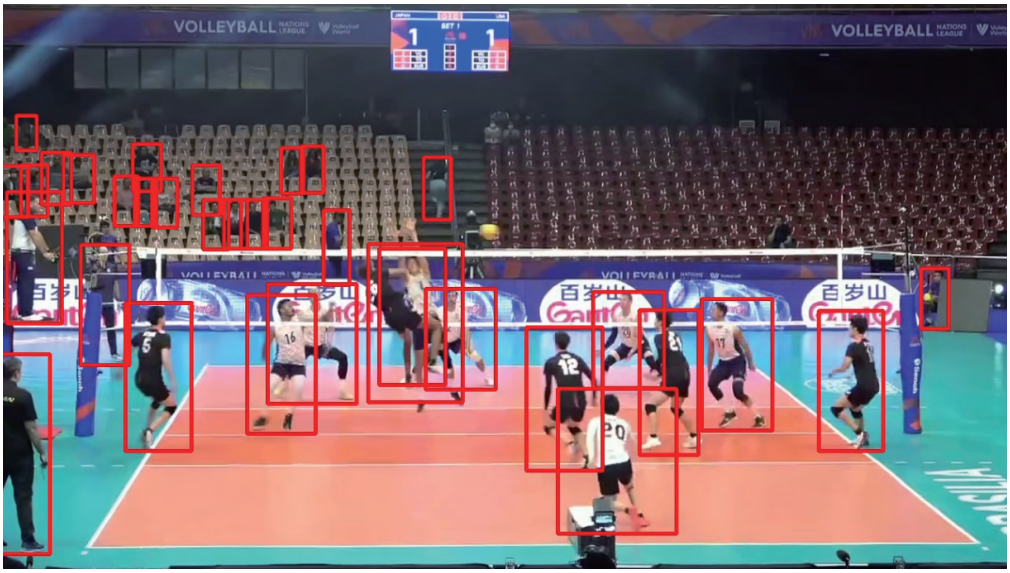

Figure 1: YOLO detection result

2 Our Method

This section describes an approach designed for detecting the spike event. The approach accepets in the area of a person detection result and the trajectory of ball movement. An input video with an entire court is captured from the vantage point of the end line side. The following procedure is used for our method.

1. Person detection
2. Recognition of the action event above the net
3. Spike event classification

In the first procedure, a person is detected to identify the player as shown in Figure 1 with the YOLO that is an object detection algorithm[4]. The detection result is utilized to track the person with ByteTrack[5].

The tracked person is identified as the player if the number of the tracked one on the court is for more than $N\%$ of the total game time within the play scene. The bounding box size of the tracked player changes due to the jump, and the box's size should be largest above the net as shown in Figure 2. A peak appears in the cumulative value of the area of the box associated with all players before and after the action event. This peak is utilized to recognize the action event.

The next step in the process is to classify the spike event from the recognized action event with the ball movement. The ball is also detected using the YOLO, and exhibits distinct behavior: it moves down during the spike event and up during a non-spike event, such as a toss as shown in Figure 3. Therefore, if the ball rises across consecutive frames during the action event, it is classified as the toss. Conversely, if it descends, the event is classified as the spike.

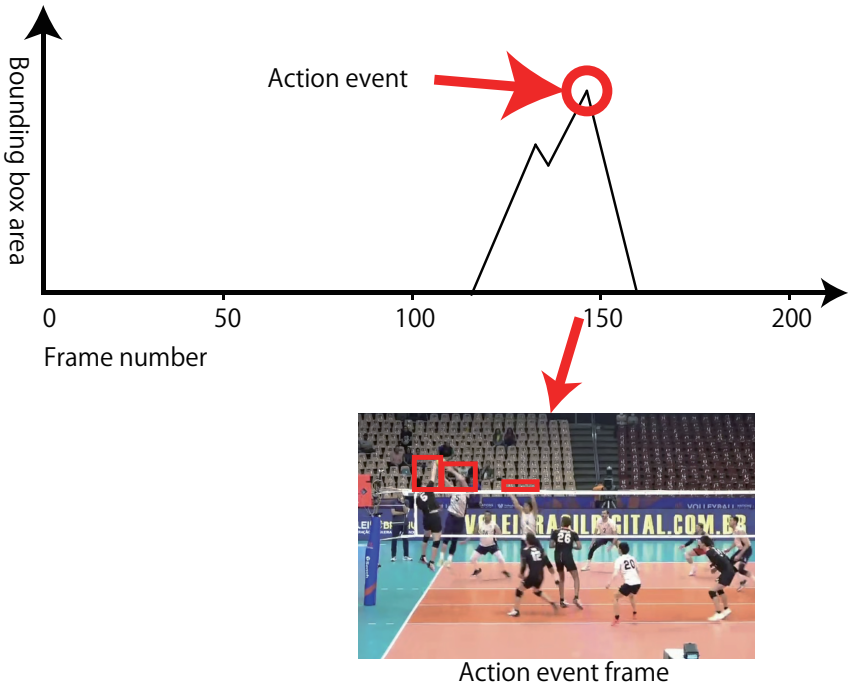

Figure 2: Transition of rectangular area for person detection

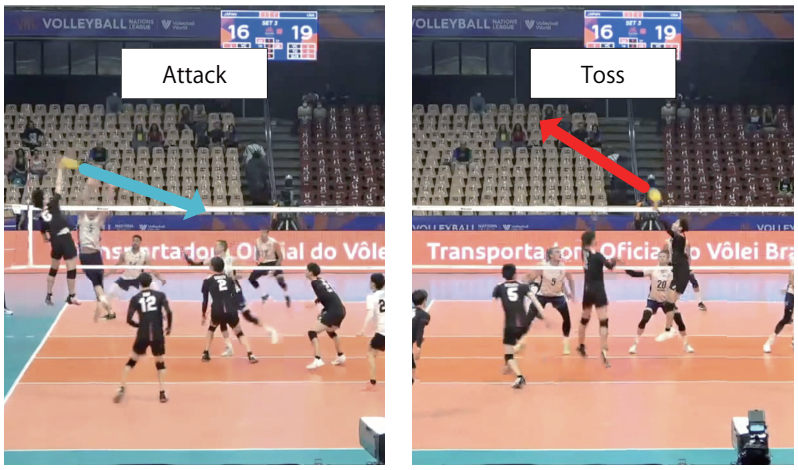

Figure 3: Directions of ball movement

3 Experiment and Discussion

In this section, the paper presents an evaluative experiment that utilizes the volleyball video[1] uploaded on YouTube, which provides a view of the full court from the end line side. In this study, the threshold N for player detection is set to 10. The spike event is a positive classification if it is detected by our method and visually confirmed. False classifications are not positive with an over-classification, that is the person is not detected, and that the action events is not recognized. The experimental results are provided in Table 1. There were 41

[1]YouTube: "MMG Volley Videos Japan", `"https://www.youtube.com/@VolleyJapan"` (verified in June 2023)

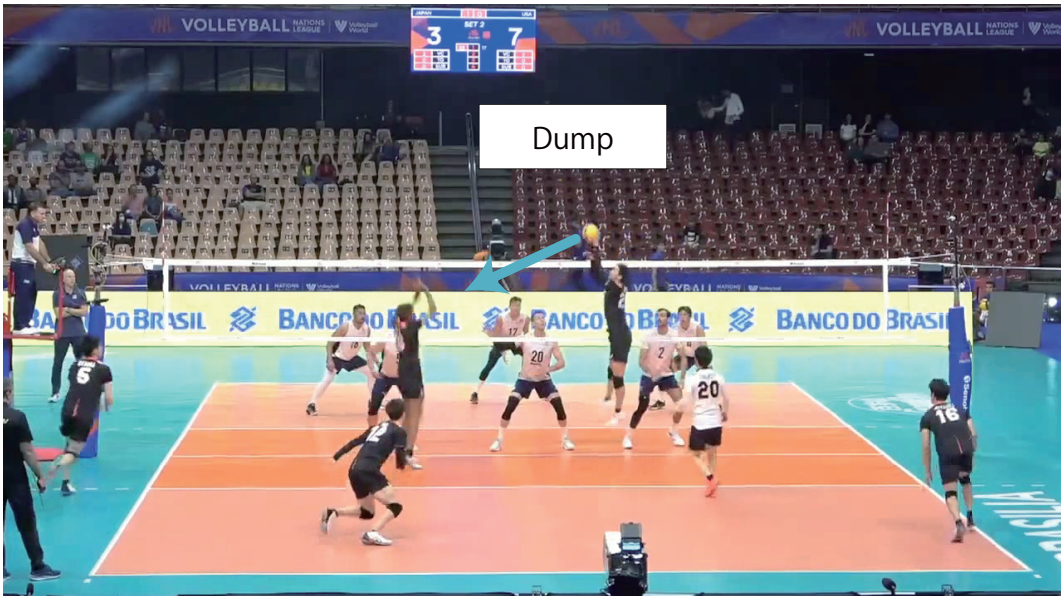

Figure 4: Over Classification example

Table 1: Comparison with existing method

Criteria	Our Method	Method of Hsu[3]	Comparison
Positive Classification	41	41	0
Over Classification	2	6	−4
Unclassification	3	3	0
Precision(%)	95	87	+8
Recall(%)	93	93	0

positive classifications, 2 over-classifications, and 3 unclassifications, yielding 95% precision rate and 93% recall rate. Our method uses ball and player detection and consequently leads to fewer instances of over-classification compared to Hsu *et al.*'s method [3]. An example of over-classification is mimicking the toss when the ball was strategically dropped on the opponent's court as shown in Figure 4.

4 Conclusion

In this paper the spike event classification approach for the volleyball match video was proposed, and was subjected to the experimental evaluation. Our method has 95% precision rate that is the 8% higher accuracy rate compared to the related method. It indicates a decrease in the number of over-classification events three times. A future direction is to enhance the current system to evaluate the performance of individual players, and to develop a method for analyzing consistent performance and effective spiking under specific situations. This will enable more strategic decision-making.

Acknowledgment

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