2ZK-08

Development of Bowling Ball Trajectory Visualization System Using Superimposed Ball Trajectories in Bowling Lane Video
ボウリングレーン映像におけるボール軌道の重畳表示による軌道可視化システムの開発

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1 Introduction

Over the recent years, ball trajectory analysis technology has played an increasingly important role in competitive sports [1–3]. For example, the technology for visualizing ball trajectories has already been implemented in the broadcasts of tournaments operated by the Professional Bowling Association of America (PBA). Specifically, lane-mounted sensors that can detect ball positions with high accuracy are used, and overhead images of the generated trajectories are displayed along with the broadcast [*1]. Other than that, there is also a system that can track thrown balls by using a monocular camera installed directly above a bowling lane, thus superimposing the trajectory on the lane in the broadcast image of official tournaments [4].

In recent years, the development of smartphone technology has led to the availability of training applications that utilize image processing and machine learning in a variety of sports. Therefore, the demand for sports coaching applications has increased. In bowling, it is important to hit the bowling pin at a specific angle continuously to obtain a high score. Therefore, it is effective to provide the trajectory of the ball in addition to the pitching posture for the purpose of analysis and coaching.

This paper proposes a system of superimposing ball trajectories by the projective transformation in a bowling lane video, which is tracked by the Kalman filter [5, 6]. This study aims to contribute to the development of applications for the practice of ball pitching.

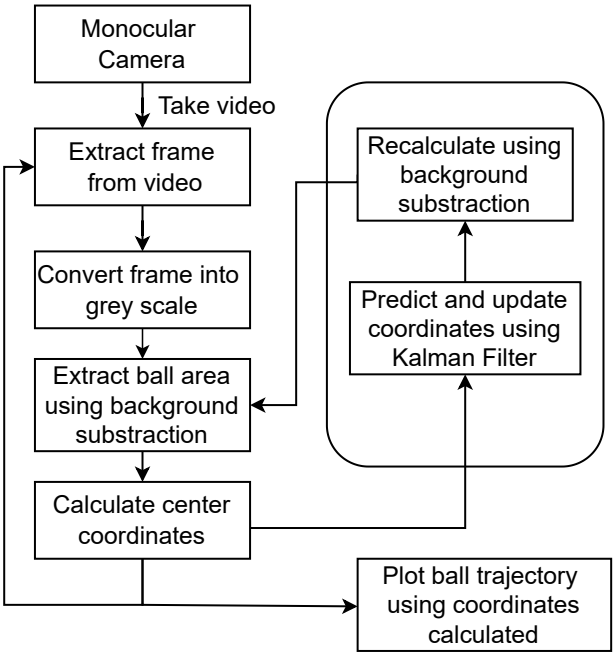

Fig.1 Overview of the proposed systems.

2 Implementation of the System

In this section, we will introduce the way to implement this method in the bowling alley. Figure 1 shows an overview of the proposed method. First of all, a wide lens camera for Raspberry Pi HQ Camera was installed behind the scoreboard to capture the pitching, as shown in Fig. 2. A smartphone app is then used to control the timing to take the video remotely. The captured video will be transferred to the server computer, and center coordinates of the ball will be calculated and projected. Lastly, a bowling lane video with the superimposed trajectory of the bowling ball displayed will be produced and can be accessed using any device like a smartphone or tablet, as shown in Fig. 3.

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[*1] https://www.spectobowling.com/

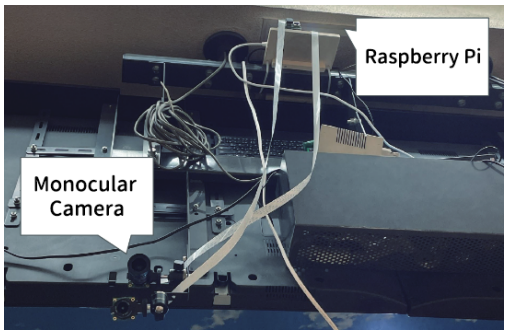

Fig.2 Installation of camera.

Fig.3 Multiple ball trajectories being superimposed on the bowling lane for comparison.

3 Observation and Future Prospects

In order to quantitatively evaluate the ball trajectories generated by the proposed method, the correct ball trajectories were manually generated and used to evaluate errors. The evaluation index is the average mean error of the correct trajectory in the short side direction of the lane as shown in Table 1.

Meanwhile, the average processing time is around 6.34 seconds. Since it takes about 10 seconds for a thrown ball to be returned to the player, this processing speed should be fine in the practical application of the proposed system.

Table 1 The average mean error of the correct trajectory.

	0-15	15-30	30-45	45-60 (feet)
ME (cm)	**3.50**	2.49	**3.85**	**5.40**

The ball trajectories can only be calculated using the static monocular camera at this phase. However, we are currently developing an AR application so players can use their smartphones to take photos and superimpose the ball trajectories on it for further analysis.

4 Conclusion

This paper proposed a ball trajectory visualization system for bowling coaching for general users. The system tracks the center coordinates of the ball and generates trajectories by repeating the prediction and correction by updating the Kalman filter. Observation confirmed the effectiveness of the proposed method.

Acknowledgement

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