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Real-time Analysis of Baseball Pitching using Image Processing on Smartphone

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Abstract

Pitching is one of the most important elements of baseball. Therefore, both professional and amateur players are interested in measuring their pitching performance, particularly their pitch speed. Conventional equipment such as radar speed guns can be used to measure pitch speed; however this approach is unpopular among amateur players because of its cost. Therefore, we proposed a vision-based speed-measuring method for baseball pitches and developed a smartphone application called iPhoneSG, which can measure the speed of pitched baseballs on a real baseball diamond in near-real-time using a standalone image-processing technique on the smartphone. Relative to conventional radar speed guns, which must be placed on the extended line of the ball trajectory, iPhoneSG widens the possible area of data acquisition. Considering the popularity of smartphones, iPhoneSG provides players with a convenient means of measuring pitch speeds. We confirmed the basic viability of the proposed method as implemented in our iPhoneSG application.

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1. Introduction

In professional sports, player performance is analyzed in order to improve competition outcomes. However, many of the relevant analyses require expensive equipment or a special environment. In baseball, pitching is one of the most important and interesting elements of the game. However, pitching analysis requires expensive equipment such as a radar gun or a high-speed camera.

Several studies have utilized vision-based approaches to detect and capture pitching motions. Theobalt et al.¹ analyzed pitching in a dark basement by attaching markers to the pitcher's hand and the ball. This method cannot be used in an actual baseball game. Moreover, it is difficult for amateur players or fans to prepare this environment.

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Hashimoto et al.² utilized four high-speed cameras for pitching analysis. This setup enables precise pitching analysis; however, the amateur players and fans find difficulties in using this setup.

We assumed that the primary users of our application would be amateur players and fans. Nowadays, smartphones have become very popular. In particular, iPhone is the most popular smartphone in Japan¹. Therefore, we considered this device for our study. Since many amateur players and fans already own smartphones, they will be able to use this application without acquiring any new equipment. In contrast to traditional radar speed guns, which must be placed on the extended line of the ball trajectory, our application, iPhoneSG, uses videos taken from the lateral direction of the ball trajectories. This approach widens the possible area of data acquisition (refer to Figure 1).

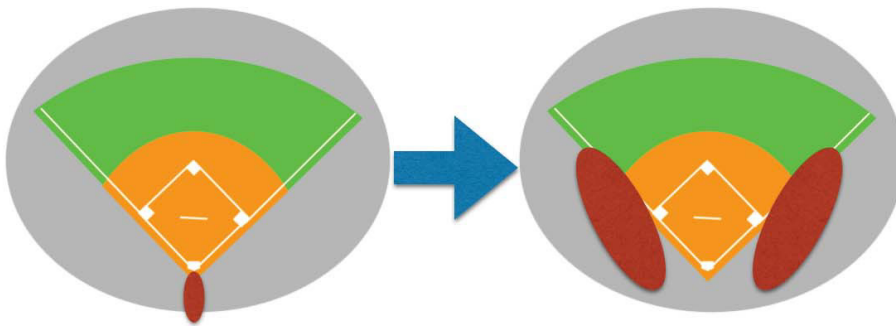


Fig. 1. iPhoneSG widens the possible area of data acquisition. The left image shows the possible data acquisition area for a commercial radar gun, whereas the right image shows the possible data acquisition area of iPhoneSG.

iPhoneSG³ tracks a pitched baseball and calculates its velocity. The tracking process can provide the trajectory of the ball. In this study, we focused on the deceleration of the pitched baseball, as knowing the pitch deceleration can help improve the user's pitching performance or that of his or her opponent or child. In this study, we employ this smartphone application not only as a speed gun substitute but also for pitching analysis.

2. Image processing for estimating the velocity of a pitched baseball

To detect and track a baseball, the following characteristics and restrictions of the game should be considered:

- The distance between the pitcher's plate and home base is constant.
- The size and shape of the baseball does not change in the video.
- It is white and round.
- There is only one baseball in each frame.
- It moves along an almost straight line and at a constant speed.
- It moves relatively fast.
- It is relatively small in a tracking context.

¹ Investigation by the following webpage, as of March 16, 2016: http://webrage.jp/mobile/data/sp_share.html

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