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Short Paper

Evaluation of Baseball Pitching Form by Ground Reaction Force Measurement and Video Analysis

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1. Introduction

Visualization technologies are utilized not only for physics, medical sciences, and engineering (Hosotani, 2006), but also for sports sciences (Ota, 2007; Page, 2006; Nosu, 2009). In addition to video analyses, many studies have reported kinematic analyses of sports participants by using various sensors (e.g., Humm et al., 1994; Watanabe et al., 2006). MacWillians et al.,1998 investigated the characteristic ground reaction forces in baseball pitching. They utilized force plates and a motion-capturing system using reflective markers and a five-camera video analysis system. The reflective markers were attached on the body of the subject. They measured and analyzed only experienced players to confirm the technical feasibility. However, because their motion-capturing system is utilized most effectively indoors, it would be difficult to use such a system outdoors.

The present paper proposes a method to evaluate the pitching form of baseball players by measuring the ground reaction forces and video analysis. The preliminary experimental results are presented. The originality of the paper is summarized as follows: (1) simultaneous measurements of ground reaction forces and wrist velocity are taken outdoors, and (2) a comparison between experienced pitchers and beginners is examined so that the system can be used to train beginners.

2. Evaluation Methods of Pitching Action

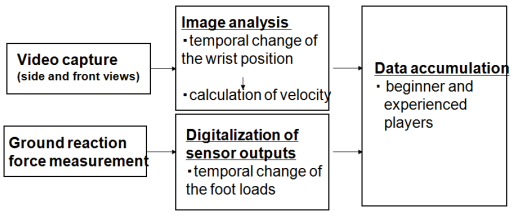


Fig. 1. System configuration

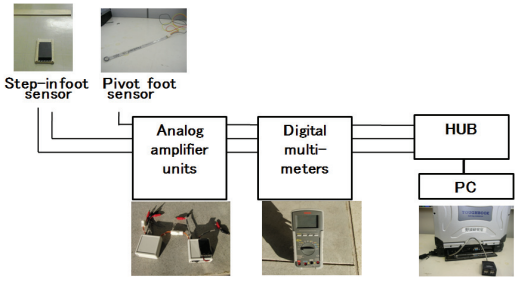


Fig. 2. Ground reaction force measurement setup

In general, overhand throwing in baseball pitching is described as a complex sequence of all body segments from ankles to upper extremities. The sequence is often described in terms of the velocities of segment endpoints. The motion-dependent interaction among segments is significant and helps explain the sequencing of segment motions, as follows. (1) When the velocity of the ankle movement reaches its maximum, the waist movement accelerates. (2) When the velocity of the waist movement reaches its maximum, the arm movement accelerates. In this way, the subsequent forward acceleration passes to the wrist and fingers of the pitching arm.

As shown in Fig.1, the system consists of two components: (1) video analysis of the pitching form and (2) ground reaction force measurements Video analysis is used to investigate the body posture, and ground force measurements show the loads of the pivot foot and step-in foot. Two high-speed video cameras (Casio EXilim Ex-F1) operating at 300 frames per second capture the front and side views of the movement. The video analysis software (Octal Easy 8 Core, ver. 5.5) traces the position of the wrist to obtain the temporal change of the wrist velocity every 0.5 second.

Figure 2 shows the setup of the ground reaction forces. The vertical loads of the pivot foot and step-in foot and the horizontal load of the step-in foot are measured by piezoelectric elements

(FlexiForce standard AZ201 sensor model, Nitta Corporation, Japan) every 0.5 second. The outputs of the piezoelectric elements are amplified, digitized and sent to a personal computer, which outputs the time-sequential changes of the ground reaction forces.

3. Results and Discussion

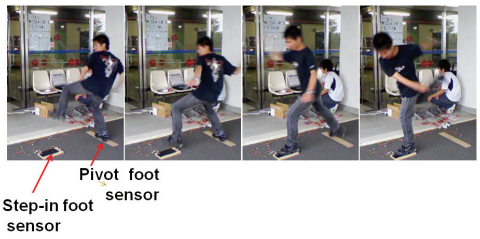
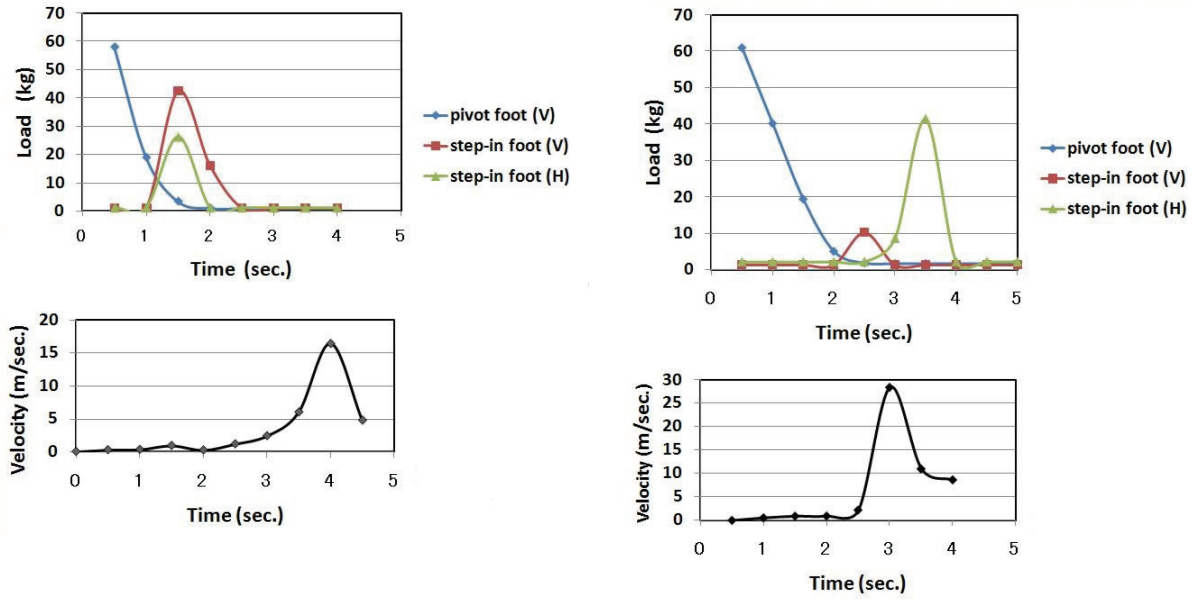


Fig. 3 System implementation

Figure 3 shows an experiment using the proposed system. The measuring commences when the step-in foot is fully lifted and the ankle moves forward.

Figure 4 shows the measured ground reaction forces and the velocities of the wrist of two university students: (a) a beginner and (b) an experienced player on the university baseball team. The velocity of the beginner reaches the maximum 2.5 seconds after the ground reaction force of the step-in foot reaches the maximum. In contrast, the experienced player reaches the maximum velocity 0.5 seconds earlier. This means that the experienced player releases the ball from his hand when the ground reaction force of the step-in foot becomes the maximum, so that the movement of the center of the gravity effectively creates the throwing power. The similar results were obtained from other beginner and experienced players. These results confirm the proposed system clearly captures the body action differences between the beginner and the experienced player.



(a) beginner (b) experienced player

Fig. 4 Measured ground reaction forces and the velocities of the wrist of two university students: (a) a beginner and (b) an experienced player. V: vertical force, H: horizontal force.

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