Motion Analysis of the Stand Technique for Men in the World Judo Championship

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1. Introduction

The motion of the stand technique for men in the “World Judo Championship” was analyzed by using commercially available video data. The purpose of this study is to examine the motion of an outstanding Judo participant, then learn the motions and train students to improve their techniques by imitating them.

2. Method

Commercially available “All Japan Judo Championship” video data was used to analyze the motion of the stand technique for men.

The video data’s frame rate was 30 frames per seconds. Frame width was 720 pixels. Frame height was 480 pixels. Therefore the aspect-ratio of this video data was 3 versus 2. The video data was disassembled into frame data called AVI, by using “XMedia Recode”. AVI is a file format for storing audio and video information developed by Microsoft Corp. Watching motion pictures of Judo were not helpful in recognizing the motions in detail. However, by converting the raw video data to AVI and watching the pictures with a “frame by frame playback” technique, every motion of the Judo movement could be stopped and viewed every thirtieth of a second. The motions performed by participants were then gathered and analyzed using a software system implemented by us based on the “Open CV”, which is an open source library for computer vision and image processing developed by Intel Corp. The positions of parts of the body were indicated manually on to the AVI picture, and then, put into a computer. The compensation of pixel values to the size of the space occupied by the participants was performed by using the known length of the “tatami” in the AVI picture. While considering aspect–ratio. By repeating these, the positions of the body were traced corresponding to the video frame rate. The compensated positional data of the body was gathered and then disassembled into x direction-time data and y direction-time data to calculate velocity. In this manner, the velocity of the specified body parts of the participant and thrown opponent were calculated. Then, the maximum velocities of the participant and thrown opponent were calculated. For these calculations, differentiation, least square data fitting, data smoothing, and scientific visualization of various graph drawings were performed by “Excel”, a component of the “Office” software suite developed by Microsoft Corp., and customized by using the macro function of “Excel”. Examples of these stand techniques were given as snap-shot pictures with descriptions of velocity at those moments according to the time progress.

3. Results and Discussion

One outstanding participant’s motion of “Uchi-mata”, From “O-uchi-gari” to “O-soto-gari”, and “Seoi-nage” were analyzed. The two contenders will hereafter be designated as Blue and White. Blue was wearing a Blue judogi. White was wearing a White judogi.

3.1 Uchi-mata

In this subsection, 100 kilogram men doing judo herein, the sequential motion of “Uchi-mata” was described.

“Blue”, while using his upper body, was attempting an “Uchi-mata” attack. At this moment his right leg up into his opponent’s (White) upper left inner thigh. This scene was depicted in Fig.1 and White left leg velocity was correspond to Frame 1 in the bar graph in Fig 7. The rising up velocity of White right leg was about 13.5 meters per seconds.

After 0.1 seconds, the right leg of Blue went to the horizontal position while his opponent was perched on his right hip. Blue was turning his waist and was raising his right leg. This scene was depicted in Fig.2 and White left leg velocity was correspond to Frame 3 in the bar graph in Fig 7. White body was moved to the opposite side of the screen. Therefore, downward velocity reduced to about 11 meters per seconds.

After 0.13 seconds, Blue was turning his body and head while his opponent was on his back and waist. Blue continued stretching his right leg upwards. White has rolled off Blue’s hip. This scene was depicted in Fig.3 and White left leg velocity was correspond to Frame 4 in the bar graph in Fig 7. Blue continued to lift White while reducing the velocity. The velocity became down to about 9.5 meters per seconds. Blue continued to lift White up strongly.

After 0.2 seconds, his opponent was airborne. Blue was pitched forward and twisting his upper body to the right while pivoting on the ball of his left foot preparing to flip White under him as depicted in Fig.4 and White left leg velocity was correspond to Frame 6 in the bar graph in Fig 7. At this moment the velocity became about 10 meters per seconds.

After 0.2 seconds, Blue has pulled his opponent strongly, and because of this motion, he joins Whites momentum and his pivot leg, which was his left leg loses contact with the “tatami”. While was turned over as depicted in Fig.5 and White left leg velocity was correspond to Frame 8 in the bar graph in Fig 7. The velocity became down to 7.5 meters per seconds.

After 0.13 seconds, White was falling toward the “tatami” with his back downward as depicted in Fig.6 and White left leg velocity was correspond to Frame 9 in the bar graph in Fig 7. Blue pulled his left hand strong. Therefore, downward velocity rose up rapidly to 15 meters per seconds.

The total time spent from starting “Uchi-mata” to full contact with the “tatami” was 0.77 seconds.


Fig.1


Fig.2


Fig.3


Fig.4


Fig.5

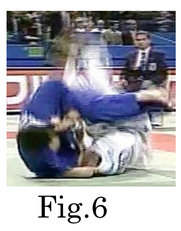
Fig.6

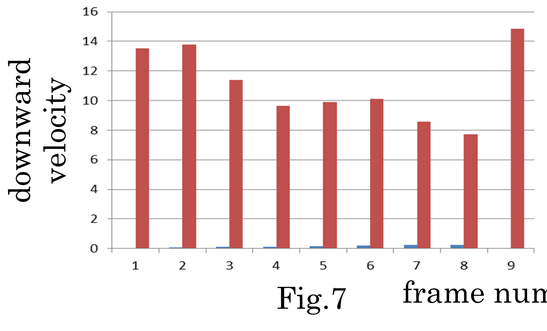

Fig.7

3.2 From O-uchi-gari to O-soto-gari

In this subsection, 100 kilogram mens judo “from O-uchi-gari” to “O-soto-gari” combination technique was described. White placed his left calf on the left inner thigh of his opponent and was pushing backward. This scene was depicted in Fig.1.

After 0.1 seconds, White’s right lower leg scissors inward and was placed on the back of his opponent’s left knee. White was pushing the right biceps of Blue with his left hand and was pulling on Blue’s left arm. This scene was depicted in Fig.2.

After 0.47 seconds, Blue was pushed back, because White was pushing Blue’s upper body back. Blue’s right leg was moving back to revive his balance. This scene was depicted in Fig.3.

After 0.63 seconds, White was balanced on his left leg, while locking his right leg on to Blues left leg. White scissored his right left on to his opponent’s left leg began thrusting his upper body forward. This scene was depicted in Fig.4.

After 0.43 seconds, White’s right leg was dislodged and he was pushing his opponent with his left leg. He was trying to revive his posture and was stepping forward forcefully. This scene was depicted in Fig.5.

After 0.1 second, White advanced with his opponent’s step back and then, he was moving his left leg forward which was his thrusting leg and was moving with his opponent’s upper body backward. This scene was depicted in Fig.6.

After 0.2 seconds, White put his left leg on to the “tatami”, faced his chest to his opponent’s and moving left-front was going to execute “O-soto-gari”.

After 0.27 seconds, White applied “O-soto-gari” to Blue’s right calf by using his right leg and pushed backward. But before doing this, White’s upper body has inclined forward. This situation was depicted in Fig.8.

After 0.6 seconds, White used his upper body to pull down his opponent by the momentum created by his body plunging forward and the upward sweep of his right leg. White has seized Blue’s upper right arm. This situation was depicted in Fig.9.

After 0.13 seconds, Blue tried to avoid falling down, but was turned over. This situation was depicted in Fig.10.

After 0.3 seconds, Blue fell down to the “tatami” as depicted in Fig.11.

The total time spent from the beginning to contact with the ”tatami” was 30.1 seconds.


Fig.1


Fig.2


Fig.3


Fig.4


Fig.5


Fig.6


Fig.7


Fig.8

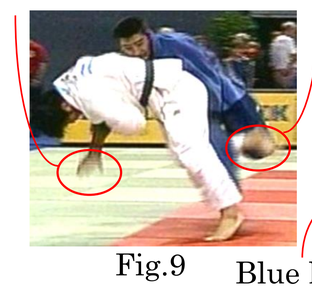

Fig.9

Fig.10


Fig.11

3.3 Seoi-nage

In this subsection, 100 kilogram mens judo “Seoi-nage” was described.

White slightly raised his left foot and both stood facing each other as depicted in Fig.1.

After 0.13 seconds, White was turning the direction of his hips and was twisting to the left, rising his legs up. White was attempting to execute “Seoi-nage”.

These scenes were depicted in Fig.2.

After 0.2 seconds, he placed both knees on the “tatami” in front of Blue. He shouldered his opponent, leaning forward and twisting.

After 0.07 seconds, he pulled his “Hikite” strongly pitching his upper body forward as depicted in Fig.4.

After 0.23 seconds, he turned his head and moved his left leg outward as depicted in Fig.5.

After 0.07 seconds, he shouldered his opponent onto his back and then rolled Blue onto his right shoulder as depicted in Fig.6.

After 0.23 seconds, Blue fell to the “tatami” with his right shoulder and waist as depicted in Fig.7.

After 0.27 seconds, Blue rolled onto the “tatami” touching it with his right shoulder and right hip. His chest was perpendicular to the “tatami” as depicted in Fig.8.

The total time spent from starting “Seoi-nage” to full contact with “tatami” was 1.2 seconds.


Fig.1


Fig.2

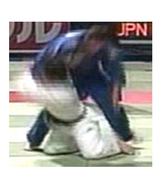
Fig.3

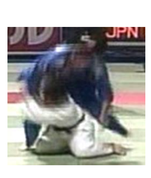
Fig.4


Fig.5


Fig.6


Fig.7


Fig.8

4. Conclusions

Three outstanding examples of the techniques called “Uchi-mata”, “O-soto-gari”, and “Seoi-nage” were analyzed visually by using a “frame by frame playback” technique. The downward velocity of the opponent was calculated by using the system implemented by us. This was a case study of motion analysis of Judo using commercially available video data. An example of an analysis method of Judo from an engineering point of view has been put forward here.