A short-time performance analysis in table tennis

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Abstract: a method of table tennis performance analysis is proposed. The key features of the proposed method is (1) the data collecting operation does not require a lot of time nor heavy workload, (2) providing performance indicators for the scoring possibility depends on the shot number. In the analysis, shot number of scoring is collected and used to automate collecting other kinds of data based on the assumption that each player hits the ball alternately. Moreover, shot number of scoring is also used to compute scoring percentage and losing percentage at each shot number. An analysis example verifies the proposed method can be performed in a short time and provide the data for performance analysis in table tennis.

Keywords: performance analysis, table tennis, shot number

1. INTRODUCTION

Recently, there has been growing interest in tactical and technical analysis with videos and/or statistics, so-called performance analysis, in sports science [1, 5-6]. The results of the analysis provide the information that coaches can use for optimizing their decision-making. There are several researches that aim to apply performance analysis methods for table tennis.

Malagoli et al. [3-4] considered the indicators for table tennis performance analysis. They listed and classified the data into the indicators about athlete, technique, tactics, equipment, playing conditions and psychology. Although the listing and classifying of data would be important to advance performance analysis in table tennis, we cannot perform analysis without the method to collect and analyze them. Zhang et al. [8] proposed the computerized method. The main idea of the method is to use neural network for analyzing enormous amount of data. Although we can analyze enormous amount of data by the method, there remains the problem how to collect such amount of data.

In table tennis, performance analysis is rarely seen in practical scene. One of the main factors for the problem is the enormous amounts of time and budget required for the data collecting operation of an analysis. In short, inefficiency of data collection methods makes it difficult for many practitioners to perform the analysis currently. However, there is no research aims to solve the problem.

In this paper, a short time method of performance analysis is proposed. The analysis results can be used as performance indicators for scoring probability that depends on shot numbers. The main idea of the method is to collect shot number[1] of scoring and to compute scoring percentage and losing percentage in each shot number.

2. ANALYSIS METHOD

The analysis of the proposed method is based on

[1] Shot number is the number of the shot in a rally, e.g. service is the first shot, service receive is the second shot, and so forth.

Table 1 An example of scoring percentage and losing percentage of a certain player at each shot number.

	1	2	3	4	5	6	7≤
scoring percentage [%]	13.8 (9/65)	20.3 (13/64)	36.4 (20/55)	18.2 (8/44)	13.3 (2/15)	14.3 (3/21)	19.5 (8/41)
losing percentage [%]	1.5 (1/65)	10.9 (7/64)	36.4 (20/55)	34.1 (15/44)	33.3 (5/15)	28.6 (6/21)	29.3 (12/41)

shot number. The shot number of scoring is collected and used to collect other data automatically and to compute statistics. In fact, shot number of scoring had been collected in previous performance analyses as ``number of shots in a rally'' [2, 7]. However, in the previous analyses, shot number of scoring was used as just the indicator of the length of rallies.

2.1 Shot number

In table tennis, many challenges are related to shot number. For example, to prevent an opponent from understanding the attributes (e.g. rotation, course and so forth) of a hit ball is one of the most important challenges in service (the first shot). When we have acquired ability to make opponents' service receive failure, to hit a ball strongly is one of the most important challenges in 3rd shot.

Based on such relation between shot numbers and challenges, scoring percentage and losing percentage at each shot number can be used as performance indicators. Let us consider the results about a certain player shown in Table 1. Since both scoring percentage and losing percentage are high at the third shot, we can guess the player often hits the ball strongly at the third shot, even if there is high risk for failure to return. At least, we can evaluate the third shots of the player do not contribute to win a match. Based on the results, to lessen the losing percentage at the third shot is important challenge for the player. To reconsider tactics, to acquire new techniques or enhance stability to return at third shot might be the solution to the problem. Thus, we can consider challenges of players in aspect of shot number.

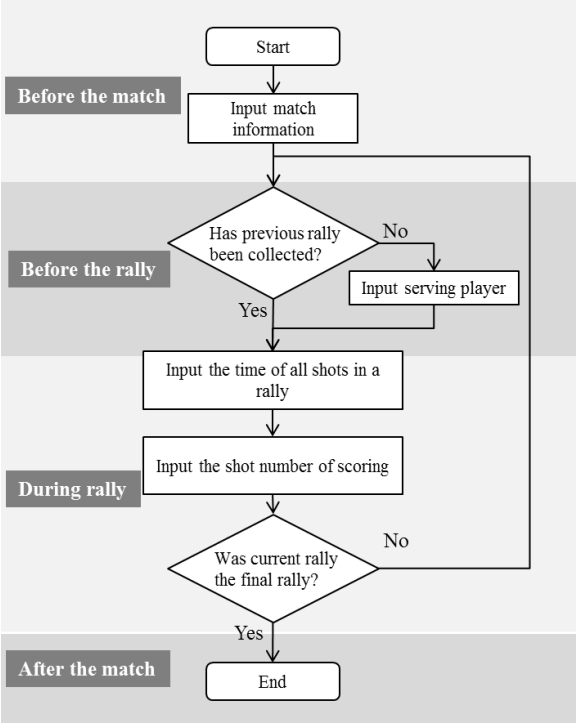
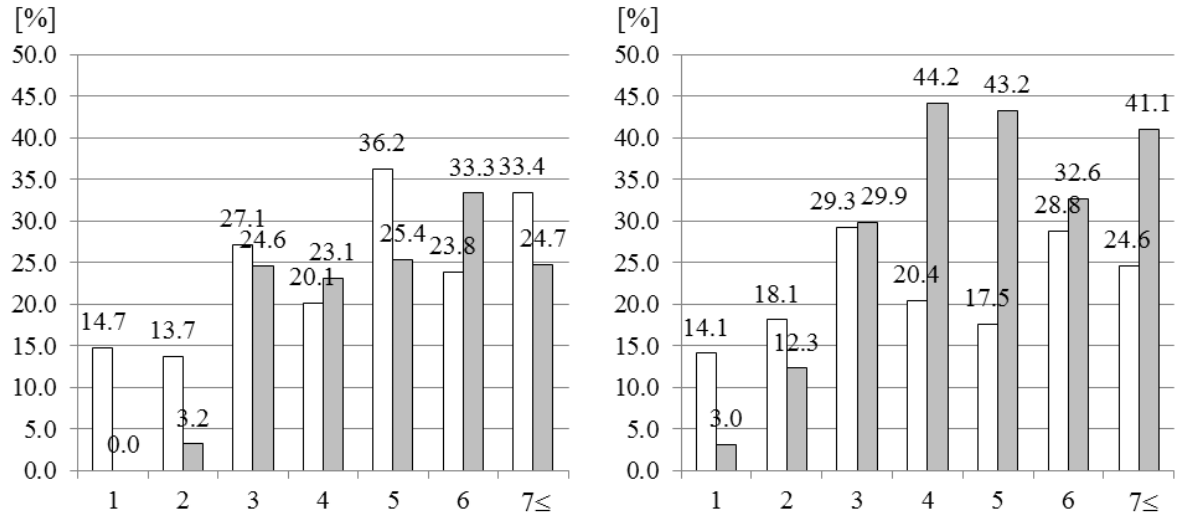


Fig. 1 Flowchart of data collecting operation at the proposed method. Match information is the attribute of a match, e.g. that players, competition name, etc.

2.2 Proposed method

With this method, we can collect many kinds of data in a short time. Fig. 1 shows the flowchart of data collecting operation in the method. For most of the rallies, all we have to do is to input the time of all shots in a rally and shot number of scoring. Through the operation, we can obtain following kinds of data: serving player, service receiving player, point score, game score, scoring player, losing player, shot number of scoring, the number of shots at each shot number. This automated data collection is based on the assumption that each player hits the ball alternately. Since the shot number of scoring can be



(a) Match 1 (b) Match 2

Fig. 2 Scoring percentage and losing percentage of player A at each shot number. White bar: scoring percentage (number of scoring shots / number of shots). Gray bar: losing percentage (number of losing shots / number of shots).

input easily by counting shots in a rally, the proposed method can be carried out in a short time without heavy workloads.

Scoring percentage and losing percentage at each shot number are computed from the shot number of scoring. Let us denote the number of scored rallies by *n*, the number of lost rallies by *m*, the shot number of scoring in *j*th scored rally by a_j, the shot number of scoring in *k*th lost rally by b_k, total number of shots at shot number *i* by S_i. S_i can be computed as:

$$S_i = \sum_{j=0}^{n} s_j^i + \sum_{k=0}^{m} t_k^i \quad (1)$$

$$s_j^i = \begin{cases} 0 & if\ a_j\ \%\ 2 \neq i\ \%\ 2 \\ 0 & if\ a_j \leq i \\ 1 & otherwise \end{cases} \quad (2)$$

$$t_k^i = \begin{cases} 0 & if\ b_k\ \%\ 2 = i\ \%\ 2 \\ 0 & if\ b_k \leq i+1 \\ 1 & otherwise \end{cases} \quad (3)$$

Where *x % y* denotes the remainder of x divided by y. Let us denote scoring percentage at shot number *i* by $\%W_i$ and losing percentage at shot number *i* by $\%L_i$. $\%W_i$ and $\%L_i$ can be computed as:

$$\%W_i = \frac{\sum_{j=0}^{n} w_j^i}{S_i} \quad (4)$$

$$\%L_i = \frac{\sum_{k=0}^{m} l_k^i}{S_i} \quad (5)$$

$$w_j^i = \begin{cases} 1 & if\ a_j = i \\ 0 & otherwise \end{cases} \quad (6)$$

$$l_k^i = \begin{cases} 1 & if\ b_k = i-1 \\ 0 & otherwise \end{cases} \quad (7)$$

3. ANALYSIS EXAMPLE

Analysis was performed to verify that the method can be done in a short time and provide results that can be used as performance indicators. The analysis subjects were four matches (412 rallies) played by a certain player (we call the player as ``Player A'') in an international competition. We call ``Match 1'' the two matches in which the scoring percentage of Player A was lower than opponent's one and ``Match 2'' the other two matches.

3.1 Results

Fig. 2 shows scoring percentage and losing percentage at each shot number. Data collecting was done by the end of each match.

4. DISCUSSION

Since data collecting was done by the end of the match, we can expect that the proposed method can be used for performance analysis in a competition venue. In a competition, opponents are decided right before the match. The proposed method enables us to carry out a performance analysis immediately after deciding the opponent of the next match.

We can analyze the features of Player A based on the results shown in Fig. 2. For example, when we focus on the scoring percentage, we can guess that Player A is good at the long rally started by Player A's services, because the values at the fifth and the seventh shot in Match 1 are high. However, this feature does not appear in Match 2. On the contrary, losing rate at the fourth, fifth, seventh shot are higher than the values in Match 1. From the differences, we can guess that the opponents in Match 2 used the techniques or tactics to make the fifth or seventh shot of Player A failure and could deal with the advantages of Player A.

There is, however, a limitation in the proposed method: the results cannot provide technical challenges concretely. In the case of the above example, we cannot consider what types of shot raised losing percentage at the fifth and seventh shot. Briefly, the proposed method certainly provides the point we should focus on, and we need other qualitative analysis, e.g. video observation, in order to mention detailed challenge.

5. CONCLUSION

In this paper, a method for table tennis performance analysis was proposed. The key features of the proposed method are (1) the data collecting operation does not require a lot of time nor heavy workload, (2) providing data that can be used as performance indicators for scoring probability depends on shot number. Experiments verified that the proposed method can provide useful data for table tennis analysis, and it can be done in a short time.

There remains a problem that the proposed method cannot mention detailed challenges. A development of the method to collect data related to detailed challenges will be the next challenge to advance performance analysis in table tennis.

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