The Evaluate Method for Shou-Men Striking of Kendo based on Fuzzy Reasoning

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ファジィ推論をもちいた剣道の正面打ちの評価法

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Abstract

In the case of evaluating the physical performance, the experts can evaluate the performance easily because of their knowledge which were accumulated as their experiences. Though the subjective evaluation were efficient, it is difficult to quantify because the experiences are unique for the experts and the knowledge are subjective. If these subjective evaluate criterion were defined as a numeric data, it can make the unique individual criterion accumulate as the experience data. The accumulating knowledge are very important to find the improving point for physical performance. So the purpose of this study is to propose the evaluation method for Shou-men Striking of Kendo based on Fuzzy Reasoning⁶¹, and indicate the efficiency of these evaluating method with comparing experts and systems. The following results were obtained:

- 1. We can express the knowledge of experts based on Fuzzy Reasoning and quantify the experience.
- 2. It is possible to evaluate the physical performance using the knowledge which were quantify
- by fuzzy rule data base.

3. We can construct non liner evaluation based on Experts knowledge.

1 Introduction

In the case of evaluating the physical performance, the experts can evaluate the performance easily because of their knowledge which were accumulated as their experiences. Though the subjective evaluation were efficient, it is difficult to quantify because the experiences are unique for the experts and the knowledge are subjective. If these subjective evaluate criterion were defined as a numeric data, it can make the unique individual criterion accumulate as the experience data. The accumulating knowledge are very important to find the improving point for physical performance. So the purpose of this study is to propose the evaluation method for Shou-men Striking of Kendo based on Fuzzy Reasoning, and indicate the efficiency of these evaluating method with comparing experts and systems.

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2 Method

2.1 Subjects

Subjects are 6 male student and graduate student of University of Tsukuba. The characteristics of subjects are shown in Table 1. The experts are 3 experts who have been practising Kendo and have got hight degree of grade. The characteristics of experts are shown in Table 2.

Table 1. The characteristics of subjects

	Average \pm SD
age	25.0 ± 2.83
height(cm)	167.0 ± 4.32
weight(kg)	72.2 ± 10.18
grade	2.2 ± 1.95
experience	7.7 ± 7.63

Table 2. The characteristics of exerts

	Average \pm SD
age	23.3 ± 2.36
height(cm)	178.0 ± 2.83
weight(kg)	76.3 ± 4.64
grade	4.33 ± 0.47
experience	15.0 ± 2.94

2.2 Fuzzy Reasoning

In the Fuzzy Reasoning, the proposition such as "degree is high " are defined as a fuzzy sets. So basing the membership value, the matching level can be calculated of each fuzzy rules. Then the Fuzzy Reasoning can estimate the approximate reasoning, which can calculate the result without input value and antecedent completely matching.



Figure 1. The Fuzzy Reasoning

2.3 Making membership functions

We make membership function basing the evaluation criteria from experts. We use pi-shape membership function⁶⁾. Each pi-shape membership function has 4 parameters (as, az, bs, bz) shown in Figure 2. We set each parameter from experts who had saw shou-men striking video.



Figure 2. The Pi shape membership function

These parameters are;

- · as the first quantile point
- · az the second quantile point
- · bs the 12.5 percentile point
- · bz the 87.5 percentile point

So, the 1.0 value of membership function are 50 percent of subjects. We made antecedent and consequent membership function these way.

3 Result

3.1 Derivation of experiences low

We use questionaire to construct fuzzy rule data base for making subjective evaluation quantify. We sort out the subjective evaluation respect to Shou-men striking on kendo. The following subjective rule are driven:

- If the Top of Shinai are not powerful, then extend the step width.
- If the up-and-down motion of loin, raise up the spine.

• If the loin was remain, quick the motion of left leg.

3.2 Measure system

The fuzzy rule data base were made by transforming IF-THEN rule from the subjective evaluation as mentioned above. The employing parameterswere shown Figure 3. The input variables were respectively, x1 (the velocity of the top of shinai), x2 (the up-and-down motion of the loin), x3 (the angle of body). And the output variables were y1 (the step width), y2 (the angle of body), y3 (the motion time of reft leg). IF-THEN rule using these parameters are

- Rule 1. IF X1 is no Power THEN y1 is widen.
- Rule 2. IF x2 is big THEN y2 is rise
- Rule 3. IF x3 is small THEN y3 is quick.

Figure 4 were shown the membership function of antecedent. And Figure 5 were shown the membership



Figure 3. The evaluation parameter



Figure 4. The membership function of antecedent



Figure 5. The membership function of consequent

subjects	outputs	Grade	experts
sub. 1	. no output		no problem
	no output	_	good posture
	no output	-	beautiful
sub. 2	no output	-	stiff
	raise the spine	1.0	no power
	no output		widen step
sub. 3	no output		don't see around
	raise the spine	0.99	raise the spine
	quick the motion of left leg	0.01	-
sub. 4	no output	-	-
	no output		move smoothly
	quick the motion of left leg	0.8	-
sub. 5	no output	-	-
	raise the spine	1.0	
	quick the motion of left leg	1.0	lean the body
sub. 6	no output	-	-
	no output	-	
	quick the motion of left leg	0.01	slow left leg

Table 3. The comparison between system output and experts



Figure 6. The output Diagram of Reasoning

function of consequent. These membership functions construct Fuzzy proposition based on IF-THEN rule. The output of this system were shown Table 3. The output from system which were constructed the way shown in Figure 6 was very smiler the experts one. The system make the experts knowledge re-useable.

4 Discussion

The output of system are similar the expert evaluation. So We can construct the system which can use expert knowledge and experiences. And our system can perform non-liner evaluation because of using expert knowledge and adapting IF-THEN rule. The fuzzy evaluating system are very efficient to evaluate human movement and sports activity.

5 Summary

The following results were obtained:

- We can express the knowledge of experts based on Fuzzy Reasoning and quantify the experience.
- 2. It is possible to evaluate the physical performance using the knowledge which were quantify by fuzzy rule data base.
- We can construct non liner evaluation based on Experts knowledge.

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