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

Mitsukimi SUGIMOTO ¹

Takaaki ASAMI ²

ファジー推論をもじった剣道の正面打ちの評価法

杉本 光公 ¹

浅見 高明 ²

1. Sport and Physical Education Center
2. Institute of Health and Sport Sciences, University of Tsukuba

1) 筑波大学体育センター
2) 筑波大学体育科学系
The Evaluate Method for Shou-Men Striking of Kendo based on Fuzzy Reasoning

Mitsukimi SUGIMOTO 1 Takaaki ASAMI 2

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 Reasoning 1), 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.

---

1. Sport and Physical Education Center
2. Institute of Health and Sport Sciences, University of Tsukuba
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 high degree of grade. The characteristics of experts are shown in Table 2.

Table 1. The characteristics of subjects

<table>
<thead>
<tr>
<th></th>
<th>Average ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>25.0 ± 2.83</td>
</tr>
<tr>
<td>height(cm)</td>
<td>167.0 ± 4.32</td>
</tr>
<tr>
<td>weight(kg)</td>
<td>72.2 ± 10.18</td>
</tr>
<tr>
<td>grade</td>
<td>2.2 ± 1.95</td>
</tr>
<tr>
<td>experience</td>
<td>7.7 ± 7.63</td>
</tr>
</tbody>
</table>

Table 2. The characteristics of exerts

<table>
<thead>
<tr>
<th></th>
<th>Average ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>23.3 ± 2.36</td>
</tr>
<tr>
<td>height(cm)</td>
<td>178.0 ± 2.83</td>
</tr>
<tr>
<td>weight(kg)</td>
<td>76.3 ± 4.64</td>
</tr>
<tr>
<td>grade</td>
<td>4.33 ± 0.47</td>
</tr>
<tr>
<td>experience</td>
<td>15.0 ± 2.94</td>
</tr>
</tbody>
</table>

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.

2.3 Making membership functions

We make membership function basing the evaluation criteria from experts. We use pi-shape membership function. 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.

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 questionnaire 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 parameters were shown Figure 3. The input variables were respectively, $x_1$ (the velocity of the top of shinai), $x_2$ (the up-and-down motion of the loin), $x_3$ (the angle of body). And the output variables were $y_1$ (the step width), $y_2$ (the angle of body), $y_3$ (the motion time of left leg). IF-THEN rule using these parameters are

- Rule 1. IF $x_1$ is no Powerful THEN $y_1$ is widen.
- Rule 2. IF $x_2$ is big THEN $y_2$ is rise
- Rule 3. IF $x_3$ is small THEN $y_3$ is quick.

Figure 4 were shown the membership function of antecedent. And Figure 5 were shown the membership function of consequent.
Table 3. The comparison between system output and experts

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

Figure 6. The output Diagram of Reasoning

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:
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 database.
3. We can construct non liner evaluation based on Experts knowledge.
The Evaluate method for Shou-Men Striking of Kendo based on Fuzzy Reasoning

References