Search-Based Construction of Finite-State Machines with Real-Valued Actions: New Representation Model

Igor Buzhinsky, Vladimir Ulyantsev, Fedor Tsarev, Anatoly Shalytso
St. Petersburg National Research University of Information Technologies, Mechanics and Optics
Computer Technologies Department

Problem Statement

Finite-State Machine:
- FSM = (S, s₀, E, A, δ, λ)
- S – finite set of states
- s₀ – start state
- E, A – event and action sets
- δ: S × E → S – transition function
- λ: S × E → A – output function

Problem:
- Control object has real-valued inputs and control parameters
- Tests are the examples of proper control
- Given a set of N tests (N = 20–30), an FSM should be constructed with behavior close to the tests

Tests (input data):
- in[i][t][k] – inputs (flight parameter values)
- out[i][t][k] – outputs (control parameter values)

Experiments & Results
- Intel Core 2 Quad Q9400 processor, four cores
- Three test sets, searching for FSMs with 3–5 states
- Comparison with the previous model (four states):

<table>
<thead>
<tr>
<th>Loop</th>
<th>Average fitness (ACO)</th>
<th>Average pitch error</th>
<th>Average roll error</th>
</tr>
</thead>
<tbody>
<tr>
<td>New representation model</td>
<td>0.9866</td>
<td>13.8881</td>
<td>2.1673</td>
</tr>
<tr>
<td>Model from Alexandrov et al.</td>
<td>0.9834</td>
<td>18.0996</td>
<td>5.1842</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Barbell roll</th>
<th>Average fitness (ACO)</th>
<th>Average pitch error</th>
<th>Average roll error</th>
</tr>
</thead>
<tbody>
<tr>
<td>New representation model</td>
<td>0.9862</td>
<td>2.2089</td>
<td>15.0424</td>
</tr>
<tr>
<td>Model from Alexandrov et al.</td>
<td>0.9854</td>
<td>4.4626</td>
<td>21.6019</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>180° turn</th>
<th>Average fitness (ACO)</th>
<th>Average pitch error</th>
<th>Average roll error</th>
</tr>
</thead>
<tbody>
<tr>
<td>New representation model</td>
<td>0.9899</td>
<td>1.6847</td>
<td>3.183</td>
</tr>
<tr>
<td>Model from Alexandrov et al.</td>
<td>0.9900</td>
<td>8.8672</td>
<td>54.1725</td>
</tr>
</tbody>
</table>

- Quality is improved
- Now it is possible to construct FSMs performing the turn
- Method run time = 20 minutes

Screenshots (FlightGear)

Publications

{buzhinsky, ulyantsev, tsarev}@rain.ifmo.ru