Optimal Control of Carbon Dioxide Exchange Process in a Membrane Oxygenator Using Particle Swarm Optimization Approach

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Abstract

The aim of this study is to evaluate the performance of Trickle-
Niche (TN) continuous cycling and particle swarm optimization
(PSO) method in tuning the optimal gains for Proportional-Integral-Derivative (PID) controller. A monophasic bidirectional
membrane blood-oxygenator incorporating a permeable substrate
was used to test the system. The oxygenator was subjected to a
variable resistive load to simulate different clinical conditions.
A validation test was performed to assess the mimicking ability
of the proposed model to the living system. The PSpice
software is used to simulate the system and to tune the best
PID controller. The results showed that the PSO algorithm is
able to tune the PID controller to the best performance.

Methodology, Particle Swarm Optimization

In this study, number of population released in 25, with
maximum iteration is 15 iterations. All the parameters such as
population size, maximum iteration and weight updated to the
fitness function used in this simulation are set heuristically by
driving it until the optimal parameters for optimal performance
is achieved.

Results

The performance index for PSpice and real-time

<table>
<thead>
<tr>
<th>Performance Index</th>
<th>PSpice</th>
<th>Real-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td>0.97</td>
<td>0.98</td>
</tr>
<tr>
<td>IAE</td>
<td>0.84</td>
<td>0.85</td>
</tr>
<tr>
<td>ITAE</td>
<td>1.58</td>
<td>1.54</td>
</tr>
<tr>
<td>ITAE</td>
<td>1.89</td>
<td>1.85</td>
</tr>
</tbody>
</table>

Discussions

The simulation results are in accordance with the
real-time results. It can be concluded that the PSO algorithm
is able to tune the PID controller to the best performance.

Conclusions

The use of PSO algorithm in tuning the PID controller
is a viable approach in tuning the PID controller to the
best performance. The simulation results are in accordance
with the real-time results.

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