Reactive Switching Protocols for Multi-Robot High-Level Tasks

Vasu Raman

California Institute of Technology

IROS
15 September 2014
Context

- cooperative, homogeneous team of robots
- nondeterministic environment
- Linear Temporal Logic (LTL)*
  task specification of task ϕ
- specific task assignment is unimportant
Context

• cooperative, homogeneous team of robots

• nondeterministic environment

• Linear Temporal Logic (LTL)* task specification of task \( \varphi \)

• specific task assignment is unimportant

Vasu Raman  
(vasu@caltech.edu)

Kiva Systems

Disaster-Response UAVs (EPFL)

*GR(1)
Approach

• model robot team as a switched system

\[
\dot{x}(t) = f_{\sigma(t)}(x(t)),
\]

mode = task assignment

• construct motion controllers for each mode

• synthesize switching protocol to realize \( \varphi \)
Key Contributions

• **Novelty**: concurrent task reassignment and planning via reactive synthesis

• **Computation**: switched system representation yields exponential improvement during synthesis

• **Virtualization**: explicit separation between motion controllers and robots
  – allows solution of otherwise infeasible tasks

Vasu Raman
(vasu@caltech.edu)
Example (simulation)

<table>
<thead>
<tr>
<th></th>
<th>r1</th>
<th>r3</th>
<th>r5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r2</td>
<td>r4</td>
<td>r6</td>
<td></td>
</tr>
<tr>
<td>Area1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r11</td>
<td>r9</td>
<td>r7</td>
<td></td>
</tr>
<tr>
<td>Area4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r12</td>
<td>r10</td>
<td>r8</td>
<td></td>
</tr>
<tr>
<td>Area3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thanks!

Reactive Switching Protocols for Multi-Robot High-Level Tasks

Vasu Raman

California Institute of Technology

Contact: vasu@caltech.edu

IROS
15 September 2014