Event Handling with Real E-pucks Using Threshold-Based Task Allocation

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Distributed Intelligent Systems - 17.12.2014
The experiment

1 cast of robot - 1 type of events

Events: red cylinders

Each event has to be handled by one robot

No consumption for a low demand

1x1m arena
5 e-Pucks
max. 10 events
(simulation and real hardware)
Experiments - robot behavior

At each iteration, the e-Puck:
- Takes one picture
- Calculates the stimulus: amount of red pixels in the picture
- Defines its state by comparing stimulus to thresholds (deterministic)
- Acts according to its state

Fig - Finite state machine describing the e-Pucks behavior
Picture analysis

- Stripes decomposition
- Use of the green channel to detect red pixels

Fig - Analysis of the image separated in vertical stripes
The experiment - tests

Comparison varying several parameters

- Group performance evaluation
- On webots:
  - 30 runs, 300 seconds each
  - Number of events: constant vs. decreasing
  - Threshold variation
- On real e-Pucks:
  - 3 runs, 300 seconds each
  - Number of events: constant
Experiments - axes, metric, parameters

\[ \text{metric} = \frac{n_{\text{events}}}{r_{\text{wheel}} \cdot \sum_{\Delta t} \sum_{i=1}^{2n_{\text{robot}}} |\alpha(t + \Delta t) - \alpha(t)|} \]

Also evaluated:

- Time to handle 10 events
- Runs that handled 10 events or more
- Robots activity / total time
Results - simulation in Webots (1)

VIDEO
Results - simulation in Webots (2)

<table>
<thead>
<tr>
<th>Homogeneous</th>
<th>T1</th>
<th>T2</th>
<th>New events</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>x</td>
<td>50</td>
<td>900</td>
</tr>
<tr>
<td>B</td>
<td>x</td>
<td>100</td>
<td>900</td>
</tr>
<tr>
<td>C</td>
<td>x</td>
<td>150</td>
<td>900</td>
</tr>
<tr>
<td>E</td>
<td>x</td>
<td>50</td>
<td>900</td>
</tr>
<tr>
<td>F</td>
<td>x</td>
<td>100</td>
<td>900</td>
</tr>
<tr>
<td>G</td>
<td>x</td>
<td>150</td>
<td>900</td>
</tr>
</tbody>
</table>
Results - simulation in Webots (2)

<table>
<thead>
<tr>
<th>Homogeneous</th>
<th>T1</th>
<th>T2</th>
<th>New events</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>80-120</td>
<td>900</td>
<td>x</td>
</tr>
<tr>
<td>H</td>
<td>x</td>
<td>0</td>
<td>900 x</td>
</tr>
<tr>
<td>I</td>
<td>x</td>
<td>300</td>
<td>300 x</td>
</tr>
</tbody>
</table>
Results - simulation in Webots (3)
Results - on real e-Pucks (1)

VIDEO
Results - on real e-Pucks (2)

**Table: Average activity**

<table>
<thead>
<tr>
<th>Run</th>
<th>Activity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>46 ± 22 %</td>
</tr>
<tr>
<td>Run 2</td>
<td>38 ± 21 %</td>
</tr>
<tr>
<td>Run 3</td>
<td>34 ± 21 %</td>
</tr>
</tbody>
</table>

**Percentage of robots activity for three different runs on real e-Pucks.**

**Diagram:**
- Metric value (t) vs. Time [s]
- Time interval from 0 to 300 seconds
- Metric value range from 0 to 2.5
Comparison between model and reality

- Metric curves similar
- Better performance of the simulation
  - less noise
  - less imperfections
  - more time during which robot are in idle state
Conclusion

**Take Home message**
- E-Pucks more efficient for a constant number of events
- Heterogeneous thresholds doesn’t improve our metric
- Simulated model as a good approximation of the reality

**Further work**
- Variable thresholds to manage the decreasing number of events
- Tests in more complex arena
Questions?

Thank you for your attention!