Distributed Sensing Using Market-based Task Allocation

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Introduction

- Task-Allocation strategies
- Multi-Level Modeling
- Results
Task-Allocation strategies Problematic

- Distributed Sensing
- Single Robot/Single Task
- Objective: minimize total energy consumption
Task-Allocation strategies Market Algorithms

- Instantaneous assignment
- Time-extended assignment
- Combinatorial auctions
Task-Allocation strategies Parameters

- Two market-based algorithm
- Number of robots 1, ..., 10
Multi-Level Modeling

- Sub-Microscopic (Webots)
- Microscopic (Matlab)
- Macroscopic (Matlab)
Multi-Level Modeling  Sub-Microscopic
Multi-Level Modeling PFSM
Multi-Level Modeling PFSM

Idle \longrightarrow \text{Active} \quad p_{i2a} \quad \text{Active} \longrightarrow \text{Idle} \quad p_{a2i}
Multi-Level Modeling Transition Probabilities

- Constant with time
- Failure rate analogy
  - \( f(t) = p \cdot e^{-pt} \)
  - Time in a state: \( \frac{1}{p} \)
Macroscopic Differential Equations

\[ N_a(k) = N_a(k - 1) \cdot (1 - p_{a2i}) + N_i(k - 1) \cdot p_{i2a} \]

\[ N_i(k) = N_{tot} - N_a(k) \]
Implementation

- Sub-Microscopic: webots (C/C++)
  - Export CSV files
  - Batch run with script

- Microscopic and macroscopic: Matlab
## Results Transition Probabilities

### Transition Probabilities for the Time-Extended Market

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<tr>
<th>$N_{rob}$</th>
<th>$P_{a2i}$</th>
<th>stddev</th>
<th>$P_{i2a}$</th>
<th>stddev</th>
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Results Model Validation

Instantaneous assignment

![Graph showing error percentage for different number of robots. The graph compares the Macroscopic Model and Microscopic Model.](image)
Results Model Validation

Time-extended assignment

![Graph showing error percentages for different numbers of robots. The graph compares Macroscopic Model and Microscopic Model.](chart.png)
Results Comparative Studies

![Graph showing energy consumption with different numbers of robots. The graph compares 'Time-Extended Assignment' with 'Instantaneous Assignment'. The energy consumption decreases as the number of robots increases.]