

Adaptive Patterns for Intelligent Distributed Systems: a Swarm robotics Case Study

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OUTLINE



- Starting point
- Architectural Adaptive Patterns
- Swarm Robotics
- Simulations
- Conclusion & Future Work

STARTING POINT



- Adaptation: ability of a system to change its behaviour to dynamic operating conditions
 - Single component
 - Whole system
 - Program each component
 - Achieve a global goal → swarm robotics
- Understand whether exploiting a specific pattern can be useful to implement an intelligent distributed system.

ARCHITECTURAL ADAPTIVE PATTERN



- A conceptual scheme that describes a specific adaptation mechanism → how to express adaptivity
- The use of an appropriate pattern help developers
- Guidelines that explain the features of each pattern → patterns' catalogue

REACTIVE STIGMERGY PATTERN



- Pattern based on swarm intelligence connected with the environment
 - coordination a large number of simple components
 - Explicit representation of the global goal is not possible
 - The collective behaviour results from components' behaviour adjusted by local environment conditions.
 - Components direct communication is not possible
 - Environment = strong stimulus

SWARM ROBOTICS

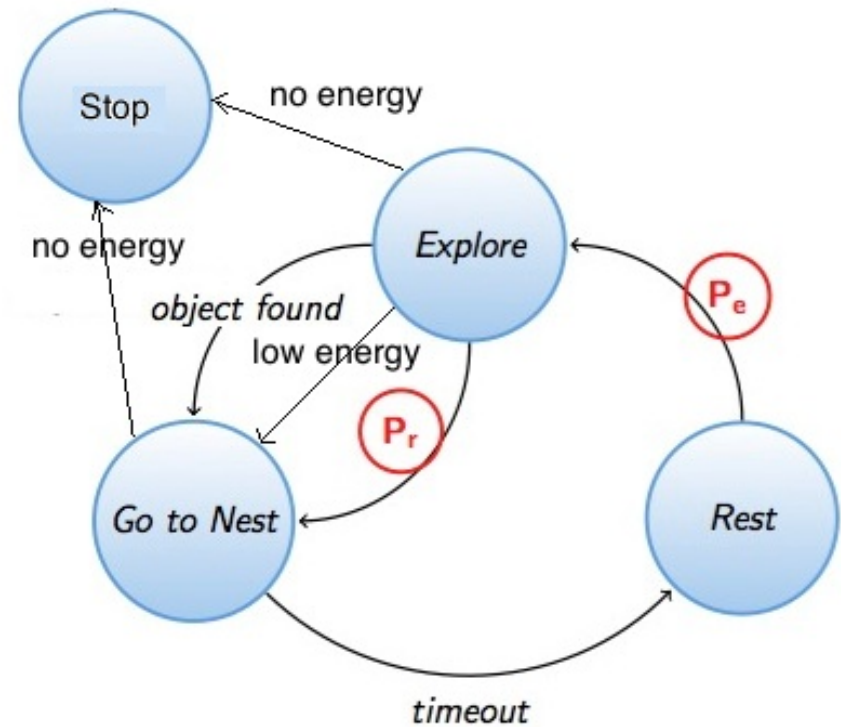
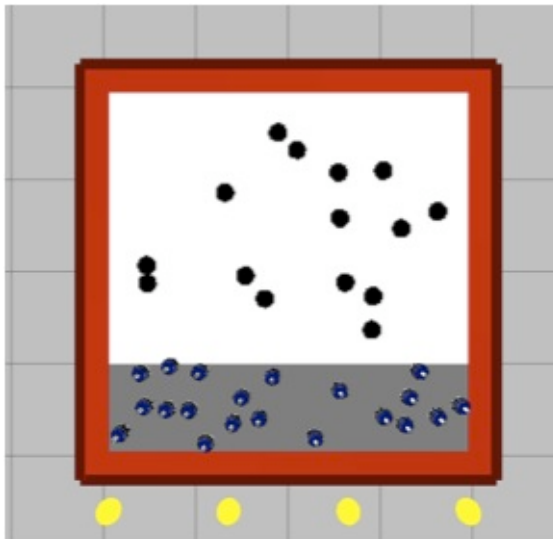


- Task allocation problem
- Goal of each robot: search for food items and bring them to the nest
avoid obstacles
- System goal: increase the nest energy
- Energy → batteries consumption → food items

SIMULATION



○ ARGoS

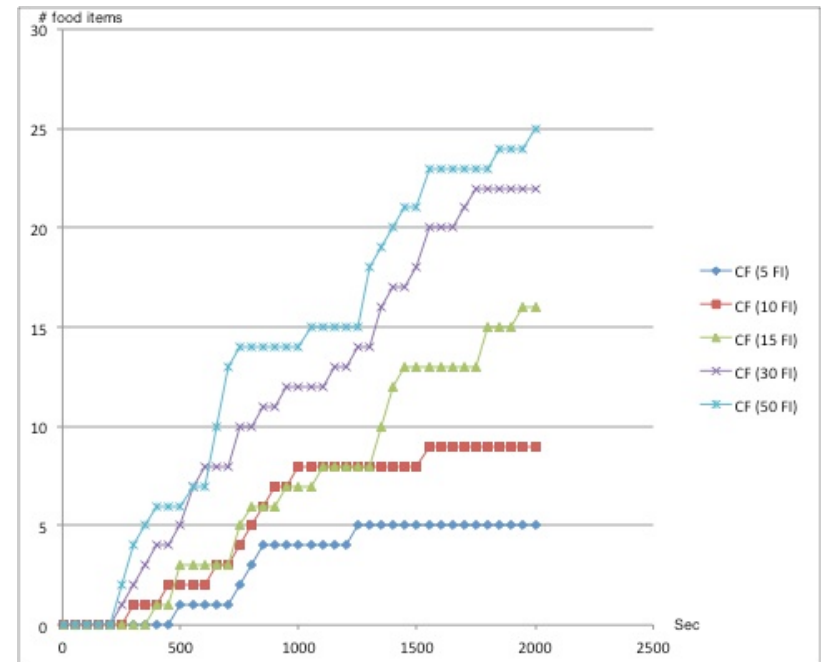
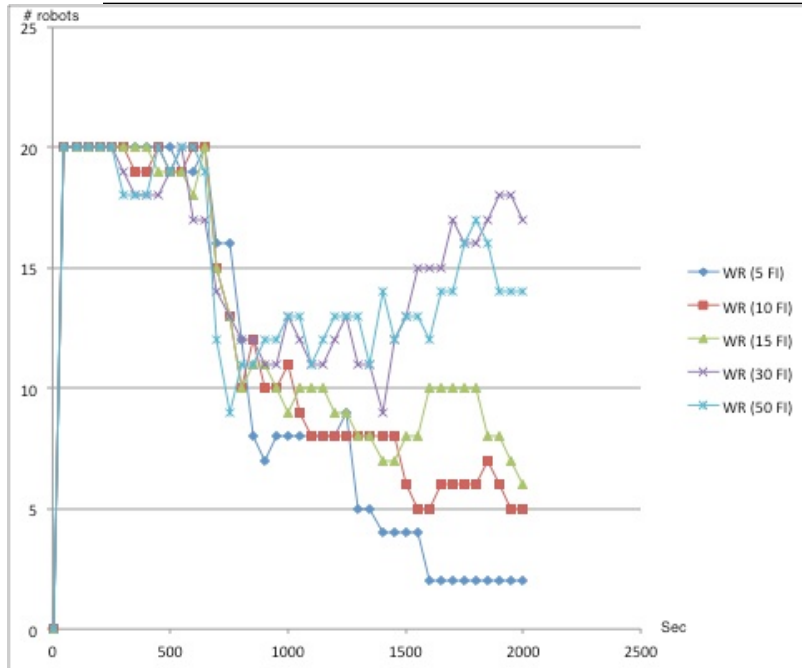


CHANGING # FOOD ITEMS



- Fix # robots: 20
- Variable # food items: 5 – 10 – 15 – 30 – 50
- If food items > 30 : average of battery consumption 400 \rightarrow constant increase of energy 100 \rightarrow robots stay out
- If # food items is low (5 or 10): robots stay out for long searching
- # collected items grows more rapidly when higher availability of food in the arena

SIMULATION RESULTS

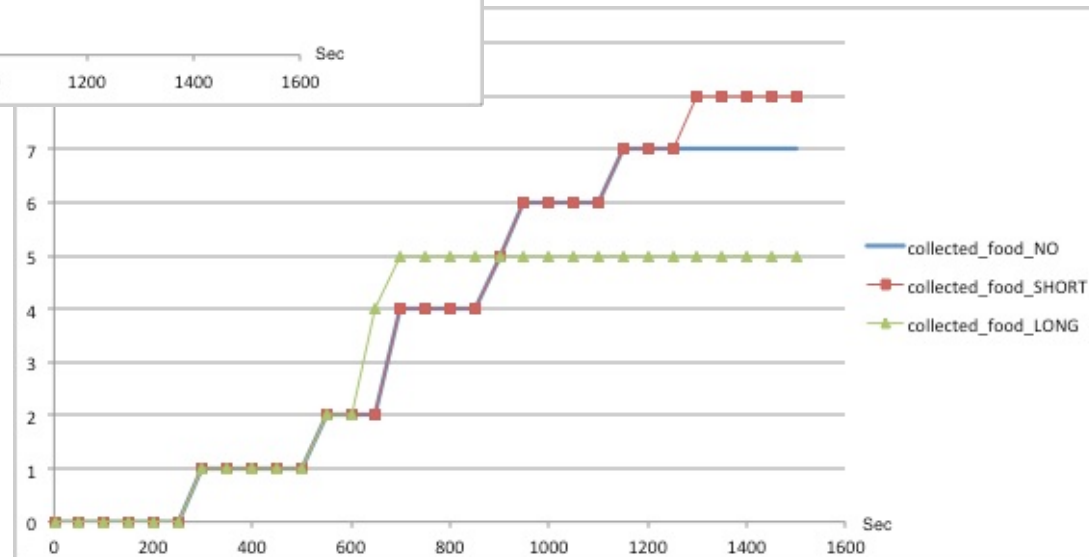
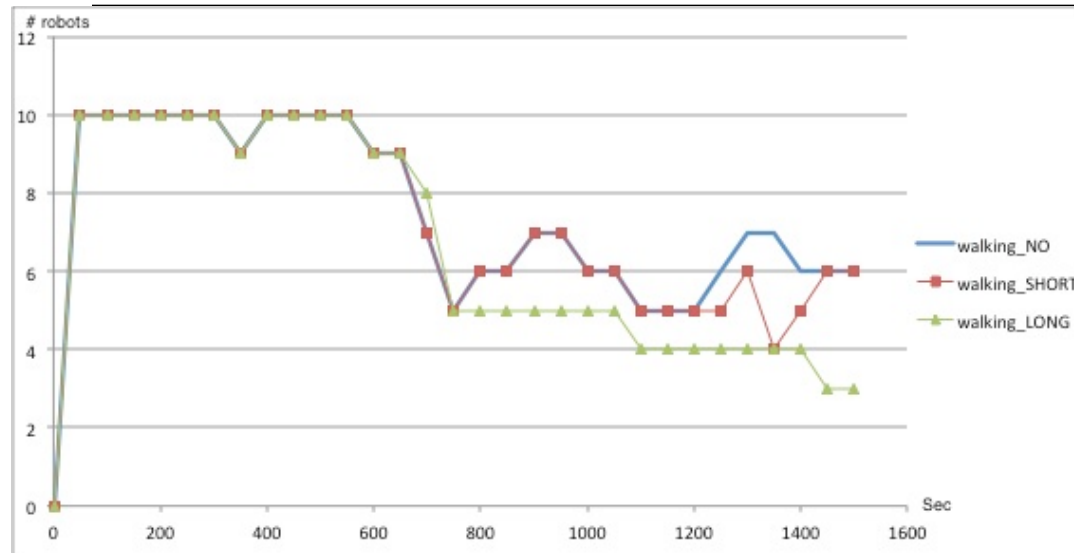


CHANGING PHYSICAL ENVIRONMENT



- Fix # robots: 10
- Variable kind of obstacles (no, short, long)
- # walking robots with a long obstacle sharply reduces → more difficult to find food and come back to the nest
- # collected items is larger when there is the short obstacle → forced the robot to change their path → this helps in finding the next way or a new food item

SIMULATION RESULTS



DIFFERENT PATTERN



- Scenario with long obstacle: decrease of performances
- direct communication between robots → map the environment
- Pattern with a direct communication between robots (based on negotiation)
- Information about the environment help to find food items and to localise the nest.

CONCLUSION



- Using an appropriate pattern → obtain an intelligent adaptive system even starting from components that behave in a probabilistic way and that have a limited knowledge
- Some patterns are more suitable than others because they better specify adaptation mechanisms for the involved components and for the whole system

FUTURE WORK



- Simulating others patterns
- Enable self-expression:
 - capability of changing the whole pattern that describes adaptation when the change of situation may require it

Thanks for your attention!!

Questions
?



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