

A Framework for Reconfigurable Robot Swarm Simulation

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IN THE future it is possible that swarms of micro and nanorobots are used for, but not exclusively, many applications in the biomedical field. These robots are foreseen to be massively produced and would have their computational power constrained with physical and electronic limitations that would make it necessary to adapt to their local environments by peer-to-peer reconfiguration. This work presents a simulator-based framework in which is possible to design the behavior of such type of robots while taking into account non-functional factors as time and energy consumption. Results are presented for a simple case with an educational minirobot and also for a prospective realistic case with ISWARM microrobots.

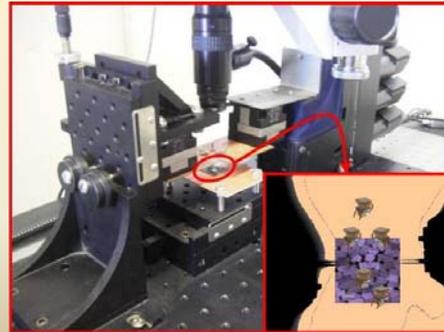
VISION

Microrobotic swarms in many applications, including those in the biomedical field: bacteria and microbes' analyses, drug developments, disease treatments, to name a few.

Many homogeneous microrobots are produced in series with similar characteristics:

- Few configurable sensors and actuators
- Limited computational resources, including memory
- Energy harvesting capabilities with small storage capacity

Nanobiocharacterization plant



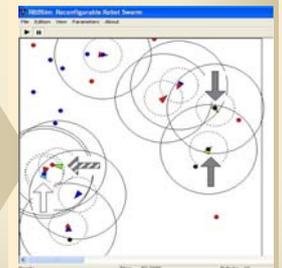
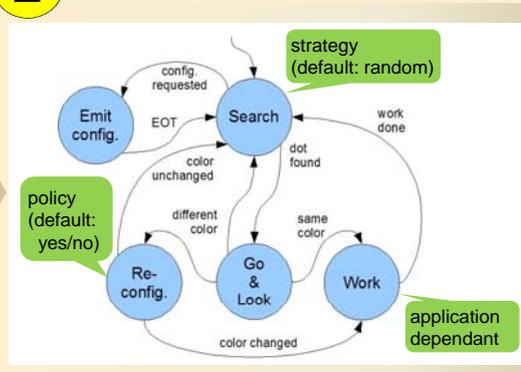
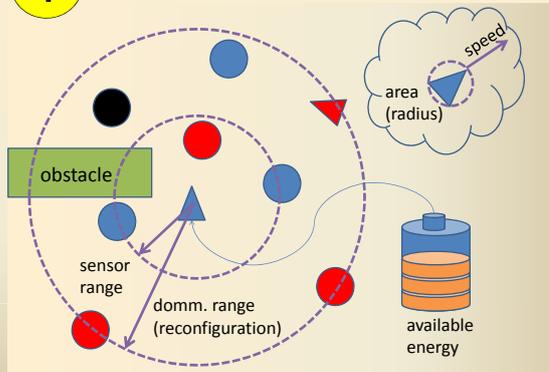
High-precision AFM probes mounted on robotic arms combined with low-precision microrobots configure this future plant. (Photo on the bottom-right side is a photo-montage with actual images of cantilevers with AFM tips, AFM of bacterial biofilm and I-SWARM robots.)

PROBLEM

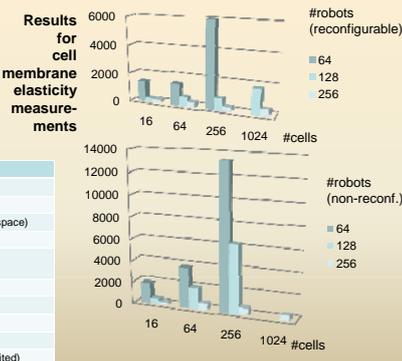
How to design the behavior of one such robots within a given application's context (*i.e.* by taking into account their constraints) so result swarm is functionally effective with a minimal cost in terms of time, energy and work.

SIMULATOR-BASED FRAMEWORK

- 1 Robot & environment parameter extraction
- 2 Robot programming on ASM template
- 3 Simulation



PROSPECTIVE CASE WITH I-SWARM



CONCLUSION

- ✓ Prospective applications of microrobots and nanohandling robots are very interesting but requires that robots can be produced in series and that can be easily programmed and reconfigured, including peer-to-peer operations.
- ✓ A toy problem (red & blue dot marking with 'red' and 'blue' robots) has been proposed and used to set up a framework to simulate a swarm of robots.
- ✓ The methodology to simulate these swarms includes robot and application's environment parameter extraction, and state programming.
- ✓ Repeated simulations allows designer to explore individual controlling algorithm search space in terms of time, energy and work.