Achieving Self-Sorting in Self-Assembly Systems

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The challenge is to build a simple efficient self-sorting systems.

- Few built physical systems with self-sorting capabilities
- Most systems are based on simulation

Observations:

This trial started with 4 vibrating modules at the corners of the water tank.

00:00

00:11

01:03

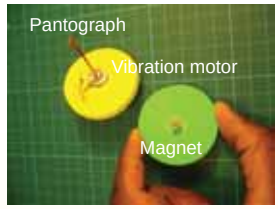
01:40

The yellow vibrating modules get along the middle of the water tank, thus the system segregated the modules into two groups : the vibrating yellow module's group and the passive green module's group)

Introdution:

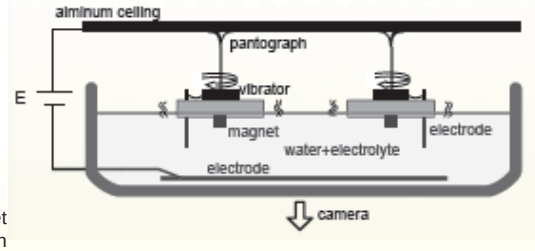
The ability of initially randomly distributed modules to segregate (or self-sort) into clusters of components with the same characteristics is of interest in the fabrication of micro and nanocomponent and could reduce the fabrication costs. In this work we propose a potential well-like interaction between modules to achieve the self-sorting behavior in a non-equilibrium distributed system.

Experimental setup



All the modules are equiped with a magnet aligned in a way such that they repel each other (north is always pointing up). The yellow module has a vibration motor (vibrating module) and the green module doesn't (passive module).

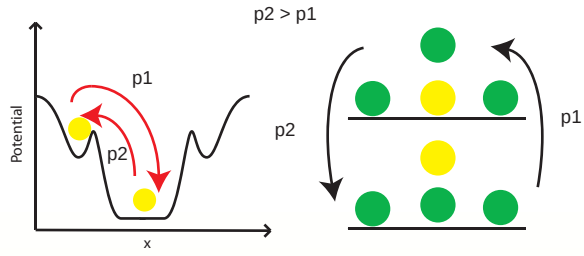
System Overview



The vibrating modules are powered using a pantograph system and can move using vibrating motors.

Hypothesis:

- The green modules have a comparable effect as a potential well. The random walk of yellow modules in virtual potential is similar to the random walk of yellow modules in the presence of green modules. What is this potential? The reconstruction of this virtual potential is possible by analysis of trajectories of yellow modules.
- The situation is also comparable to entropic forces in many particle systems. What is this potential? The reconstruction of this virtual potential is possible by analysis of trajectories of yellow modules.



If there was a potential well surrounding the yellow modules, we would also observe assembly in the center. The yellow modules are therefor subject to a potential well-like interaction created by the presence of the green modules. The self-sorting behavior can also be explained by the fact that, the probability p2 that the vibrating yellow modules move from the corners of the water tank to the middle is higher than the probability p1 that they move in the opposite direction.

Conclusion

We presented a non-equilibrium self-sorting systems composed of heterogeneous modules (vibrating and non-vibrating modules). The mechanism uses a potential-like interaction between the modules to achieve the self-sorting. Our work seems to provide a starting point for the study of the physical phenomena leading to the emerging sorting behavior especially the calculation of the and open new perspectives for the self-sorting of systems with more than two components.

References

[1] Miyashita, S., Kessler, M., Lungarella, M.: How morphology affects self-assembly in a stochastic modular robot. In: Proc. Int. Conf. on Robotics and Automation, pp. 3533-3538 (2008)
[2] Roderich Groß, Stéphane Magnenat, Francesco Mondana: Segregation in Swarms of Mobile Robots Based on the Brazil Nut Effect. In: Proc. Int. Conf. Intelligent Robots and Systems (2009)

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