Swarm of robots simulator

1er semana de las ciencias de la complejidad

17 de noviembre al 20 de noviembre 2015.

November 17, 2015.
Rosa G.CH. Barrera, Superior School of Computer Sciences, National Polytechnic Institute, Mexico City, Mexico
Luz N.O. Moreno, Superior School of Computer Sciences, National Polytechnic Institute,Mexico City, Mexico,
Genaro J. Martínez, Unconventional Computing Centre, University of the West of England, Bristol BS16 1QY, United Kingdom.,
Andrew Adamatzky, Bristol Robotics Laboratory, University of the West of England, Bristol BS16 1QY, United Kingdom.
Complex Systems Instituto Politécnico Nacional. Contact: zso.boo@gmail.com

Swarm of Robots?

If a robot can perform a specific task by itself… Can you imagine the work that can be done by hundreds of robots working all together?.

Swarms have emerged as a way to assimilate the behavior of nature like insects, school of fish or flocks; because this kind of conduct allows to perform complex tasks with simple rules.

A complex system consists of many diverse and autonomous but interrelated and interdependent components or parts linked through many (dense) interconnections. They cannot be described by a single rule and their characteristics are not reducible to one level of description. They also exhibit properties that emerge from the interaction of their parts and which cannot be predicted from the properties of the parts.

CELLULAR AUTOMATA

Cellular Automata (CA) can be contructed in one, two, three or more dimensions and can best explained by giving an example using Conway's rule. Start with an infinite grid of squares. Each individual square has 8 touching neighbors; typically these neighbors are trated the same (a "Moore neighborhood"), whether they touch a candidate square on a side or at a corner. We now fill in some of the squares; we shall say that these squares are "alive". Discrete time units called generations evolve; at each generation we apply a "rule" to the current configuration in order to arrive at the configuration for the next generation; in our example we shall use the rule below.

- If a live cell is tpuching 2 or 3 live cells (called "neighbors"), then it remains alive next generation, otherwise it dies.
- If a non-living cell is touching exactly 3 live cells, it comes to life next generation.

Throughout history, scientists have developed many researches of cellular automatons. Some of the most relevant scientists are mentioned below:

- John Horton Conway (Game of life).

The feature of his "game" that probably caused this intensive interest was undoubtedly the discovery of "oscillators" (periodics forms) and "gliders" (translating oscillators).

- Kilobot Harvard

The Kilobot swarm is a thousand-robot swarm designed to allow one to program and experiment with collective behaviors in large-scale autonomous swarms. Each robot has the basic capabilities required for an autonomous swarm robot (programmable controller, basic locomotion, and local communication), but is made with low-cost parts and is mostly assembled by an automated process. In addition, the system design allows a single user to easily and scalably operate a large Kilobot collective, such as "hands-off" programming, powering on, and charging all robots.

Project

This project consists in simulate as close as possible the swarm behavior.

It is worth mentioning the construction of physical robots is a complex task due to the limited resources.

So, the simulator is based on the observations of a few robots working all together (12 robots). Then, when we program the rules in a computer, we can simulate a swarm of robots with hundreds of them.

The simulator is based on cellular automatons, in which each robot checks if there is an object on its way, if so, they decide which path to follow (front, right, left, back).

When the simulator starts its operation and robots begin to interact, we can see very interesting results, that include wave propagation.

The Simulator was developed in Java, with an IDE named NetBeans.

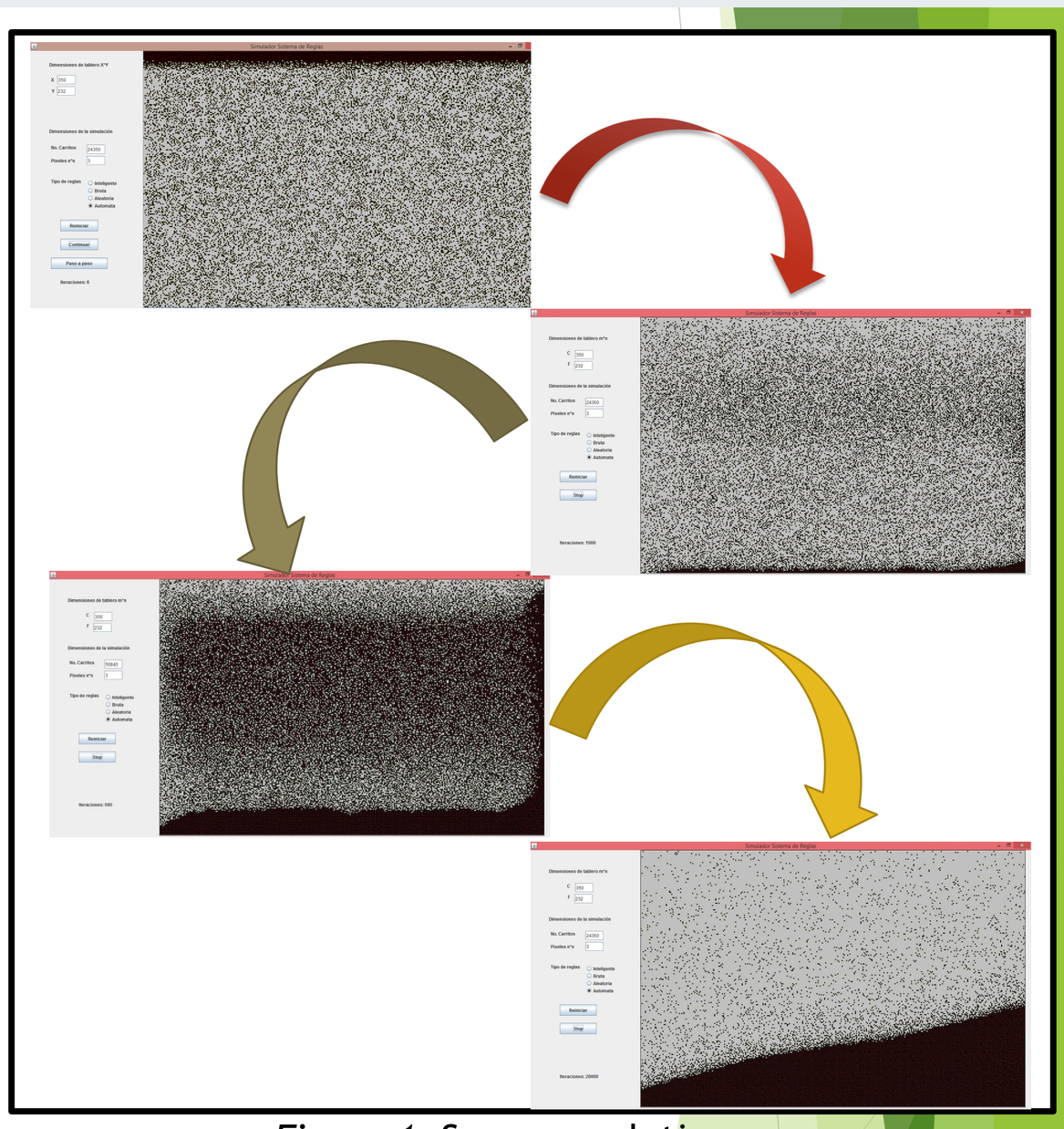

Figure 1. Swarm evolution.

Conclusion

- Currently, computing scientist complex systems are working on the building of unexpensive minirobots prototypes.
- We are working on the PC simulation of a swarm of robots in high densities through a rule system based on the behavior of a few mobile robots, so that, we checked the collaborative work to solve many problems of applied sciences.

Bibliography

1. **Primer Encuentro Interpolitécnico en Sistemas Complejos 2013. Comportamiento colectivo no trivial en mini robots.** *Luz Noé Oliva Moreno, Genaro Juárez Martínez* (ESCOM). 28 de agosto de 2013.
2. **Una Introducción a los Sistemas Complejos.** Juárez Martínez, Genaro. **URI:** http://www.repositoriodigital.ipn.mx/handle/123456789/13728. Febrero 24, 2013.
3. **Kilobot: A Low Cost Scalable Robot System for Collective Behaviors.** Michael Rubenstein, Christian Ahler, Radhika Nagpal IEEE Intl. Conf on Robotics and Automation (ICRA), 2012.
4. Game of Life Cellular Automata, Andrew Adamatzky. Springer Science & Business Media, 2010. 579 pages.
5. Simposio UNAM Complex System IPN, Centro de Ciencias de la Complejidad de la UNAM. Primer Simposio de Estudiantes del C3. Octubre 9, 2014