Research Meeting on Distributed Computing by Mobile Robots

Open Problems

1 Gathering fat mobile robots – A. Pelc

Robots are represented as closed unit discs situated in the plane. Robots are opaque (robots cannot "see through" other robots) and one robot cannot penetrate into another. Robots operate in asynchronous Look-Compute-Move cycles (CORDA model). The total number of robots is k and all robots know k.

The aim is for all robots to reach some gathering configuration defined as follows: the union of all discs representing robots is a connected set and all robots see that it is a connected set. See [1] for details of the model.

In [1] gathering algorithms are provided for an arbitrary initial configuration, for $k = 2, 3, 4$.

Question: Is gathering always possible for any $k > 4$? If so, provide an algorithm, if not - characterize gatherable configurations and give an algorithm for them.

2 The "Magneto" Problem: Can Robots Work Together in the Presence of an Adversary with a Magnet? – M. Kellett

A common assumption in work on robot compasses is that their agreement or error is in relation to some "magnetic north". What happens when an adversary (like Magneto from X-Men) introduces a new north that is actually a point on the plane on which the robots are working? Essentially, can robot algorithms be made to work in spite of "jamming"?

There are many possible variations on this problem.

- The effect can be absolute in that it replaces the previous magnetic field, thus creating a new north, or the effect could be a function of distance.
- The location of the magnet might be known to the robots or not.
- The robots might be able to communicate to help them locate the magnet or not.
- There might be more than one magnet.
- The magnet might not be a point. It could be a line or circle or some other shape. Think of robots working above the LHC at CERN.
- The magnet might move in some regular pattern or it might be an adversarial robot that the other robots can see.

3 The boundary patrol problem by mobile robots – J. Czyzowicz

A set of n mobile robots is working in the polygonal environment (a polygon with possibly polygonal obstacles in the Cartesian plane) having boundary P. Each agent has a visibility bounded by some constant $r \geq 0$. Each robot may move with a speed bounded by some constant. The agents have to perform a perpetual movement within the environment so that the maximal time interval T while a point of the boundary is not being seen by any robot is minimized.

More precisely, suppose that $P(t)$ denotes the set of points of P, each of which is being seen at time t by at least one robot, and $U(t_1, t_2)$ denotes the union of all sets of points $P(t)$ for $t_1 \leq t \leq t_2$. We want to minimize the value of T, so that for every value of $t^* \geq 0$, we have $U(t^*, t^* + T) = P$.

Different versions of the problem are possible: the bound on the speed may be common to all robots or robots may have different maximal speeds; the movement of the robot may be restricted (or not) to the interior of the environment.

References

[1] Czyzowicz, Gasieniec, and Pelc. Gathering few fat mobile robots in the plane. *Theoretical Computer Science*, 410:481–499, 2009.