

Simple Local-information-based Self-optimizing Algorithms in Grid Networks

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Recently molecular robotics, which uses molecules as robot components, has received a lot of attention as a new paradigm for artifacts [1]. To realize molecular robots, it is necessary to assemble a large number of molecular devices in a self-organizing manner. That is, each molecular device operates autonomously based on local information (obtained with their sensors), but the molecular devices as a whole should work cooperatively as a robot. This behavior is similar to that of large-scale distributed systems, where each computer operates based on local information but the computers as a whole work cooperatively as a system.

For this reason, it is natural to apply distributed algorithms (i.e., algorithms for distributed systems) to molecular robotics. Many distributed algorithms are proposed for many problems in literature. However, since such distributed algorithms are designed for computers to achieve the highest performance, the algorithms are complex and implementing them in molecular devices is difficult. To apply distributed algorithms to molecular robotics, it is necessary to develop simple distributed algorithms.

In this poster, we focus on grid networks, and introduce simple distributed algorithms for the shortest path construction [2] and the BFS (bread-first-search) tree construction. The shortest path is useful to transmit a signal from the source to the destination quickly, and the BFS tree is useful to transmit a signal from the source to all devices quickly. The algorithm for the shortest path construction (resp., the BFS tree construction) constructs the shortest path (resp., the BFS tree) from any initial path (resp., tree) in a self-optimizing manner. Both algorithms are simple: the algorithm for the shortest path construction uses only three rules and that for the BFS tree construction uses only four rules. These rules locally update a path or a tree with preserving the connectivity and can be executed asynchronously.

While the characteristics of the above distributed algorithms are suitable for molecular robots, it still requires some researches to implement them in molecular robots because the capability of current molecular devices is limited. As future work, we intend establishing a theoretical model for molecular robotics and developing distributed algorithms on the model.

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