Simulation of Firefly Synchrony using Two Dimensional Cellular Automata

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The research project in synchronic behaviors in the biological world gives insight to the self-organizing principle and communication protocols among fireflies. Our objective is to simulate firefly synchronization using two dimensional Cellular Automata and prove that the algorithms developed based on biological principles can be used to build communication mechanism in wireless networking. Algorithm inspired from firefly's behavior can be used in wireless sensor networks. Due to several restrictions including limited battery capacity, random deployment, and a large number of fragile sensor nodes, a communication mechanism should be energy efficient, adaptive, robust, fully distributed, and self-organizing. Individual fireflies are represented as simple oscillators operating in a two dimensional grid which have the following characteristics: 1) has an inner timer, 2) a flash frequency parameter adjustable to a given number of time units, 3) flashes lasting one clock-tick, 4) random motion across the grid, and 5) Moore's neighborhood rule for synchrony range. A target firefly resets its timer according to the neighbor's flash and coincides with neighbor's flash. So the synchronization is achieved. Cellular Automata are essentially rules of dynamic behavior and the rules describe the state of a cell for the next time step, depending on the states of the cells in the neighborhood of the cell. The evolving synchronization is successfully simulated by setting rules in Cellular Automata. It is also mathematically described and governed by the system of differential equations in the Kuramoto Model where the oscillators are considered as fireflies. Our simulation result shows that the communication among fireflies is efficient, scalable, and autonomously organized in massively distributed systems. Our simulation results can be easily used in simulating wireless sensor networks.