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Gathering a Euclidean closed chain of robots in linear time and improved algorithms for chain-formation. (English) Zbl 1499.68351


Summary: We consider formation problems for chains of disoriented, mobile robots with limited visibility operating in asynchronous rounds (ASYNC). More precisely, we study the CHAIN-FORMATION and the GATHERING problem. CHAIN-FORMATION considers a chain of robots between two stationary outer robots: Each inner robot has two identifiable neighbors, and the goal is to arrange the robots on the line segment connecting the outer robots. The GATHERING problem considers a closed chain (without outer robots) and demands all robots to gather on a single, not predefined point. The robots move in the Euclidean plane and are luminous, i.e., equipped with a light visible to the neighboring robots. At each point in time, the light can have one out of a constant number of colors.

We introduce a family of algorithms inspired by the HOPPER algorithm [J. Kutyłowski and F. Meyer auf der Heide, Theor. Comput. Sci. 410, No. 36, 3391-3405 (2009; Zbl 1191.68714)]. For the CHAIN-FORMATION problem, we modify the HOPPER algorithm so that we can guarantee a \((1+\varepsilon)\)-approximation to the optimal chain length (instead of a \(\sqrt{2}\)-approximation). Our main result is an asymptotically optimal algorithm for GATHERING of a closed chain of disoriented, luminous robots with limited visibility in the Euclidean plane. All algorithms have a worst-case optimal runtime of \(O(n)\).

MSC:
68T40 Artificial intelligence for robotics
68M14 Distributed systems
68U05 Computer graphics; computational geometry (digital and algorithmic aspects)

Keywords:
gathering; limited visibility; disoriented; runtime

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