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REACH GENERALIZED REULEAUX POLYGON FORMATIONS

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Abstract. *Formation of geometrical patterns is useful in many applications of networked multi-agent systems. From a more practical standpoint, pattern formation problems provide a first step towards more complicated cooperative tasks. In this paper, we investigate the nearest-and-farthest neighboring rule in continuous time, a distributed strategy for a group of anonymous homogeneous point agents to achieve a regular generalized Reuleaux polygon (a circle or a Reuleaux polygon). The algorithm results in a mathematical model of switched system, in which measurement uncertainties of the agents are also taken into account. We prove the global convergence of distributed point agents to the circumference of a regular generalized Reuleaux polygon with a desired diameter and predict the effect of parameter choices on the precise geometric pattern.*
Keywords: Cooperative control, Pattern formation, Reuleaux polygon

1. **Introduction.** Cooperative control of networked autonomous agents has attracted a great deal of interest within the past decade. Many researchers have initiated their studies on problems of formation control [1,2], consensus and rendezvous [3-5], coverage control [6,7], flow control [8], parallel computing [9], etc. Also, they have long envied and attempted to look for distributed solutions rather than centralized ones due to the absence of centralized entity and global information exchange. In other words, only local information is available to individuals, and it is expected that collective behaviors emerge from local interactions of individual agents utilizing the available local information [10,11].

The work done in this paper is inspired by Sugihara and Suzuki [12]. In their paper, a discrete time algorithm, which is simple and fully distributed, was proposed. The algorithm for each agent only used the relative position information of its farthest and nearest neighbors. It was demonstrated by simulations that a large number of agents can form an approximation of a circle with a pre-specified radius. Tanaka [13] later improved the algorithm by letting each agent treat the midpoint of its farthest and nearest neighbors as the center of the circle to be reached and adjust its position accordingly. It was verified by simulations again that the modified algorithm can generate a better approximation of a circle. Further studies were done in [14,15], including collision avoidance, converging to a common point.

Previous work has assumed idealized measurements and considered mostly achieving an approximation of a geometric pattern. In the paper, we would like to study the problem of achieving a precise geometric pattern, take into account the measurement errors, predict the effects of parameter choices on the final geometric pattern, and provide rigorous mathematical verifications. For this objective, a switching control law in continuous time is proposed for each point agent. Uncertainties are considered in the system model to simulate the measurement errors. Then, by non-smooth analysis, we prove that a group