ABSTRACT

INDEX No. 11/16/Maths./24

THESIS TITLE: Network localization and Pattern formation in some Network topologies under Discrete domain

SUBMITTED BY: Manash Kumar Kundu

A wireless sensor network is a wireless network consisting of a large number of small autonomous sensors spatially distributed in a region to monitor physical or environmental parameters. The knowledge of the physical location of sensor nodes is essential in many applications. Novel schemes have been proposed to determine the positions of the nodes in a network where only some special nodes called anchors are aware of their positions with respect to some global coordinate system. In these schemes, the nodes can measure the distances to their neighboring nodes and then try to determine their positions by using the distance information. This process of computing the positions of the nodes is called range based network localization or simply network localization. Now if instead of autonomous sensors, they are autonomous mobile robots, then the distributed system is called robot swarm where they collaboratively execute some complex tasks. Among many problems (eg. gathering, scattering, exploration), Arbitrary Pattern Formation (APF) is a classical problem in the field of swarm robotics.

The main focus of study of the thesis is network localization problem and pattern formation problem in some network topologies under discrete domain. The problems have been considered under the distributed environment.

Firstly, we study the network localization problem, i.e., the problem of determining node positions of a wireless sensor network modeled as a unit disk graph. Here we proposed a distributed localization scheme with a theoretical characterization of nodes that are guaranteed to be localized.

Then, we consider the problem of gathering (point formation) of a set of autonomous, identical, oblivious, asynchronous, mobile robots at a vertex of an anonymous hypercube. We have shown that the problem is unsolvable if the robots do not have multiplicity detection capability. With weak multiplicity detection capability, the problem is solvable in an oriented hypercube. Our proposed algorithms are optimal with respect to the total number of moves. Next, we are solving APF on infinite grid with asynchronous opaque robots with lights. The robots do not share any global co-ordinate system. The main challenge in this problem is to elect a leader to agree upon a global co-ordinate where the vision of the robots are obstructed by other robots. Since the robots are on a grid, their movements are also restricted to avoid collisions. The aforementioned hardness are overcome to produce an algorithm that solves the problem. Lastly, we extend the result APF on infinite grid to more realistic opaque fat robot model.

Buddhadeb Sau 03/01/2023.

Prof. Buddhadeb Sau

DR. BUDDHADEB SAU
Professor
Dept. of Maths., Jadavpur University
Kolkata - 700 032, INDIA

Manash Kumar Kundu 03/01/2023

Manash Kumar Kundu