Consensus-based Robotic Formation Control

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Our research is focused on proposing a new algorithm for formation control based on consensus equations. This algorithm is suitable for the networks where there is a very limited range of communication between the robots. Most existing formation control strategies can be characterized as: behavior based, leader-follower, graph-theory based, artificial potential field, and others. Each strategy has its own advantages and disadvantages. We have applied consensus-based algorithms to implement leader-follower based and graph-theory based formation control.

In our research model implementation, we considered all the robots to have the following properties. Decision Making**:** All the robots have a controller on board that allows them to make computations to carry out the desired task. Sensing the Position**:** All the robots can sense their current position and the angle of orientation with respect to its origin. Moving Autonomously**:** All the robots can move freely within the environment based on the computations from the controller. Communication**:** All the robots are equipped with communication devices, that allows them to send and receive messages within their communication range.

Challenges addressed by our newly implemented consensus-based algorithm are itemized. 1) Limited range communication, as each robot can only communicate with the robots that are in its limited communication range, the algorithm can handle data transfer between all the robots to agree on a formation; 2) Obstacle avoidance, so the algorithm makes sure to avoid obstacles between the robots when they are traveling to their destination position. 3) Deadlock prevention, to avoid the deadlocks when the robots are waiting for the data from each other. 4) Race condition avoidance, so that no two robots try to occupy one destination point.

We used the Robotic Operating System (ROS) to simulate the behavior of robots. ROS is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms. We implemented the algorithm on turtlebot robots using Gazebo simulator.