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Formation control of multiple mobile robots

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Keywords: mobile robots, formation control, hybrid approach, non holonomic constraint, behavior based.

We propose the method for the mobile robots with non holonomic constraint moving in formation.

Because a mobile robots belong to the non-linear systems, their control are difficult. Abobe all, since a wheeled mobile robots belong to the drift-free affine systems, their control are very difficult. Therefore, in the mobile robots literature, we used I/O linearization, neural networks, heuristics technique, and so on.

In contrast, we use the other approach that attends to the interaction with the environment in the working area of the mobile robots. This approach emphasizes the behavior that dynamically changing to interact in the enviorment. We use the behavior as the descrete behavioral parameter determinated symboricaly. This approach is called the behavior-based approach. The behavior-based is well known to be robust for the changing environment. Because this approach is not holomorphic, it has the problem when we require the reliability.

In recent years, hybrid approach is attended. This is the new method which combine the dynamical approach with the descrete approach. In our study, we address the hybrid approach for the behavior of the mobile robots, and apply to the formation control of the multiple mobile robots.

The formation is the moving with the mobile robots as the geometorical form. The moving in formation has many advantage not only transporting

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large objects, exploring an area for surveillance, and fault tolerance, but also applying to the car platoon, the formation flight of the aircraft, and space craft.

In the formation control, we often have the point of view. One is the control system, the other is the information flow.

From the view of the contorol system, We use the approach which dynamical or descrete, when we study the problem of the formation control. In the dynamical approach, we consider the formation as the virtural link. The other approach, we use pre-discribed behavior for the mobile robots.

From the view of the information flow, we use the three approaches which are centralized, leader-following, and decentralized. The centralized is the making formation quickly, but weak for the fault-tolerance. The decentralized is the strongly fault-tolerance, but making formation slowly. The leader-following is an intermidiate approach between centralized and decentralized.

We address the formation control using dynamical from the system view, and leader-following from the information flow. We use the $l - \psi$ control method[Des98]. The $l - \psi$ method is able to converge the relative distance, and relative angle from leader to follower. This method is able to make formation certainly, but found the some problem in the conputer simulation. For the solution of this problem, we propose the hybrid approach. This approach is the switching strategy which is based on the relative angle from the leader to the follower.

We examined this approach in the computer simulation. In the formation changing, our approach is stable compared to $l - \psi$ method not only in the trajectory, but also in the velocity and the angular velocity. In the changing the behavior of the leader, our approach is stable too.

Applying to the real robot, we examined our approach with steering constarint. They are stable, too.

Since our approach focuses on the dynamical control, the coordinates are central focus on the leader. The problem of the composition rate is a future work.

References

[Des98] Jaydev P. Desai. *Motion Planning and Control of Cooperative Robotic Systems*. PhD thesis, University of Pennsylvania, 1998.