DISPUTATION I MATEMATIK
Tove Gustavi

skall disputera på avhandlingen

Control and Coordination of Mobile Multi-Agent Systems

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Abstract of the thesis

In this thesis, various control problems originating from the field of mobile robotics are considered. In particular, the thesis deals with problems that are related to the interaction and coordination of multiple mobile units. The scientific contributions are presented in five papers that together constitute the main part of the thesis. The papers are preceded by a longer introductory part, in which some important results from control theory, data processing and robotics are reviewed.

In the first of the appended papers, two stabilizing tracking controls are proposed for a non-holonomic robot platform of unicycle type. Tolerance to errors and other properties of the controllers are discussed and a reactive obstacle avoidance control, that can easily be incorporated with the proposed tracking controls, is suggested. In Paper B, the results from Paper A are extended to multi-agent systems. It is demonstrated how the tracking controls from Paper A can be used as building blocks when putting together formations of robots, in which each robot maintains a fixed position relative its neighbours during translation. In addition, switching between the different control functions is shown to be robust, implying that it is possible to change the shape of a formation on-line.

In the first two papers, the tracking problem is facilitated by the assumption that the approximate velocity of the target/leader is known to the tracking robot. Paper C treats the case where the target velocity is neither directly measurable with the available sensor setup, nor possible to obtain through communication with neighbouring agents. Straight-forward computation of the target velocity from available sensor data unfortunately tends to enhance measurement errors and give unreliable estimates. To overcome the difficulties, an alternative approach to velocity estimation is proposed, motivated by the local observability of the given control system.

Paper D deals with another problematic aspect of data acquisition. When using range sensors, one often obtains a mixed data set with measurements originating from many different sources. This problem would, for instance, be encountered by a robot moving in a formation, where it was surrounded by other agents. There exist established techniques for sorting mixed data sets off-line, but for time-depending systems where data need to be sorted on-line and only small time delays can be tolerated, established methods fail. The solution presented in the paper is a prediction-correction type algorithm, referred to as CCIA (Classification Correction and Identification Algorithm).

Finally, in Paper E, we consider the problem of maintaining connectivity in a multi-agent system. Often inter-agent communication abilities are associated

with some proximity constraints, so when the robots move in relation to each other, communication links both break and form. In the paper we present a framework for analysis that makes it possible to compute a set of constraints which, if satisfied, are sufficient to guarantee maintained communication for a given multi-agent system. Constraints are computed for two sorts of consensus-based systems and the results are verified in simulations.