National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Distributed Robust Formation Control for Multi-Agent Systems: An LMI Approach
Speaker	: Arnab Pal (Rollno : 518ee1007)
Supervisor	: Asim Kumar Naskar
Venue	: EE401
Date and Time	: 28 Apr 2025 (05.00pm)
Abstract	: This thesis investigates robust distributed formation control algorithms for multi-agent systems (MAS), addressing critical challenges such as model uncertainties, input delays, external disturbances, and measurement noise. Combining approaches from three related studies, this work introduces a cohesive framework basedonlinearmatrixinequalities (LMI) to develop distributed control strategies that guarantee stability, robustness, and accurate formation tracking in real-world applications such as robotics, autonomous systems, and networked control. First, the problem of input delay and model uncertainty is tackled using a predictor-based control scheme, exploiting the finite spectrum assignment (FSA) technique to mitigate the effects of delays. The approach simplifies the multi-agent formation problem into a single-agent stability analysis, with controller and predictor gains derived via LMIs to maximize the allowable perturbation bound under delays. Additionally, practical digital implementation aspects are explored, providing insights into stability preservation in discrete-time realizations. Next, a mixed H2/H&infin performance-based formation tracking controller is introduced to enhance robustness against disturbances and measurement noise. This controller optimally balances performance and disturbance attenuation, ensuring accurate formation tracking under directed topologies. The control synthesis is formulated as an LMI problem, offering a systematic method for tuning performance and robustness trade-offs. Further, extending the robust control framework, a consensus strategy is developed for descriptor-type multi-agent systems, where agents exhibit singular dynamics. A distributed observer-based consensus protocol is designed to handle both structured and unstructured model uncertainties. By transforming the consensus problem into an equivalent single-agent stability framework, stability conditions are derived using LMI formulations, ensuring scalability and resilience in uncertain environments. Theoretical contributions are validated via numerical simulations in MATLAB, demonstrating enhanced robustness, disturbance rejection, and adaptability to delays, disturbances, and uncertainties. The results underscore the efficacy of LMI techniques in advancing distributed formation control for complex, real-world multi-agent applications.