ABSTRACT

The design of control systems for unknown nonlinear plants remains a fundamental challenge, particularly in modern digital and networked environments. Traditional model-based control approaches rely heavily on precise system representations, while many existing data-driven methods suffer from scalability issues, sensitivity to noise, and limited robustness under practical constraints. These challenges are further compounded by intermittent measurement availability arising from communication limitations and information loss.

This thesis addresses the problem of data-driven control for unknown nonlinear systems operating under multirate sampling, external disturbance and data loss. A unified framework is developed that relies exclusively on measured input–output data and avoids explicit system identification. For an unknown linear system, multirate samples of output and input are used to compensate for the external disturbance present in the system. A linearization method is proposed employing multirate sampling and dynamic linearization for an unknown nonlinear system. Central to the proposed approach is a multirate compact form dynamic linearization framework, which explicitly exploits fast output measurements available within each slower control input update interval. By organizing inter-sample output information in a principled manner, the framework captures essential inter-sample dynamics while maintaining a compact representation suitable for real-time implementation.

Building on this modeling framework, an instantaneous or greedy optimal control strategy is proposed. The control law is derived directly from the multirate compact representation and is expressed in an explicit form, thereby avoiding computationally intensive horizon-based optimization. To compensate for aggregated nonlinearities and disturbances, a learning-based mechanism is incorporated. The learning strategy is performance-oriented and boundedness-focused, with the objective of ensuring predictable closed-loop behavior rather than exact model reconstruction.

The thesis further investigates robustness under data loss due to denial of service attack. The closed-loop system is analyzed under switching data patterns, and boundedness is established for tracking error and control input. Rather than relying on classical asymptotic stability notions, the analysis emphasizes explicit performance bounds that reflect realistic operating conditions in data-driven and networked control systems.

The results demonstrate that systematic exploitation of multirate sampling within a data-driven dynamic linearization framework can significantly enhance robustness, performance, and implementability. The proposed approach provides a structured alternative to both classical model-based designs and heuristic data-driven methods, and offers a practically relevant foundation for control of unknown nonlinear systems under uncertainty and data loss.