Event-triggered Predictive Control of Networked Control Systems with Output Transmission

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by

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Chapter 5

Conclusions and future scopes

In this brief chapter, the conclusion of the thesis work is presented by summarizing its key attributes. Additionally, attention is given to potential future scopes.

5.1 Conclusions

The stabilization problem in NCS confronted with random network delays, dropouts, and limited communication resources has been addressed in this work. The proposed TEPC scheme, incorporating event-triggered state estimation through a remote predictive controller, has demonstrated effective performance in maintaining the stability of the closed-loop NCS.

A comparative analysis has been conducted, contrasting the performance of the proposed complete event-triggering NCS setup with systems utilizing event-triggering solely in the feedback channel. The results revealed that after integration of event-triggering in both the feedback and forward channels also the system performs effectively compensating for delays and dropouts, ensuring overall stability. Furthermore, the proposed TEPC scheme outperformed recent event-triggered predictive control methods, highlighting its effectiveness in stabilizing NCSs, particularly due to the added advantage of transmission of output rather than the state information.

To enhance the performance of predictive controllers for NCSs constrained by limited bandwidth resources and affected by network-induced time delays and packet dropouts, the transmission of sequential output information in a single packet is explored through the integration of a remote sequential observer.

Further, the implementation of predictive triggering in the feedback and forward paths demonstrated efficient communication channel utilization in NCSs. Simulation results confirmed the effectiveness of the proposed control method, showcasing optimized network utilization.

In conclusion, the strategies for compensating random delays and dropouts, optimizing communication efficiency through output transmission, and strategically applying ET methods on both feedback and forward paths of NCS have been successfully developed and implemented.

5.2 Future scopes

The findings of this thesis pave the way for several promising future scopes and avenues for further research:

- **Predictive control by delay regulation:** Subsequent research efforts may concentrate on advancing predictive control methods that employ buffers to regulate variations in delay.

- **Sequential state transmission:** As an evolution of the sequential output transmission approach, a sequential state transmission may be tailored in the future, proving beneficial for systems characterized by a limited number of states. As internet advancements surmount packet size constraints, this technique can also find application in systems featuring a substantial number of states.

- **NCS with nonlinear dynamics**: Many systems are time-varying in nature that include some of the nonlinear systems that can be represented as the time-varying one. Considering such systems with time-varying A_k and B_k matrices in 2.1 and updating the corresponding prediction following the system dynamics will be a future work.

- **Stochastic framework for the ETPC:** In the future, Event-triggered predictive control techniques may undergo further development within a stochastic framework. This framework could leverage probabilistic information and Kalman filtering to enhance the performance of NCS.

- **ETPC by burst transmission:** Taking into consideration the inherent challenges of communication networks, such as bandwidth limitations, and leveraging various communication access techniques, future work on NCS could explore burst transmission. This approach involves communicating burst information as needed, with no transmission required between burst to burst.

- **Multi-agent systems in dynamic environments:** Expanding the application of research findings in Multi-agent systems to dynamic and complex environments represents a promising future scope. This involves exploring consensus strategies in MAS under varying network conditions and agent behaviors.