Abstract

Networked Control Systems (NCS) have emerged as a prominent field of research due to their potential to revolutionize various applications, including automation, energy management, and healthcare. By integrating control systems with communication networks, NCS offers enhanced flexibility, scalability, and distributed control capabilities. However, several challenges need to be addressed to ensure efficient and reliable control in networked environments. NCSs are known to offer control design challenges involving network-induced time delays, packet dropouts, packet size, and limited bandwidth resources in NCS. While the first two are often addressed using predictive controllers, the limited bandwidth issue is addressed by using event-triggering mechanism. However, the issue of packet size is limitedly addressed in literature. It is known that larger data packets also deteriorate the network bandwidth leading to more delays and packet losses. In order to reduce the size of the data packets, output transmission over the network for an NCS is considered in this thesis and new solutions to overcome its limitations are proposed.

As a first problem, an event-triggered NCS with output transmission instead of state transmission is considered. The NCS is considered to be having conventional event-triggering mechanism in both the feedback and forward channels. Such a situation is helpful in improving the network bandwidth when shared network channels are used for both the forward and feedback channels. A predictive controller with an observer to estimate the states from delayed event-triggered output is developed to take care of the random delays and dropouts in the NCS. Stability analysis of the predictive controller is studied and effectiveness of the proposed scheme is shown through numerical examples.

Since output transmission deteriorates the system performance by trading off the network bandwidth improvement, the next problem is considered to study if sequential output transmission through a single packet can be potentially used to improve the per-

formance of such NCS. A sequential observer-based predictive controller is proposed for such an NCS to utilize the sequential output information transmitted in a single packet. It is shown that the proposed predictive controller improves the performance of the NCS as more sequential information is transmitted in a single packet even in presence of event-triggering in both the feedback and forward channels.

While conventional event-triggering works well for NCS, it is well known that predictive triggering can further optimize the network utilization. A predictive controller is then designed for the NCS in the presence of predictive triggering with output transmission. It is seen that the predictive controller works as expected in the presence of predictive triggering as well.