

Tugas V sistem pengaturan Berjaringan

Muhammad Azriel Rizqifadiilah - 6022221047



Departemen teknik elektro

fakultas teknologi elektro dan informatika cerdas

INSTITUT TEKNOLOGI SEPULUH NOPEMBER 2023

1. Mean-square stability of a system implies that the expected value of the square of the system state remains bounded over time, for any bounded initial condition. This is a stronger notion of stability compared to, say, stability in the sense of Lyapunov, which just requires the state to remain bounded. Here, we also require the mean of the squared state to remain bounded.

In the context of this paper, the 'mean-square sense' stability likely relates to how the data rate of the channel impacts the system's stability. Specifically, it may address the question of what the necessary and/or sufficient data rates are for the system to remain stable in the mean-square sense, given the time-varying nature of the feedback channel.

1. Theorems in control theory often present conditions under which a certain system property holds true. In your case, Theorem 4.1 seems to state that, given certain assumptions A0-A3, there is a necessary and sufficient condition for the stability of the plant (4) in the mean square sense (3). This means that if the system satisfies this condition, the system is stable in the mean square sense, and if the system is stable in the mean square sense, it must satisfy this condition.

On the other hand, Theorem 5.1 presents a necessary condition for the stability of system (17) in the mean square sense (3), under the same assumptions. This means that for the system to be stable in the mean square sense, it must satisfy this condition. However, satisfying this condition doesn't guarantee mean square stability; there could be other conditions that also need to be met.

1. In a scalar system, the quantizer is a device or algorithm that transforms continuous or discrete input signals into a set of discrete output values, also known as "quantization levels". The basic principle behind this is to map the continuous range of input values into a finite set of output values.

Range Division: The range of possible input values is divided into a set of intervals. In a uniform quantizer, all intervals are of the same size. This size is often denoted as (delta) and is called the "quantization step size".

Quantization: For each input signal value, the quantizer identifies the interval that this value falls into.

Representation: Each interval is associated with a specific output value, which is usually the midpoint of the interval. The quantizer maps the input value to the output value corresponding to the interval it falls into. This output value is the "quantized" version of the input signal.

Encoding: The output value is then encoded into a binary format, resulting in a digital signal that can be easily processed, transmitted, or stored by digital devices.

1. The notion of controllability and observability is essential here. A system is said to be controllable if it can be driven from any initial state to any final state in a finite time using the system inputs. Similarly, a system is observable if the state of the system can be inferred from the outputs. If a system is both controllable and observable, it can be stabilized by a suitable choice of feedback control law.

When noise, disturbances, or other non-ideal factors (like a time-varying digital communication link as in your context) are introduced, the boundaries of these regions can blur, and the stability analysis can become more complex. The stability region can depend on the noise or disturbance levels, as well as the specifics of the control scheme. The control gain, for example, may need to be adapted based on the noise level in order to maintain stability.

However, separating stabilizable and non-stabilizable regions might be less clear in the case of nonlinear or time-varying systems, or systems with constraints on the control inputs. In these cases, more advanced stability analysis techniques like Lyapunov's methods or input-output stability theory might be necessary.

1. This study addresses the mean square stabilizability of a discrete-time linear system linked through a noiseless time-varying digital communication channel, a scenario inspired by control problems that occur over time-varying channels. This system allows for process and observation disturbances that span an unbounded support. Using information-theoretic methodologies, we derived necessary conditions and developed a stabilization technique based on an adaptive successively refinable quantizer. In scalar scenarios, the proposed scheme demonstrated optimal performance. The study further revealed a fascinating polymatroid structure as a necessary condition for stabilization in vector situations. Subsequently, an optimal stabilization scheme was proposed under specific limiting regimes. Notably, this research bridges information-theoretic results of stabilization over rate-limited channels with corresponding network-theoretic results on critical dropout probabilities in systems with unbounded disturbances, marking a significant contribution to the field.
2. Instead of continuously changing the quantization parameters, use a hybrid control technique. First, there may be limitations on how many values and how frequently these parameters can be changed in certain circumstances. Consequently, a discrete adjustment policy is more straightforward to adopt and more natural than a continuous one. Second, compared to systems produced by continuous parameter adjustment, the analysis of hybrid systems formed in this approach seems to be more manageable. In fact, we shall show that a tool for understanding the behaviour of the closed-loop system is provided by invariant areas defined by level sets of a Lyapunov function.
3. the quantization error is . They can think of as the "zoom" variable: increasing corresponds to zooming out and essentially obtaining a new quantizer with larger range and quantization error, whereas decreasing corresponds to zooming in and obtaining a quantizer with a smaller range but also a smaller quantization error. Update at discrete instants of time, so it will be the discrete state of the resulting hybrid closed-loop system.
4. There are notion of stability use on this paper based on linear and nonlinear system.

Lyapunov Stability: This is a fundamental concept of stability for both linear and nonlinear systems. A system is said to be Lyapunov stable if, for every small initial deviation from the equilibrium, the state remains bounded and doesn't go off to infinity. Lyapunov stability is commonly used in the analysis of nonlinear systems due to its general applicability.

Asymptotic Stability: A system is said to be asymptotically stable if it's Lyapunov stable and, additionally, any initial deviation from equilibrium tends to zero as time goes to infinity. That means, not only does the system stay close to the equilibrium point, but it also eventually returns to it.

Exponential Stability: This is a stronger form of stability. A system is exponentially stable if the state converges to the equilibrium exponentially fast. This type of stability is often discussed in the context of linear systems.