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Study of Smith Predictors for Time-delay System with Uncertainties

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Abstract

In this thesis instability phenomena caused by uncertainty of a plants and its a model is studied .So ,practical stability properties of multivariable feedback systems with time-delays and uncertainties controlled by a Smith predictors is considered . As stated above , Practical stability for MIMO systems with time-delays controlled by a Smith predictors is defined . A necessary and sufficient condition for a control system to remain stable in presence of infinitesimal uncertainty is presented .

First, the system which involves a delay the transmission of needful signal to control the plant is called the system with time-delays . So, time-delays between inputs and outputs are common phenomena in many industrial processes and cause considerable difficulties in effective control of such processes. The Smith predictors is well-known control method for a time-delay system. Smith predictors is constructed a miner feedback contained two models of the plant: the model of the whole plant and that of the time delay-free part of the plant. The subsystem the model of the plant and the model without time-delay model of the miner feedback works to eliminate an effect of time-delay from the closed-loop system. Thus, a control problem for a system with time-delay is reduced to a control problem without time-delay and it becomes easier to get a good response to a reference inputs. Smith predictors is needs an exact model of the plant, however, it is difficult to represent a mathimatical mode. Therefore, it is necessary to investigate the phenomena caused by the uncertainty from the practical point of view. It is a fact that the closed-loop with time-delay using Smith predictor(Smith-Systems) can be destabilized by small disturbances in the time-delay constants for the property of the Smith-Systems, So, it is important to consider practical stability which guarantee stable against very small perturbation . and the system which remains stable

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for very small perturbation is said to be practically stable. The term "practical stability" was used to describe the ability of a time-delay system to be stable in the presence of small perturbations. The concept of practical stability could be easy to understand if it were token the other way round . Therefore , we try to consider a practical instability. When a Smith Predictors is properly designed in the ideal case (no uncertainty between the plants and assumed models) the overall system is easy to stable . Nevertheless, in certain circumstances, the system may lose its stability for slight changes in the time-delays .Systems which are stable in the nominal case but which become unstable for small uncertainty between the plant and assumed model are called practically unstable systems. So, the conception of this reverse, its is a practical stability which guarantee stability in the presence of very small uncertainty. Practical stability is a weaker condition than the usual robust stability since only infinitesimal deviation of the plant dynamics is taken into account. However, practical stability may be of importance in that it is necessary for robust stability in any other sense. We can understand as follows, if the stability of the closed-loop containts be guaranteed under the existence of very small uncertainty, At first practical stability should be considered to get robust stability . Consequently, the various research of a practical stability study about Smith method which deteriorate stability under the existence of small uncertainty. Now, a research result for a practical stability of Smith-systems, if a system is only proposed for a single input and a single output (SISO) now, its is obtained a necessary and sufficient condition of a practical stability. But to apply the Smith-systems of multiple inputs and multiple outputs (MIMO) with multiple parameter, it is not studied enough . It should be studied more . The purpose of this paper is to consider for a practical stability of MIMO Smith-System.

However, the structure of the MIMO system which is used a usual research is structure certaining the time-delays the element of plants. Furthermore, this structure is a kind of the structures on the MIMO system, and it is the any structure that the MIMO system have the other structure. Hence, I would like to focus attention on the structure of the plant in the MIMO Smith-systems. Then we examine a practical stability of the plant which have a different structure from a usual structure. In a word, we don't consider the MIMO system of time-delays from the SISO to the MIMO. Let us consider both the transfer function of timedelay parts and without time-delay parts. Then , we make a MIMO system with time-delays of its, and make a plant of this study. Beside, the structure of transfer matrix with time-delays is diagonal.

Using the structure like the above , We consider the case where uncertainty takes place only in time-delays .In a study of the practical stability ,all uncertainty should be taken into consideration for time-delays and plants , in general . But we will here restrict our interest to the case of where the uncertainty existences only in the timedelays . Because the uncertainty which exists only in the time-delays happen an error in proportion the frequency and have an effect on the closed loop system . It is shown that the practical stability depends only on the nature of the system at infinitely high frequency .

In chapter 1, the back grounds, the purposes, the distinctive features of this study are proposed. The mathematical preliminaries and the notation are introduced in chapter 2. In chapter 3, a brief description of the Smith predictors is presented . In chapter 4, a special stability properties induced by the Smith predictors is discussed. The practical stability problem of the Smith predictors is defined. In chapter 5, the main results of this paper are given. The about practical stability theorem of the main results is shown. The main results is demonstrated in some detail in chapter 6. The Finally, we provide the illustrative examples demonstrating, and the effect of the main result is obtained