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Author(s)	内藤, 浩行
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Description	Supervisor: 示村 悦二郎, 情報科学研究科, 修士

Study of Smith Predictors for Time-delay System with Uncertainties

Hiroyuki Naitou

School of Information Science,
Japan Advanced Institute of Science and Technology

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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

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 taken the other way round . Therefore , we try to consider a practical instability . When a Smith Predictor 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 contains 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 time-delay 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 time-delays . 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 intro-

duced 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