論文 / 著書情報
Article / Book Information

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Title(English)	Performance Analysis of Evolving Dynamical Network systems Based on Control Theory
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis provides a line of work on performance analysis of evolving dynamical network systems, which are constructed by a network connection of multiple dynamical subsystems in a step-by-step manner. In conventional robust control-based design strategy, the robust performance of the entire network system evaluated by, e.g., the worst-case performance can be guaranteed. On the other hand, on the premise that the composition of the entire network system may be change by the connection of the additional subsystems, it is also important to suppress the degree of the performance deterioration/variation in addition to the certification of the worst-case performance. Furthermore, it is desire to improve the entire control performance by the evolution of the network system, rather than preserving or not deteriorating the stability and the control performance. With this background, we address the problems of performance variation and improvement with the system evolution toward the development of the design strategy of the evolving dynamical network systems. In Chapter 2, we propose a new performance measure, which is called by localizability, on the basis of the retrofit control. The retrofit controller is a plug-in type local controller such that the stability of the resultant feedback system is preserved for any variation of neighboring subsystems other than the subsystem of interest as long as the feedback system before implementing the retrofit controller is stable. It should be noted that the design of the retrofit controller requires only a model of the subsystem of interest. Then, we define the localizability index as the H∞-norm of an error system defined based on the isolation of the subsystem of interest from the entire system. The localizability index measures the degree of the performance deterioration for any variation of neighboring subsystems other than the subsystem of interest. It is shown that the localizability index requires only the model parameters of the subsystem of interest in the upper bound evaluation. We illustrate a numerical analysis of retrofit controller placement problems for power systems by using the localizability index. In Chapter 3, the problem of the performance improvement is addressed for a feedback system composed of two passive systems. We employ a model set description for each subsystem: each subsystem is assumed to be passivity property that is characterized by two matrix parameters. The parameters are utilized for the evaluation of L2-gain of the model set, which is defined as the worst-case system in the model set. The feedback system composed of the performance-integrated passive systems is also passive. In addition, the parameters characterizing the model set describing the feedback system is given as the parameter transition. Then, we derive conditions on the passivity parameters such that the performance improvement is achieved; the L2-gain of the model set describing the feedback system is strictly reduced as compared to that describing the subsystems. In the above discussion, only parameters characterizing the model set of subsystems is not required for the L2-gain evaluation of the feedback system. In this sense, the problem addressed in this paper is referred to as the model-set-based analysis. Subsequently, the model-set-based analysis of the feedback system is extended to that of an iterative feedback system, which is a special class of the evolving network system. Then, conditions on the passivity parameters to achieve the gradual improvement are derived. In Chapter 4, we address the performance improvement problem of the homogeneous network system composed of identical clusters, each of which involves multiple nodes. The dynamics of each node is described by a dynamical system with a single integrator, which can express a general system including, e.g., a single integrator and a second-order oscillator. In particular, we give attention to external and internal network structure: the network structure among clusters and the network structure among nodes inside each cluster. The sensitivity of the network system to disturbances is analyzed from the viewpoints of the sparsity of external and internal networks as well as the increase of the number of nodes that represents the evolution of the network system. In this chapter, the disturbance sensitivity is evaluated by the H∞-norm of the overall network system in which input and output ports are assigned at the interconnection links among clusters. First, we numerically find that, as the number of nodes increases, the disturbance sensitivity of the network system tends to be reduced if the external network structure is sparse and the internal network structure is dense. In order to support the finding observed from the numerical experiment, we further confine our attention to a network involving clusters each of which has identical nodes. Then, we theoretically prove that, in the limit of sufficiently large number of nodes, the minimum disturbance sensitivity level, evaluated by the maximum eigenvalue associated with the external network, is achieved if the internal network is the complete graph. Finally, Chapter 6 concludes this thesis and shows the future tasks.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).