Network Control of Microgrid by Using Computational Intelligence and its Stability Analysis

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INTRODUCTION

The control of large-scale dynamical systems is one of the biggest challenges facing control system design Large-scale systems are common in applications such as chemical process control, power generation and distribution, highway and air traffic control, among others. These systems normally compose of complex non-linear interacting dynamics, external disturbances, model uncertainty, physical constraints and complicated nested interactions

The hierarchical control for microgrids have been proposed recently in for standardize the microgrid operation and functions. This hierarchical control can be divided into three levels of control namely primary, secondary and tertiary level, each of these levels has objectives and methods of controlling which are designed and manipulated by different controllers.

CHALLENGES OF DISTRIBUTED CONTROL

- Weighted graph partitioning of complex systems
- Optimize interaction between subsystem
- Divided complex system into controllability balanced subsystems
- Plug and Play problem
- Design optimal controller with consideration of interaction between subsystem
- Guarantee over all system stability

Methodology

When distributed power with the function of “plug and play” accesses to the grid, management technology will be needed. It includes the control strategy of the system change, energy management, quality of power maintenance and management etc. But because of the limit of the current standards and level of development, related technology of the inverter is difficult to implement in the short term.

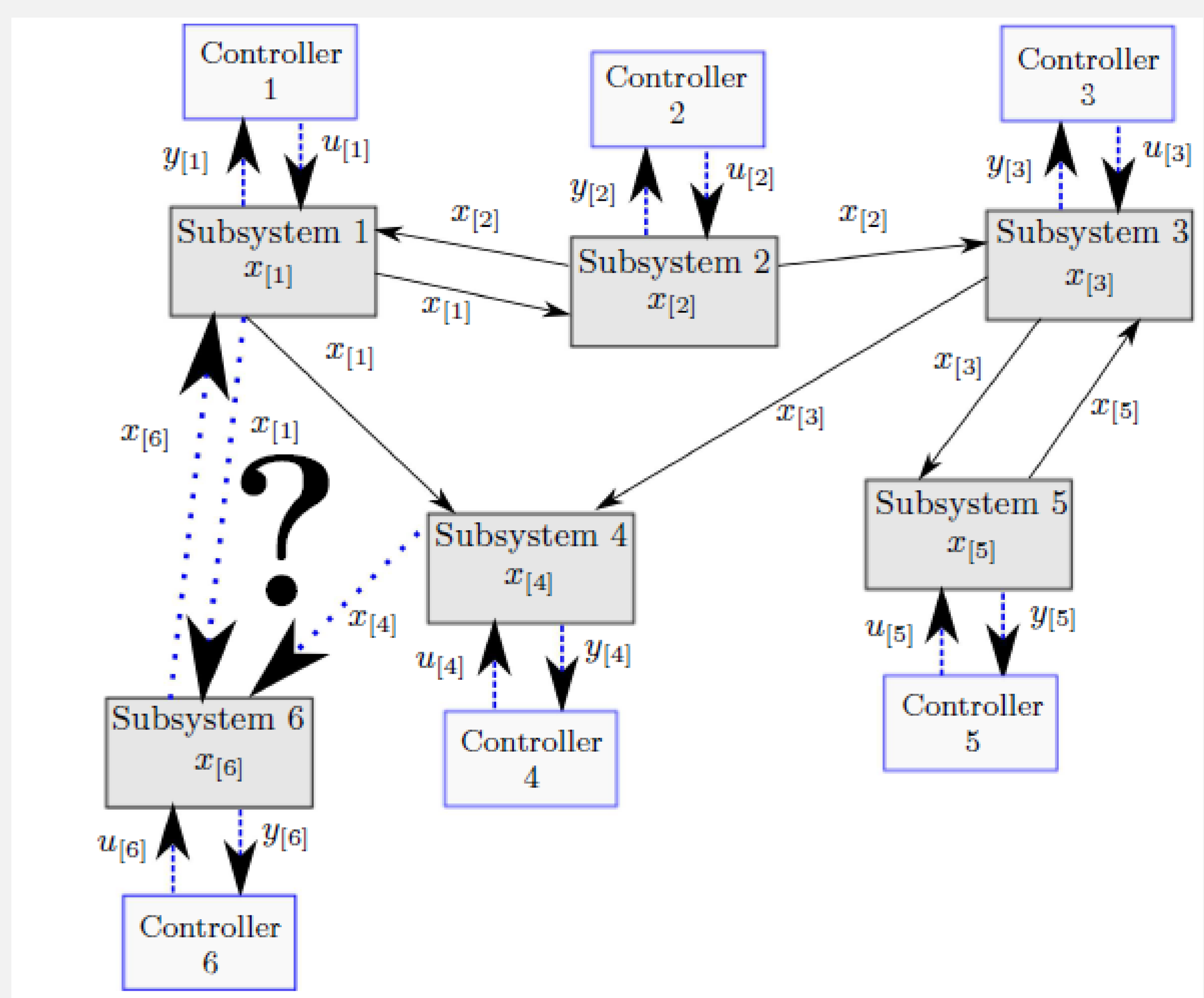
In this project, Distributed Computational Intelligence Control System is recommended to building the control system of microgrid with the function of “plug and play”..

And make a detailed analysis of the strategy method of each element microgrid control.

It is more challenging to stabilize an LSS with a decentralized/ distributed controller than a centralized controller. The first part of the project focuses on centralized and decentralized design of distributed controllers and observers for networked systems. A decentralized output-feedback dynamical controller always exists only if the LSS is stabilizable and detectable and there are no unstable decentralized fixed modes, i.e. uncontrollable and unobservable modes that cannot be modified using a decentralized controller. It provides a new way to optimize the operation control of microgrid.

SYSTEM MODEL

In our study, we are interested in distributed control of large scale system.



PROBLEM FORMULATION

we are considered discrete-time LTI LSS given by

$$x^{+} = Ax + Bu + Dd$$
$$y = Cx$$

Where $x \in \mathbb{R}^{n}, u \in \mathbb{R}^{m}, y \in \mathbb{R}^{p}$ are respectively the stat, the input and the output. We assume that the above mention model can be written as

$$\Sigma_{[i]} : x^{+}_{[i]} = A_{ii}x_{[i]} + B_i u_{[i]} + \sum_{j \in N_i} A_{i,j} x_{[j]} + D_i d_i$$
$$y_{[i]} = C_i x_{[i]}$$

where $A_{i,j} \in \mathbb{R}^{n_i \times n_j}, B_i \in \mathbb{R}^{n_i \times m_j}, C_i \in \mathbb{R}^{p_i \times n_i}$ and N_i is the set of parents of subsystem i defined as $N_i = \{A_{ij} \neq 0, i \neq j\}$

We will want to design distributed optimal neural network and we prove stability by Lyapunov function. The control input can be considered as

$$u_i = \hat{W}_i \sigma_i(\hat{V}_i x_{NN})$$

and the updated law to tune neural network weights can be considered

$$\dot{\hat{W}}_i = -\eta_1 \frac{\partial J_i}{\partial \hat{W}_i} - \rho_1 |e_i| \hat{W}_i$$

$$\dot{\hat{V}}_i = -\eta_2 \frac{\partial J_i}{\partial \hat{V}_i} - \rho_2 |e_i| \hat{V}_i$$

Moreover, we can develop controller for nonlinear system Such as

$$\dot{x}_{i1} = x_{i2}$$
$$\dot{x}_{i1} = x_{i3}$$
$$\vdots$$
$$\dot{x}_{in} = f(\mathrm{x}_i, \mathrm{x}_j) + u(t)$$
$$\mathrm{y}_i = \mathrm{x}_{i1}$$

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