ROBUST OVERLAPPING DECENTRALIZED CONTROL FOR MULTI-AREA LONGITUDINAL POWER SYSTEMS

Xiaohua Li[1,2], Xue-Bo Chen[2], Yuanwei Jing[1], Wei Wang[3]

1.Faculty of Information Science and Engineering, Northeastern University Shenyang, 110004, China
2.School of Electronic and Information Engineering, Anshan University of Science and Technology, Anshan, 114044, China
3.Dalian University of Technology, Dalian, 116023, China

Abstract: The problems of robust overlapping decentralized control for a class of multi-area longitudinal power systems are discussed in this paper. A special overlapping decomposition method is presented in terms of inclusion principle. Based on the decomposition, a new control method is formed by means of Linear Matrix Inequality (LMI) approach of Organically-Structured Control (OSC). The proposed method is applied to a three-area longitudinal power system, and the simulation results show that the performances of the controllers designed by proposed method are better than the one by OSC directly.

Key words: overlapping decomposition, robust decentralized control, longitudinal power systems, Linear Matrix Inequality (LMI)

1. INTRODUCTION

It is well known that the overlapping decomposition has been widely applied to various control designs of complex systems (Siljak, 1991; Chen and Stankovic, 1996; Akar and Ozguner, 2002; Knittel *et al*., 2002). The concept of overlapping decentralized control has been put forward to solve the problems about the decentralized control of the interconnected systems. Generally, the overlapping means that there is a common part in different subsystems, which is called overlapping part. It may be different when the partition of the subsystems is different. The choice of the overlapping or the partition of the subsystems will affect the overlapping decentralized control of overall system. Knittel *et al*. (2002) provided an example about choosing overlapping, and pointed out the fact that considering the overlapping in systems can make overall system has better control performances. Therefore, how to use of the overlapping and overlapping decomposition in complex systems to improve control performances is a researchable problem.

The decentralized control for interconnected power systems has also attracted considerable attention of researchers in the field of complex and large-scale systems (Siljak, 1991; Chen and Stankovic, 1996; Chen *et al*., 2001; Chen *et al*., 2002; Stankovic, 1999). We know that multi-area interconnected power systems have a complex structure. They often exist in network forms, but in some special cases, they can also exist in longitudinal or loop or radial structure. In order to simplify the problem on control design, we can study respectively for different cases. Chen *et al*. (2001 and 2002) presented a decentralized control method for multi-area power systems, *i.e.* it decomposed the overall system as a group of pair-wise area subsystems, then designed the decentralized controllers for each area according to the decentralized design method for two-area overlapping power systems (Chen and Stankovic, 1996). In this way, maybe there are many decentralized controllers for each area. But the method did not give us the strategy to choose, optimize and coordinate the controllers. It also did not consider the interconnections between the pair area systems when the pair area subsystems are designed. Therefore, the performances of control are not perfect. To improve the control performance indices and consider the interconnections between subsystems more completely, a special overlapping decomposition method is studied in framework of the inclusion principle and LMI method of Organically-Structured Control (Siljak and Stipanovic 2001) is adopted to add the positive effect of the interconnections in the control design for the multi-area interconnected power systems.

The objective of this paper is to present a new decentralized controller design idea for multi-area longitudinal interconnected power systems. In order to implement the control idea, an overlapping decomposition method, which decomposes the interconnected power system into a group of pair-wise area subsystems, is presented in terms of the restriction conditions of Inclusion Principle. The decomposition mode can separate out the interconnections between each pair-wise area. When the controllers are designed, the interconnections can be considered as a positive factor. Based on the decomposition, the decentralized controllers of each subsystem in pair-wise area subsystems are designed by using LMI approach of OSC in expanded space. Then all the controllers can be combined together and contracted back to original space by using the contraction condition of inclusion principle and implemented in original space. The proposed method is applied to a three-area longitudinal power system, and the simulation results show that the performances of the controllers designed by proposed method is better than the one by OSC directly.

2. MODELS AND STRUCTURE OF SYSTEMS

We consider a class of interconnected power systems composed of interconnected *N* areas described by the following differential equations (Calovic, 1984; Siljak, 1978)

$$S: \begin{cases} \dot{x} = Ax + Bu + F\xi \\ y = Cx \end{cases} \tag{1}$$

where, the state vector $x(t) \in R^n$, control input $u(t) \in R^m$, output $y(t) \in R^l$ and perturbation input $\xi(t) \in R^n$. The corresponding constant matrices with appropriate dimensions can be represented by

$$A = \begin{bmatrix} A_{11} & A_{12} & \cdots & A_{1N} \\ A_{21} & A_{22} & \cdots & A_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ A_{N1} & A_{N2} & \cdots & A_{NN} \end{bmatrix}$$

$$B = blockdiag(B_{11}, B_{22}, \cdots, B_{NN})$$

$$C = blockdiag(C_{11}, C_{22}, \cdots C_{NN})$$

$$F = blockdiag(F_{11}, F_{22}, \cdots F_{NN}) \tag{2}$$

In matrix A , the diagonal block A_{ii} represents the parameter of i-th area subsystem, and A_{ij} is the interconnection between areas. The equation of i-th area subsystem can be described as

$$\begin{cases} \dot{x}_i = A_{ii}x_i + B_{ii}u_i + F_{ii}\xi_i + \sum_{j=1, j\neq i}^{N} A_{ij}x_j, \\ y_i = C_{ii}x_i, \end{cases}$$
$$i = 1,2,\ldots,N \tag{3}$$

where, $x_i \in R^{n_i}$ is the *i*-th area state vector, $x_i = [\Delta x_i, \Delta v_i, \Delta Pe_i]$, $x_j \in R^{n_j}$ is the state vector of the other areas, $x_j = [\Delta x_j, \Delta v_j, \Delta Pe_j]$. Suppose $n_i = n_j$, $j = 1,2,\cdots,N$, $j \neq i$, and $\sum_{i=1}^{N} n_i = n$. The physical meaning of each variable can be found in (Calovic, 1984; Siljak, 1978). $u_i \in R^{m_i}$ is the control input vector of *i*-th area, $\sum_{i=1}^{N} m_i = m$. In the system, $m_i = 1$, i = 1,2,…,*N*. A_{ii} , A_{ij} , B_{ii} , C_{ii} and F_{ii} in (3) are described as follows

$$A_{ii} = \begin{bmatrix} A_i & 0 & a_{ti} \\ d_i^T & 0 & 1 \\ \alpha_{1i} \sum_{i=1, j\neq i}^{N} m_{ij}^T & 0 & 0 \end{bmatrix}, \quad A_{ij} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\alpha_{1i} m_{ji}^T & 0 & 0 \end{bmatrix},$$

$$B_{ii} = \begin{bmatrix} b_i \\ 0 \\ 0 \end{bmatrix}, \quad C_{ii} = \begin{bmatrix} C_i & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad F_{ii} = \begin{bmatrix} f_i \\ 0 \\ 0 \end{bmatrix} \tag{4}$$

where A_i, C_i is the constant matrix blocks corresponding to the state Δx_i ; $a_{ti}, m_{ij} \in R^{n_i - 2}$, $m_{ji} \in R^{n_j - 2}$ are constant coupling vectors; $d_i \in R^{n_i - 2}$ is the bias factor related to area control error of AGC; $\alpha_{1i} = P_{10} / P_{i0}$ is a steady-state load normalization factor based on area 1. In fact, the normalization factor α_{1i} is uncertain, because the loads of the areas are inconstant along with the load perturbation and the fluctuation of generating power.

We notice the fact from the model (1) and (2) that there are the interconnections only in matrix *A*. B , C and F have been block-diagonal matrices. If the power systems have longitudinal structure, the matrix *A* can be simplified as follows:

$$A=\begin{bmatrix} A_{11} & A_{12} & 0 & \cdots & 0 & 0 \\ A_{21} & A_{22} & A_{23} & \cdots & 0 & 0 \\ 0 & A_{32} & A_{33} & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & A_{N-1N-1} & A_{N-1N} \\ 0 & 0 & 0 & \cdots & A_{NN-1} & A_{NN} \end{bmatrix} \quad (5)$$

The main characteristic of longitudinal structure is that the area subsystems are connected like a chain. Suppose i-th area subsystem is in the middle of the chain. Because i-th area subsystem includes simultaneously the information of two areas connecting with it, i.e., the information overlapping affected by the other two areas is formed in i-th area. Therefore, i-th area can be regarded as the overlapping structure of adjacent areas. The overlapping decomposition of this structure has a particular character.

3. SPECIAL OVERLAPPING DECOMPOSITION OF LONGITUDINAL STRUCTURE

Special overlapping decomposition is different from general overlapping decomposition, it regards the whole area subsystem not part subsystem as the overlapping part. The interconnected system will be expanded and decomposed into a group of pair-wise area subsystems by using the restriction condition of inclusion principle. Suppose the expanded system of the longitudinal power system (1) is

$$\tilde{S}: \begin{cases} \dot{\tilde{x}} = \tilde{A}\tilde{x} + \tilde{B}\tilde{u} + \tilde{F}\tilde{\xi} \\ \tilde{y} = \tilde{C}\tilde{x} \end{cases} \quad (6)$$

where $\tilde{x}(t) \in R^{\tilde{n}}$, $\tilde{u}(t) \in R^{\tilde{m}}$, $\tilde{y}(t) \in R^{\tilde{l}}$, $\tilde{\xi}(t) \in R^{\tilde{n}}$ are the state, control input, output and uncertain perturbation input of the expanded system $\tilde{S}$ respectively. $\tilde{A}$, $\tilde{B}$, $\tilde{C}$ and $\tilde{F}$ are still constant matrices with expanded dimensions. And there are always $n < \tilde{n}$, $m < \tilde{m}$, $l < \tilde{l}$. Suppose that the pairs of matrices (U,V), (Q,R), (S,T) are given, and V, U, R, Q, S and T are all full rank transformation matrices, their dimensions are $\tilde{n}\times n$, $n\times\tilde{n}$, $\tilde{m}\times m$, $m\times\tilde{m}$, $l\times\tilde{l}$, $\tilde{l}\times l$ respectively, and satisfy $UV = I_n$, $QR = I_m$, $ST = I_l$, where I_i denotes a $i\times i$ identity matrix. In terms of inclusion principle, then the matrices $\tilde{A}$, $\tilde{B}$, $\tilde{C}$ and $\tilde{F}$ can be expressed as

$$\tilde{A} = VAU + M_A ,\ \tilde{B} = VBQ + M_B ,$$
$$\tilde{C} = TCU + M_C ,\ \tilde{F} = VFQ + M_F . \quad (7)$$

where M_A, M_B, M_C and M_F are the complementary matrices with the dimensions $\tilde{n}\times\tilde{n}$, $\tilde{n}\times\tilde{m}$, $\tilde{l}\times\tilde{n}$, $\tilde{n}\times\tilde{m}$. To let $\tilde{S}$ be an expansion of S, a proper choice of M_A, M_B, M_C and M_F is required, and the restriction conditions of the inclusion principle can be used. The conditions are divided into two classes. They are provided by the following theorem (.Siljak, 1991; Stankovic, 1999).

Theorem 1. The system S is one of restrictions of $\tilde{S}$ if there exists full rank matrices V, R and T such that

$$\tilde{A}V = VA ,\ \tilde{B}R = VB ,\ \tilde{C}V = TC ,\ \tilde{F}R = VF . \quad (8)$$

Theorem 2. The system S is one of restrictions of $\tilde{S}$ if there exists full rank matrices V and R such that

$$M_A V = 0 ,\ M_B R = 0 ,\ M_C V = 0 ,\ M_F R = 0 . \quad (9)$$

Because the interconnections between subsystems are only in matrix A for the system (1), we only consider the overlapping structure decomposition of the state equation in the system (1).

First of all, the transformation matrices should be chosen. For the longitudinal power systems, choose the overlapping decomposition factor β =0.5 according to the inclusion principle method, then 1-β=0.5. The matrices are

$$V = blockdiag(I_{n1}, \begin{bmatrix} I_{n2} \\ I_{n2} \end{bmatrix}, \begin{bmatrix} I_{n3} \\ I_{n3} \end{bmatrix}, \cdots, \begin{bmatrix} I_{n(N-1)} \\ I_{n(N-1)} \end{bmatrix}, I_{nN})$$
$$U = blockdiag(I_{n1}, 0.5\begin{bmatrix} I_{n2} \\ I_{n2} \end{bmatrix}^{\mathrm{T}}, \cdots, 0.5\begin{bmatrix} I_{n(N-1)} \\ I_{n(N-1)} \end{bmatrix}^{\mathrm{T}}, I_{nN})$$
$$R = blockdiag(I_{m1}, \begin{bmatrix} I_{m2} \\ I_{m2} \end{bmatrix}, \begin{bmatrix} I_{m3} \\ I_{m3} \end{bmatrix}, \cdots, \begin{bmatrix} I_{m(N-1)} \\ I_{m(N-1)} \end{bmatrix}, I_{mN})$$
$$Q = blockdiag(I_{m1}, 0.5\begin{bmatrix} I_{m2} \\ I_{m2} \end{bmatrix}^{T}, \cdots, 0.5\begin{bmatrix} I_{m(N-1)} \\ I_{m(N-1)} \end{bmatrix}^{T}, I_{mN}) \quad (10)$$

When $\tilde{A}$ satisfies the condition $\tilde{A}V = VA$ in (8), we have

$$\tilde{A} = \left[\begin{array}{cc:cccc:cc} A_{11} & A_{12} & 0 & \cdots & 0 & 0 & 0 \\ A_{21} & A_{22} & 0 & \cdots & 0 & 0 & 0 \\ \hdashline A_{21} & 0 & A_{22} & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & A_{(N-1)(N-1)} & 0 & A_{(N-1)N} \\ \hdashline 0 & 0 & 0 & \cdots & 0 & A_{(N-1)(N-1)} & A_{(N-1)N} \\ 0 & 0 & 0 & \cdots & 0 & A_{N(N-1)} & A_{NN} \end{array}\right] \quad (11)$$

where dotted lines mark out N-1 pair-wise area subsystems. When $\tilde{A}$ satisfies the condition $M_A V = 0$

in (9), the complementary matrix M_A is

$$M_A = \begin{bmatrix} 0 & 0.5A_{12} & -0.5A_{12} & \cdots & 0 & 0 & 0 \\ 0 & 0.5A_{22} & -0.5A_{22} & \cdots & 0 & 0 & 0 \\ 0 & -0.5A_{22} & 0.5A_{22} & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 0.5A_{(N-1)(N-1)} & -0.5A_{(N-1)(N-1)} & 0 \\ 0 & 0 & 0 & \cdots & -0.5A_{(N-1)(N-1)} & 0.5A_{(N-1)(N-1)} & 0 \\ 0 & 0 & 0 & \cdots & -0.5A_{N(N-1)} & 0.5A_{N(N-1)} & 0 \end{bmatrix} \tag{12}$$

In the same way, when $\tilde{B}$ satisfies the condition $\tilde{B}R = VB$ in (8), we have

$$\tilde{B} = \begin{bmatrix} B_{11} & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & B_{22} & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & B_{22} & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & B_{(N-1)(N-1)} & 0 & 0 \\ 0 & 0 & 0 & \cdots & 0 & B_{(N-1)(N-1)} & 0 \\ 0 & 0 & 0 & \cdots & 0 & 0 & B_{NN} \end{bmatrix} \tag{13}$$

When $\tilde{B}$ satisfies the condition $M_B R = 0$ in (9), the complementary matrix M_B is

$$M_B = \begin{bmatrix} 0 & 0 & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0.5B_{22} & -0.5B_{22} & \cdots & 0 & 0 & 0 \\ 0 & -0.5B_{22} & 0.5B_{22} & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 0.5B_{(N-1)(N-1)} & -0.5B_{(N-1)(N-1)} & 0 \\ 0 & 0 & 0 & \cdots & -0.5B_{(N-1)(N-1)} & 0.5B_{(N-1)(N-1)} & 0 \\ 0 & 0 & 0 & \cdots & 0 & 0 & 0 \end{bmatrix} \tag{14}$$

Similarly, $\tilde{F}$ and $\tilde{C}$ can be obtained too. It should be noted that the state vector of overall systems is transformed from $x = [x_1^T, x_2^T, \cdots, x_N^T]^T$ to $\tilde{x} = [x_1^T, x_2^T, x_2^T, \cdots, x_{N-1}^T, x_{N-1}^T, x_N^T]^T$.

4. ROBUST DECENTRALIZED CONTROL DESIGN

The power system (1) is decomposed into a group of pair-wise area subsystems in expanded space after overlapping decomposition. We can use LMI approach of OSC (Siljak and Stipanovic 2001) to design the robust decentralized controllers for each pair subsystems. The model of pair-wise area subsystems can be described by the following

$$\begin{aligned} S_i : \dot{x}_i &= A_{ii}x_i + B_{ii}u_i + F_{ii}\xi_i + A_{ij}x_j \\ S_j : \dot{x}_j &= A_{jj}x_j + B_{jj}u_j + F_{jj}\xi_j + A_{ji}x_i \end{aligned} \tag{15}$$

where $i = 1, 2, \cdots, N-1$, $j = i+1, j \le N$. $A_{ij}x_j$ and $A_{ji}x_i$ are the interconnections between two subsystems. Here, suppose there is not self-interconnection in each subsystem. Let $A_{ij}x_j = h_i(x)$, $A_{ji}x_i = h_j(x)$, where x denotes $x = [x_i, x_j]^T$. The first one of the equations in (15) is used to account for the design procedure.

Because the load normalization factor α_{1i} is uncertain but bounded in the interconnections A_{ij}, we can suppose the interconnections to satisfy the following quadratic constraints.

$$h_i^T(x)h_i(x) \le \alpha_i^2 x^T H_i^T H_i x \tag{16}$$

where $\alpha_i > 0$ is the bounds of uncertain interconnections, H_i is a constant matrix. Consider the decentralized state feedback control laws as follows

$$u_i(x_i) = K_i x_i \tag{17}$$

Then the closed-loop subsystems can be described as

$$S_i : \dot{x}_i = A_{ii}x_i + B_{ii}K_i x_i + h_i(x) \tag{18}$$

Rewrite the model to a compact form

$$\begin{aligned} S : \dot{x} &= A_D x + B_D u + h(x) \\ u &= K_D x \end{aligned} \tag{19}$$

where $K_D = blockdiag(K_i, K_j)$. In the compact form, the quadratic constraint of the interconnection $h(x)$ is

$$h^T(x)h(x) \le x^T \left(\sum_i^{i+1} \alpha_i^2 H_i^T H_i \right) x \tag{20}$$

Considering the robust connective stability of the system (15), the interconnected matrix $E = (e_{ij})$ is added into the interconnections of the system (Siljak, 1978). Therefore

$$h_i(x) = e_{ij} A_{ij} x_j \tag{21}$$

Then the size of the interconnections is further limited by imposing the constraints

$$\| h_i(x) \| \le \alpha_i \bar{e}_{ij} \beta_{ij} \| x_j \| \tag{22}$$

where $\bar{e}_{ij}$ is a element of the fundamental interconnection matrix $\bar{E} = (\bar{e}_{ij})$ with 2×2

dimensions corresponding to the system (15), β_{ij} is a norm of the interconnection A_{ij} excepted uncertain normalization factor α_{1i} in each two-area system. Based on (22), the quadratic constraints of the interconnection can be denoted as

$$\|h_i(x)\|^2 = h_i^T(x)h_i(x)$$
$$\leq \alpha_i^2 \bar{e}_{ij}^2 \beta_{ij}^2 \|\tilde{x}_j\|^2 = \alpha_i^2 x^T H_i^T H_i x \qquad (23)$$

where

$$H_i = blockdiag\{\bar{e}_{ii}\beta_{ii}I_{n_i}, \bar{e}_{ij}\beta_{ij}I_{n_j}\} \qquad (24)$$

Similarly,

$$H_j = blockdiag\{\bar{e}_{ji}\beta_{ji}I_{n_i}, \bar{e}_{jj}\beta_{jj}I_{n_j}\} \qquad (25)$$

In order to obtain the decentralized control law $u = K_D x$ such that the closed-loop system (19) to be robust connectively stable, we use Lyapunov stability theory and Schur complementary formula to educe following LMI optimization problem (Siljak and Stipanovic 2001).

Minimize $\sum_{i}^{i+1} \gamma_i$

Subject to $Y_D > 0$

$$\begin{bmatrix} \Phi & I & Y_D H_i^T & Y_D H_{i+1}^T \\ I & -I & 0 & 0 \\ H_i Y_D & 0 & -\gamma_i I & 0 \\ H_{i+1} Y_D & 0 & 0 & -\gamma_{i+1} I \end{bmatrix} < 0 \qquad (26)$$

where $\Phi = A_D Y_D + Y_D A_D^T + B_D L_D + L_D^T B_D^T$, $\gamma_i = 1/\alpha_i^2$. And the gain matrix K_D of the controller can be computed as

$$K_D = L_D Y_D^{-1} \qquad (27)$$

After the decentralized controllers are designed for each pair-wise area subsystem, the gain matrix $\tilde{K}_D$ can be formed in expanded space as follows

$$\tilde{K}_D = blockdiag(K_1, K_2^1, K_2^2, K_3^1, \cdots, K_N) \qquad (28)$$

To implement the decentralized control in the original system and form overlapping decentralized control laws, $\tilde{K}_D$ should be contracted back to the original space based on the restriction conditions of the inclusion principle (Siljak, 1991). The robust decentralized controllers for system (1) satisfy

$$K = Q\tilde{K}V \qquad (29)$$

Therefore, we can arrive at

$$K = blockdiag(K_1, K_2, \cdots, K_N) \qquad (30)$$

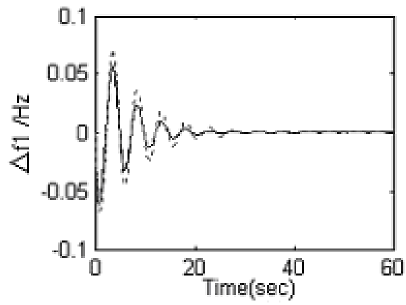
5. SIMULATION RESULTS

Consider a three-area interconnected power system with longitudinal structure. The parameters of the two areas in three areas can be found in (Calovic, 1984; Siljak, 1978), and the other one is chosen according to the one of the parameters of two areas. The parameters are

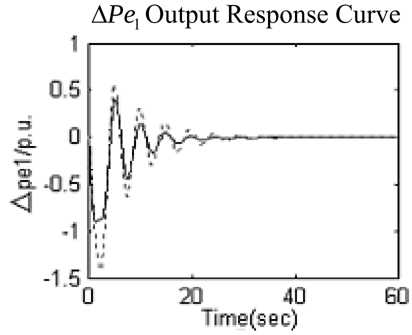
$$\begin{aligned} & A_{33} = A_{22}, \\ & a_{t3} = [0 \quad 0 \quad 0 \quad 0 \quad 0.6667 \quad 0 \quad 0 \quad -0.0833]^T, \\ & d_3^T = [0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 100], \\ & m_{23}^T = m_{32}^T = [0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 20.1116], \\ & B_{33} = [2 \quad 0 \quad 0 \quad 0 \quad 5 \quad 0 \quad 0 \quad 0]^T, \\ & f_3 = a_{t3},\ C_{33} = C_{22} \end{aligned} \qquad (31)$$

Let N=3, the expanding matrices are selected by (10). After the procedure of expansion and contraction, the decentralized controllers are designed in terms of above proposed method. Apply them to the three-area interconnected power system, the output response curves to the load disturbance including deviation of frequency variations $\Delta f_{1,2,3}$ and the tie line power exchange variations $\Delta Pe_{1,2,3}$ are shown in Fig 1. The comparison is done between the results obtained by proposed method and the one by using OSC approach directly in (Siljak and Stipanovic, 2001). The real lines denote proposed method and the dotted lines denote OSC approach.

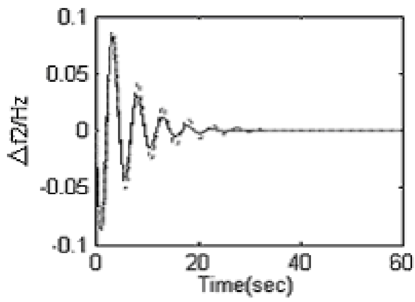
Δf_1 Output Response Curve



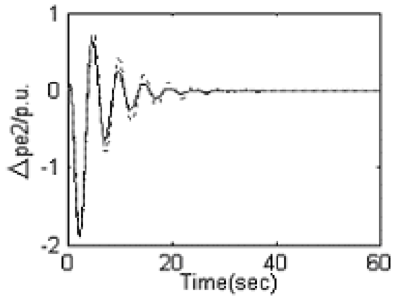
ΔPe_1 Output Response Curve



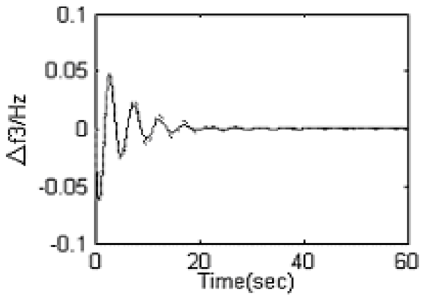
Δf_2 Output Response Curve



ΔPe_2 Output Response Curve



Δf_3 Output Response Curve



ΔPe_3 Output Response Curve

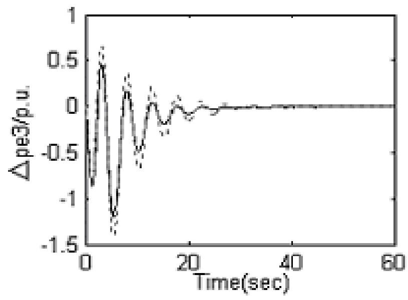


Fig 1. The output response curves of the main variations to the load disturbance

From Fig.1, we can know that the performances of the controllers designed by the former are better than the latter. The reason is that the two controllers considering different interconnections are combined together and the interconnections are used sufficiently. The simulation results illuminate that the proposed method are feasible.

6. CONCLUSIONS

Making use of special overlapping decomposition of the systems, the paper presents a new robust decentralized control method for multi-area longitudinal interconnected power systems. Because OSC approach sufficiently considers the inter-connections between subsystems and the effect brought by uncertain structure perturbation, the control is robust and it guarantees the connective stability of the systems. At the same time, the simulation results of proposed method prove the fact that considering the overlapping in systems properly can improve control performances of overall systems. The proposed method can be also applied to the other control systems.

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