Collaborative Control Of Power System Based On Source Network Load Storage Management

Wei Lin¹, a, Zhe Zhang¹, b, Yang Yu¹
Northeast power regulation and control sub center of Northeast Branch of State Grid Corporation of China
¹huapengyifeng@163.com ²doublejdz@163.com

Abstract: Vertical coordination of charge storage in source network refers to the coordination among energy transmission network, transport resource network and utilization and development of resources and energy through energy flow, information flow interaction and energy conversion technology, which plays a role in unifying user energy demand, expanding power demand side management function and amplifying power demand side operation. In this paper, the differential equations are combined with the power system circuit structure to obtain differential equations, and the differential equations are calculated and park transformed. On this basis, the construction goal of the power system cooperative control model is proposed, and the power grid cooperative storage optimization element is considered to construct the power system cooperative control model. It is proved by simulation experiments that the research method in this paper has higher frequency deviation adjustment capability, can provide more stable power output capability, and has better promotion effect.

1. Introduction
China is also actively engaged in the construction of large-scale wind power projects and the continuous development and utilization of wind power energy. In the research of power system collaborative control, it mainly focuses on the real-time tracking of load change, the maintenance of active power balance and the maintenance of stable frequency. The research direction is secondary frequency modulation and primary frequency modulation, and various cooperative control methods such as fuzzy control and intelligent control are proposed successively. Wind energy is a fluctuating, intermittent energy that cannot be accurately controlled or predicted. After the wind power generation is incorporated into the power grid, it will seriously affect the smooth operation of the power grid, cause obvious frequency fluctuation, make the voltage fundamental frequency fluctuate greatly, limit the power, the penetration degree of wind power admittance power of the system. Therefore, it is necessary to coordinate the power system to realize large-scale wind power grid connection. In order to carry out diversified research on collaborative control of power systems, a collaborative control method based on source network load and storage optimization is proposed[1-2].

2. Establish the cooperative control model of power system

2.1 Establishment of differential equations and Park transformation
Based on the optimization of source network charge storage, the collaborative control model of power system is constructed to carry out the coordinated optimization of power system. Before the model is built, the construction objectives are firstly analyzed. The main purpose is to realize the horizontal
complementation of multiple sources and the vertical coordination of source network charge storage. Among them, multi-source horizontal complementation refers to the coordination and complementation of various energy resources, including natural gas supply system, heating system, petroleum system and electric power system. It emphasizes the substitutability of various energy sources, and users can choose various energy sources and their access methods[3-4].

According to the result of Park transformation, the Park transformation coordinate system is shown in Figure 1.

![Figure 1 Park transform coordinate system](image)

According to Figure 1, the specific relation of coordinate system can be obtained as follows[5]:

\[
\begin{bmatrix}
  u_\alpha \\
  u_\beta \\
  u_0
\end{bmatrix}
= \frac{2}{3}
\begin{bmatrix}
  1 & -\frac{1}{2} & -\frac{1}{2} \\
  0 & \sqrt{3} & -\sqrt{3} \\
  1 & 1 & 1
\end{bmatrix}
\begin{bmatrix}
  Aaxis \\
  Baxis \\
  Caxis
\end{bmatrix}
\]

(1)

\[
\begin{bmatrix}
  ud \\
  uq \\
  u0
\end{bmatrix}
= \frac{2}{3}
\begin{bmatrix}
  \sin(\omega t) & -\cos(\omega t) & 0 \\
  \cos(\omega t) & \sin(\omega t) & 0 \\
  0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
  u_\alpha \\
  u_\beta \\
  u_0
\end{bmatrix}
\]

(2)

\[U_{\phi0} = P U_{\alpha\beta0}(12)\]

In Equation (1), \( U_{\phi0} \) represents coordinate set of \( u_\alpha, u_\beta, u_0 \), and \( P \) represents the Park transformation matrix, and the specific calculation formula is as follows:
Multiply both sides of formula (3) by the Park transformation matrix to obtain the following formula[6]:

\[
P = \frac{2}{3} \begin{bmatrix}
\sin(\alpha) & \sin(\alpha - 120^\circ) & \sin(\alpha + 120^\circ) \\
\cos(\alpha) & \cos(\alpha - 120^\circ) & \cos(\alpha + 120^\circ) \\
\frac{1}{2} & \frac{1}{2} & \frac{1}{2}
\end{bmatrix}
\]

(3)

In Equation (4), \( U_{\text{idp}0} \) represents the ac side voltage of the invert bridge after Park transformation; \( E_{\text{dp}0} \) represents the grid voltage after Park transformation; \( I_{\text{dp}0} \) represents the reactive power flow of the output current of the Park transformed invert bridge; \( I_q, I_d \) respectively represent the current of different distribution lines after Park transformation[7-10].

3. Simulation Experiment

Two macro variables are substituted into the collaborative control model. First, a power system simulation model is constructed. The specific parameters of the model are shown in Table 1.

| The serial number | Parameters of the project | Parameter data |
|-------------------|--------------------------|----------------|
| 1                 | Bus capacitance (μF)     | 1200           |
| 2                 | Sampling frequency (kHz) | 10             |
| 3                 | Switching frequency (kHz)| 5              |
| 4                 | A logarithmic            | 2              |
| 5                 | Bus voltage (V)          | 1200           |
| 6                 | Network side resistance (Ω)| 0.7         |
| 7                 | Fixed rotor-turn ratio   | 0.27           |
| 8                 | Rotor resistance (pu)    | 0.0121         |
| 9                 | Stator resistance pu)    | 0.0108         |
| 10                | Rated voltage (V/Hz)     | 690/50         |
| 11                | Reticulated inductance (mH)| 0.5        |
| 12                | Rotor leakage flux (pu)  | 0.11           |
| 13                | Stator leakage inductance (pu)| 0.102   |
| 14                | Excitation inductance (pu)| 3.362     |
| 15                | Rated power (MW)         | 2              |

The power system simulation model is built in simulink environment. The model consists of three parts, namely, the electrical main loop part, the grid side converter algorithm control part and the machine side converter algorithm control part. The components of the electrical main circuit are selected from PowerSimsystem toolbox; The control part of the grid-side converter algorithm and the control part
of the machine-side converter algorithm are both written in The S function through C language. After obtaining the reference voltage, the switching pulse signal is transmitted through the PWM module in the PowerSimsystem toolbox.

Four regions in the power system were randomly selected as test objects to verify the FM control deviation results of the proposed method in different regions for collaborative control, as shown in Figure 2.

As can be seen from Figure 2, for different regions of the power system, the frequency modulation control deviation obtained by adopting the proposed method for collaborative control presents an overall trend of first rising and then falling.

4. Conclusion
The power system collaborative control based on source grid storage and storage management is designed in this paper. Therefore, the frequency control deviation is large, after a period of operation, the frequency control deviation decreases significantly. Among them, the deviation of frequency control deviation in different regions is consistent, and only the gap between region 4 and other regions is obvious, which indicates that this method can realize the coordinated adjustment of different regions, effectively reduce the adjustment deviation, and achieve better control effect.

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