Experimental Verification of Real-time Oscillatory Instability Prediction Scheme in CRIEPI's Power System Simulator − Development of Oscillatory Instability Prediction System for Multi-machine System −

Background

As electric power deregulation proceeds, uncertainty in operating conditions of the power system will increase. As a result, the system operating point can be found outside the secure operating limits under severe contingencies. This fact leads that the development of a real-time monitoring, control, and protection scheme using wide-area measurement system typified by PMU (Phasor Measurement Unit) will be more important to prevent large blackout.

Real-time oscillatory stability assessment scheme that can recognize the vulnerability of the power system using phase difference of voltage between substations has been proposed[1][2]. In order to achieve a practical use of the proposed scheme, validation of the scheme on multi-machine power system using noisy data which has transmission delay is needed.

Objectives

To develop Real-time Oscillatory Instability Prediction System (ROIPS) which can be applied to multi-machine power system and to verify the performance of the developed system in CRIEPI's power system simulator;

Principal Results

1. Development of Real-time Oscillatory Instability Prediction System (ROIPS)

The oscillatory stability in power system is evaluated based on the already developed scheme applying to two types of time series data; 1) the phase differences of voltages between substations, 2) rotor angles of generators relative to the phases of their terminal voltages. If both time series data sets have same frequency of unstable oscillatory mode, the power system is judged as unstable. Otherwise, it is stable.

Real-time Oscillatory Instability Prediction System (ROIPS) based on the multi-layered wide-area monitoring architecture was developed (see Fig.1). The first layer is made up of 8 local instability prediction units which are responsible for calculating phase difference of voltage, deriving oscillatory modes and sending the instability prediction result to another unit of second layer. The second layer consists of 1 system instability prediction unit which is responsible for collecting all of the instability prediction results through LAN (local area network) and judging the oscillatory stability of the whole power system.

2. Verification of the performance of the Real-time Oscillatory Instability Prediction System

The ROIPS is tested on a 5 machine system including several complex power oscillatory modes using CRIEPI's power system simulator. A good performance is verified in detecting an oscillatory stability limit produced by setting fault clearing time.

(1) The ROIPS can judge oscillatory stability of the power system every 0.1 seconds.
(2) The ROIPS has sufficient detection accuracy of the frequencies of oscillatory modes and it also assesses oscillatory stability which exhibits complex power swing oscillation (see Fig.2).

Future Developments

We will try further extension of the Real-time Oscillatory Instability Prediction System (ROIPS) to optimal remedial action scheme by generator tripping for preventing large blackout.

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References

(1) K. Yamashita, et.al., 2001, "Development of Step-out prediction through Oscillation Mode Detection based on Time Series Analysis", CRIEPI Report T00026 (in Japanese)
(2) K. Yamashita, et. al., 2005, "Experimental Verification of Real-time Oscillatory Stability Assessment in CRIEPI's Power System Simulator -Development of oscillatory stability assessment system and verification of its basic performance-", CRIEPI Report R04003 (in Japanese)

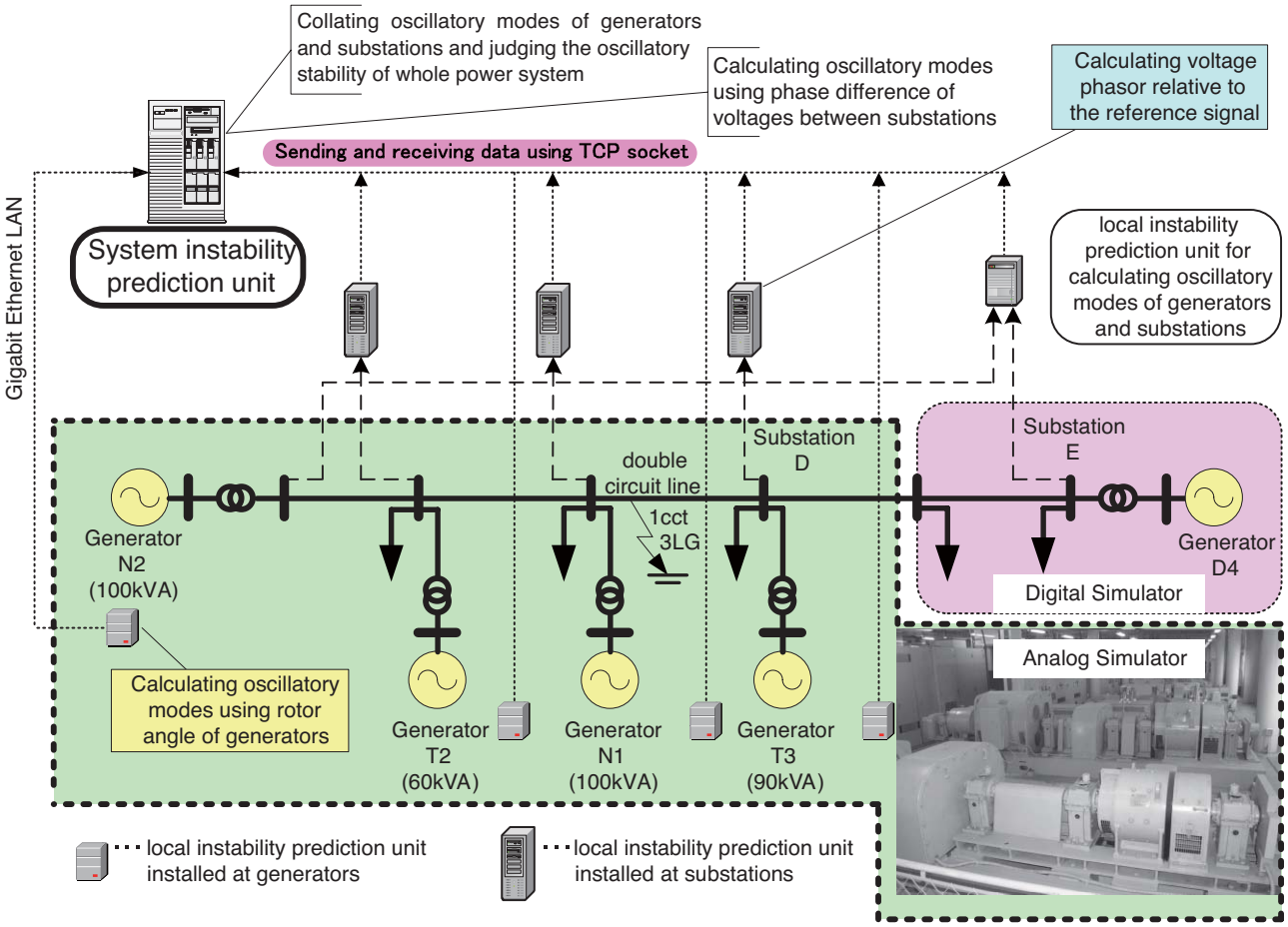

Fig.1 Outline of Real-time Oscillatory Instability Prediction System and the Test System

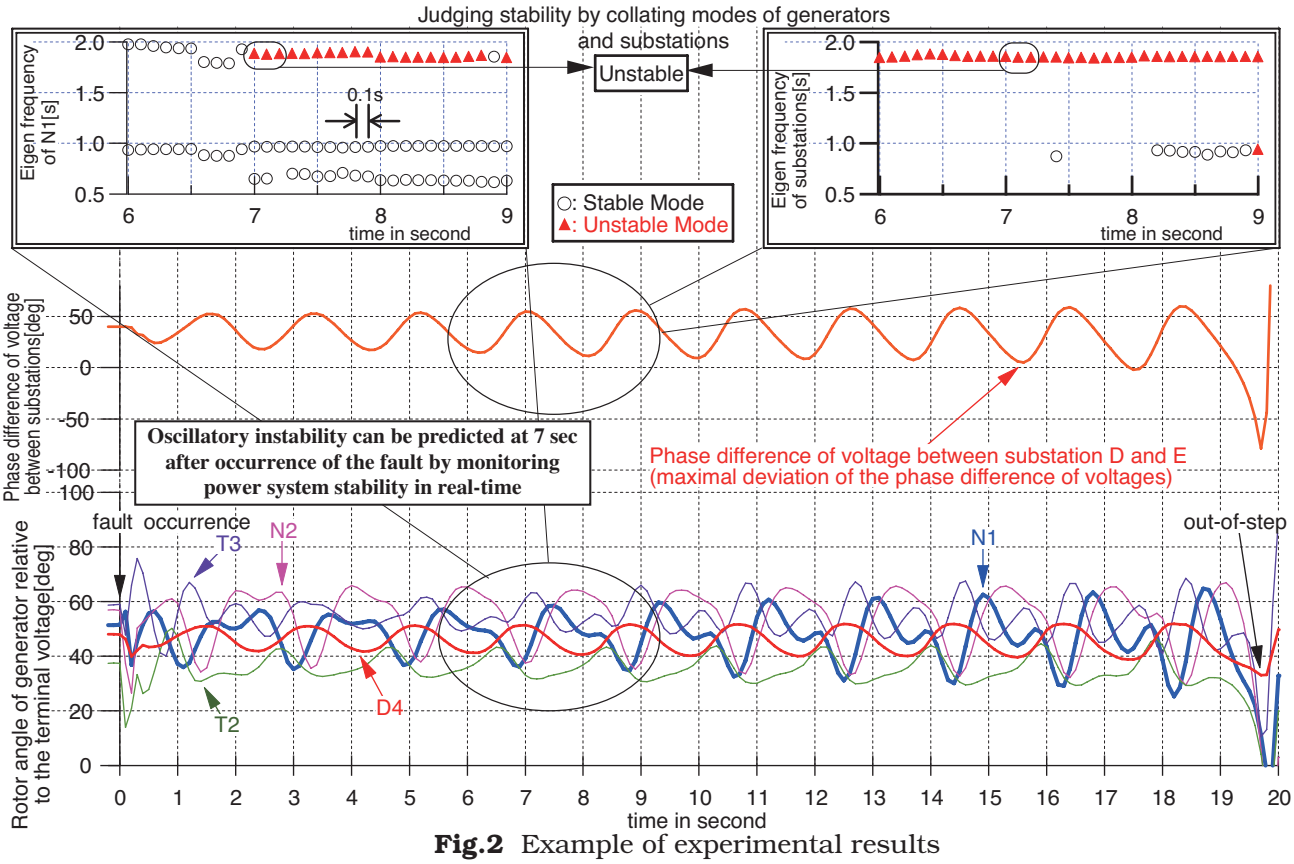

Fig.2 Example of experimental results