Design of a Fuzzy Logic Power System Stabilizer for the Main Interconnected System of Oman

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Abstract

Power systems are subjected to low-frequency disturbances that might cause loss of synchronism and eventually might lead to blackouts. The oscillations, which are typically in the frequency range of 0.2 to 3.0 Hz, might be excited by the disturbances in the system or, in some cases, might even build up spontaneously. These oscillations limit the power transmission capability of a network and, sometimes, even cause a loss of synchronism and an eventual breakdown of the entire system. To mitigate this, Power system stabilizers (PSS) are used to generate supplementary control signals for the excitation system in order to damp these low frequency power system oscillations.

Previous studies show that Oman Main Interconnected System (Oman-MIS) experienced low frequency oscillations that might affect the system’s stability. The existence of a lightly-damped low frequency oscillations was observed across many geographical locations in Oman after a three-phase short circuit fault occurred on a 132 kV transmission line. Furthermore, the system is now expanded and have three main voltages for the transmission network: 400kV, 220kV and 132kV. Therefore, it is advisable to investigate the low frequency oscillations in the upgraded network and propose solutions to overcome such oscillations.

The main objective of this research is to design a fuzzy logic controller (FLC) for Oman-MIS to damp unpredicted oscillations. Unlike the Conventional Power System Stabilizers (CPSS), the fuzzy logic controller design does not need exact mathematical equations of the system. It just depends on some logic rules, IF-THEN rules, which use the linguistic knowledge of system’s operator.

In order to compare performance, two PSS’s were designed: a CPSS was designed using frequency-response approach, and a fuzzy logic PSS (FLPSS) was designed based on normalized membership functions and linguistic rules. Then, the Oman Main Interconnected System (MIS) was modeled using MATLAB/Simulink extracted from a DgSILENT model. The system performance for each PSS was achieved by simulating the whole system in MATLAB/Simulink environment.

A three-phase short circuit fault was imposed in one of the 400kV bus bars. The built model of Oman-MIS in MATLAB/Simulink experienced severe low-frequency oscillations when there was no PSS installed on the generators. With the use of the CPSS only, light damping to the systems oscillations was observed. Whilst the proposed FLPSS had much better damping to those oscillations.