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Fuzzy-based controller for DVR in the presence of DG

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Abstract

The fuzzy logic (FL) comes as a vital and viable solution method in various engineering fields which mutates the optimal point in many engineering issues. This study presents a fuzzy-logic approach to promote the controller performance. The power system is one of the fundamental, complicated and principle systems in the world, doing so there has been several control ways to survive system stability such as dynamic voltage restorer (DVR). DVR is a power component that deals with power quality improvement and compensation of voltage sags and swells. The importance of DVR increases intensively, due to numerous counts of prohibitive sensitive loads throw power swing condition. The necessity to have a secure power supply in feeding DVR, leaned the presence of distributed generators (DG). Accordingly, the results indicate the effectiveness of the fuzzy-based adaptive PI-controllers versus a classic proportional-integral (PI) controller which has been accomplished in MATLAB/SIMULINK software.

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Keywords: Fuzzy logic (FL); dynamic voltage restorer (DVR); distributed generator (DG); voltage sag; voltage swell; power quality.

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1. Introduction

Increasing the energy consuming more over the effect of sensitive nonlinear loads in power systems, the optimal operating and high-quality power transferring becomes a considerable issue. There have been different components to reach this purpose such as flexible alternating current transmission systems (FACTS) in high voltage transmission lines and custom power devices in medium and low voltage distribution grids Anaya-Lara and Acha (2001). The custom power components improved operating system reliability as well as power quality. Dynamic voltage restorer (DVR) is a common solution to attain this objective. Continuously switching and curtailment of giant loads or happening severe faults cause to voltage sags and swells.

The voltage sags and swells are harmful to voltage sensitive loads Babaei et al. (2007). Under such circumstances the protection circuit of sensitive load operates when the curtailment happens, so the reliability factors in system decrease. Referring to IEEE standard 1159 voltage sag and swells divided into three types as instantaneous, momentary and temporary. In first, second and third types duration subsequently defined 0.5-30 cycles, 30 cycles up to 3 seconds and 3 seconds till 1 minute. Henceforth, the magnitude in all types of voltage sag phenomenon is from 0.1 to 0.9 in per unit. However, there are distinct magnitude levels for voltage swell in each type (1.1-1.8, 1.1-1.4 and 1.1-1.2 respectively) IEEE std (2009).

Nomenclature

NB	negative big
NM	negative medium
NS	negative small
Z	zero
PS	positive small
PM	positive medium
PB	positive big

2. Dynamic voltage restorer (DVR)

DVR is a solid state device connected in series before fuse and sensitive load. It operation mode bisected as standby and injection (boosting mode). Standby status illustrated the acceptable range of voltage in the system and it looks like on the shelf condition because DVR has been bypassed ideally. The standby status could adjust to compensate the voltage drop of transformers in line. Injection status is under fault occurring situation and DVR should inject voltage to point connected couple (PCC) under voltage sag circumstances and absorb the additional voltage from PCC during voltage swells. By reduction of magnitude during a voltage sag, DVR ought to inject rested magnitude to restore nominal voltage signal. That's necessity to have an accurate controller for reverting voltage signal considering phase, magnitude and frequency. This process could carry out in three phase. This compensating device has various virtue comprising of line voltage harmonics compensation, fault current limitations and reduction of transient in voltage Banaei et al. (2006). The main structure of DVR contains storage devices, injection transformer (down-step), harmonic filter (low-pass), control and protection system, voltage source converter (VSC) and DC charging circuit.

2.1 Conventional control units of DVR

The control unit aims to make a steady form of the voltage signal in disturbances either system normal operating at PCC. The common infrastructure of control unit consists voltage correction processing. Pulse width modulation (PWM) is the later stage after control unit to prepare the signal for VSI/VSC stage. The difference of reference voltage and PCC measured voltage has been determined by the control unit and it orders to inject given voltage to the system. Proportional-integral (PI) is the most common controller type utilizes in DVR as the vice is no efficiency in promoting