Mitigation of High Frequency Forced Oscillation through Renewables

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Abstract

Forced oscillations pose a major threat to the stability and secured operation of power system as they can have detrimental influences, such as reducing transmission capacity or even resulting in outages. Conventionally, a controller is placed in a renewable power plant close to the forced source to suppress the oscillations temporarily. The conventional controller can suppress low frequency oscillations to a great extent. However, in case of high frequency oscillations, the controller has limitations. With some modifications in the controller structure, the controller can be capable of damping high frequency forced oscillations effectively.

Challenges and Opportunities

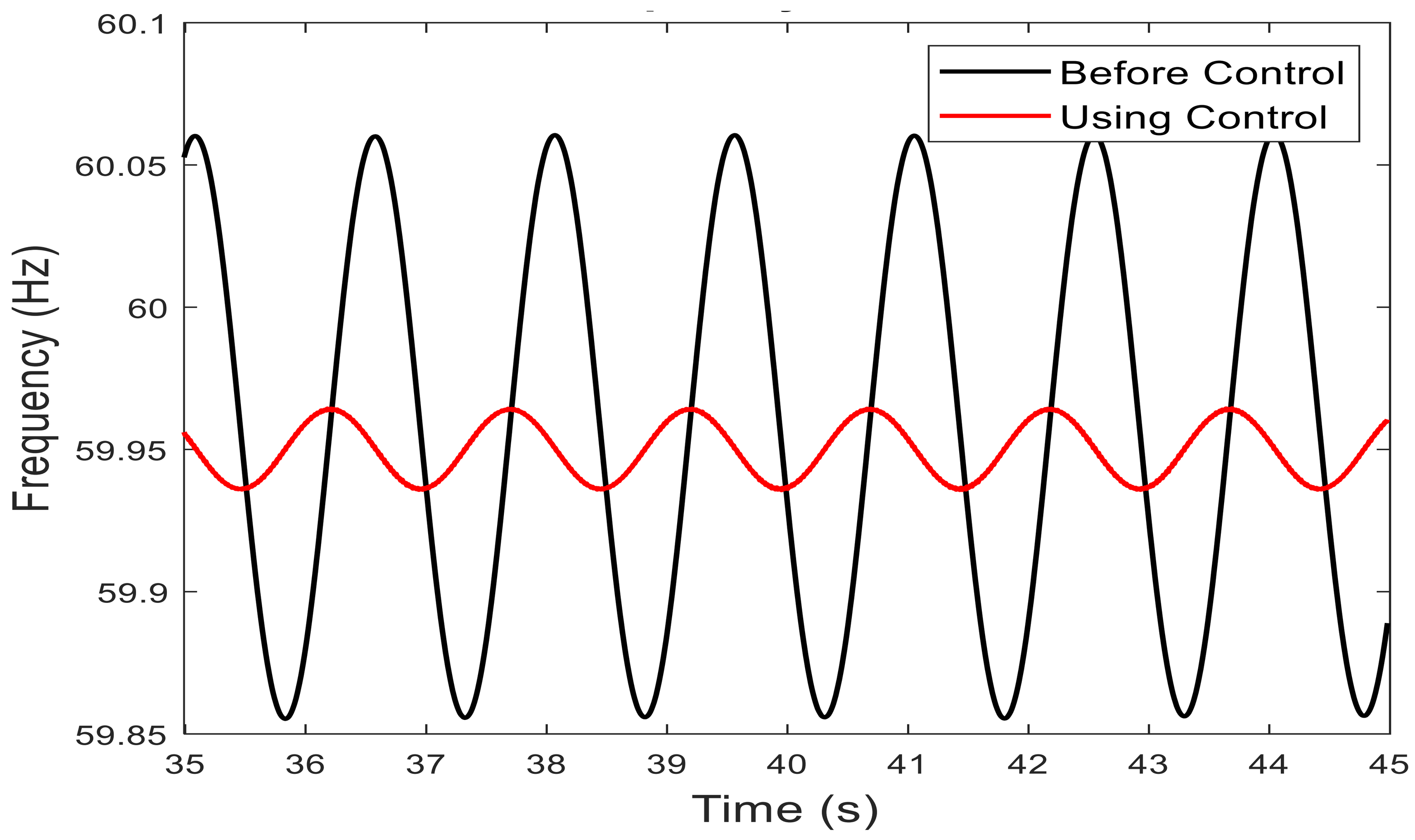

Fig 1: Sufficient damping performance for low frequency forced oscillation (0.67Hz)

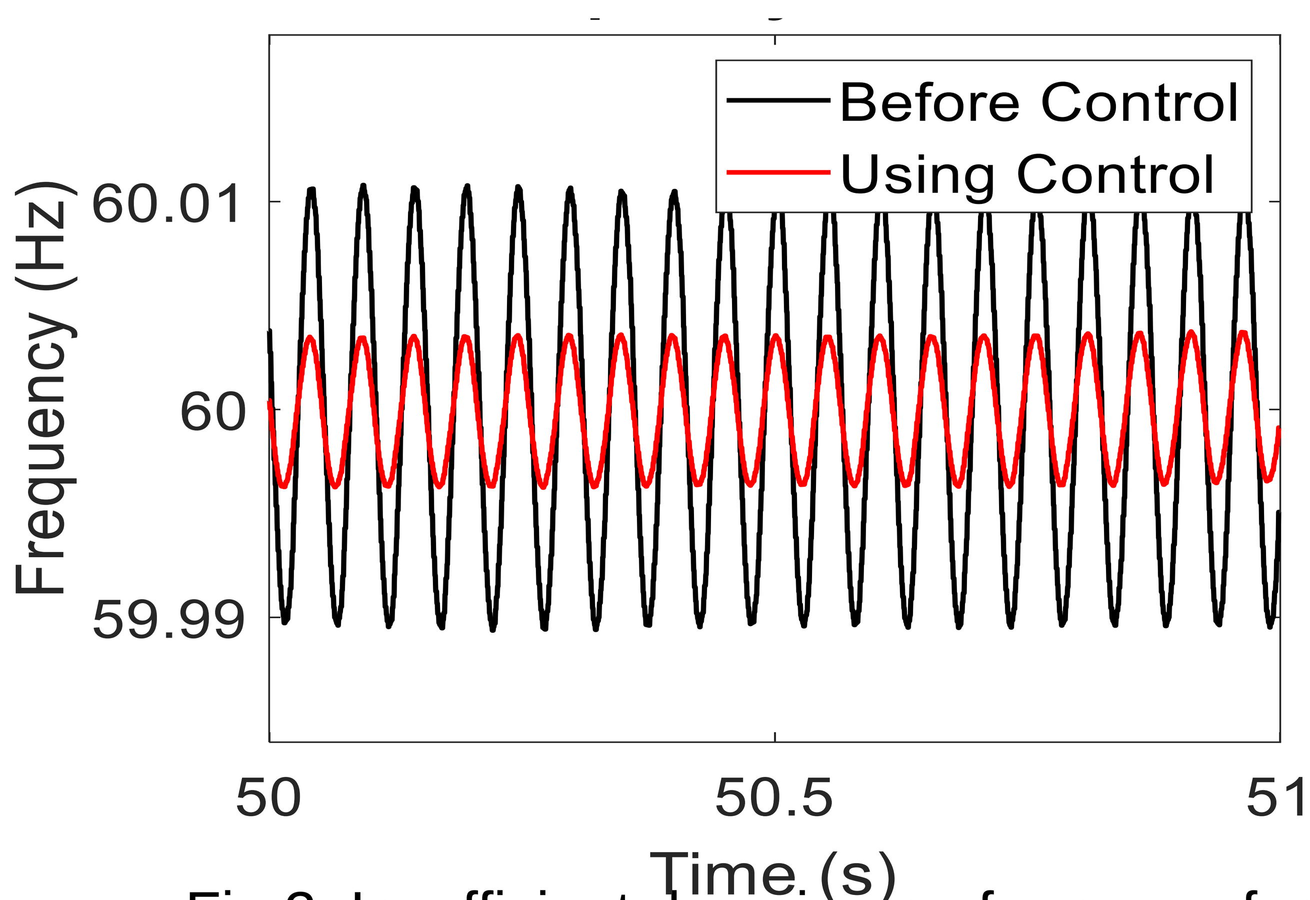

Fig 2: Insufficient damping performance for low frequency forced oscillation (19.5Hz)

- Simulations on a 13-bus model developed in PSCAD shows that low frequency forced oscillations can be damped sufficiently the traditional droop controller, whereas high frequency forced oscillations can only be damped by no more than 60%.
- By exploring the actuator (PV models) behave, we found that the actuator does not response to the high frequency oscillations as sufficiently as to the low frequency oscillations.
- The existing controller is no longer appropriate for high frequency oscillation design since it does not consider the controller impact on both high frequency and low frequency, which will finally limit its damping performance.

Solutions and Improvements

Controller which consists of a control gain, second order high pass filter and phase shift blocks is proposed to damp high frequency oscillation and minimize the control impact on the system dynamics at other frequency bands. Figure 9 illustrates 82% damping achieved with the proposed controller in the source location. This is a great improvement compared to 60% damping with conventional controller illustrated in Figure 2.

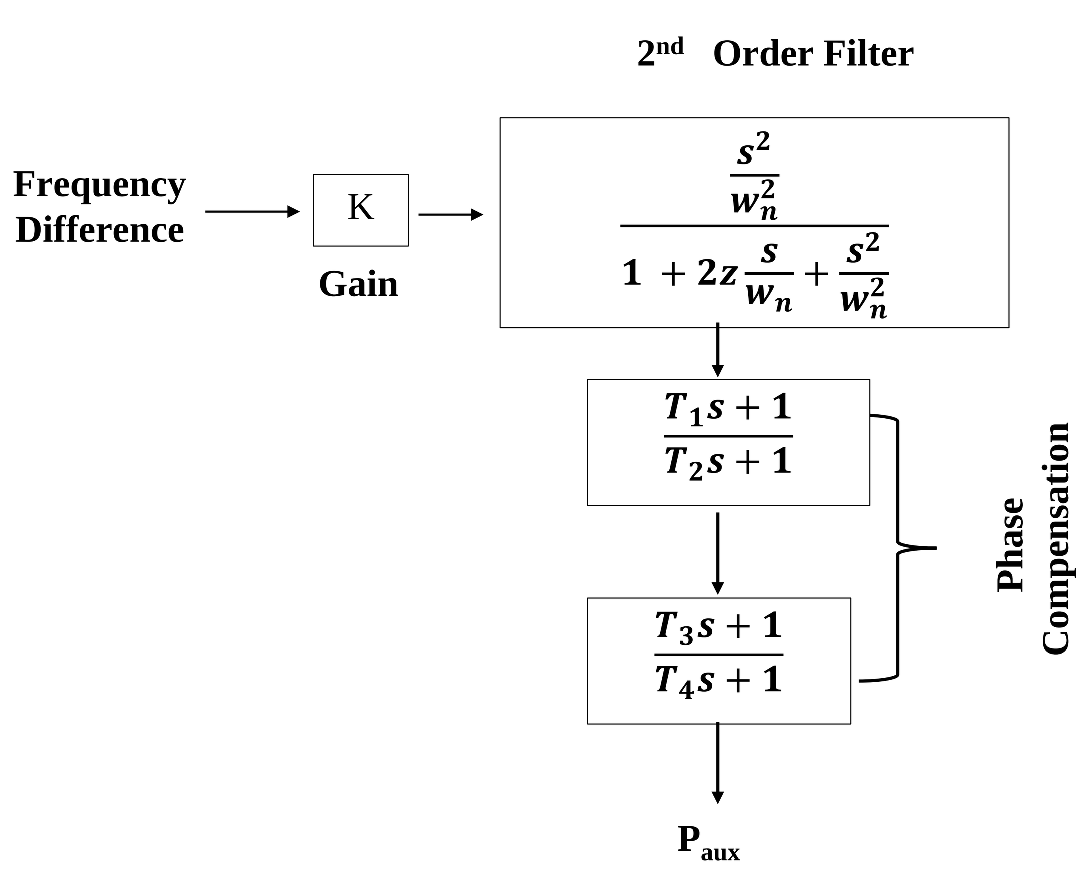

Fig 3: Modified Controller Scheme

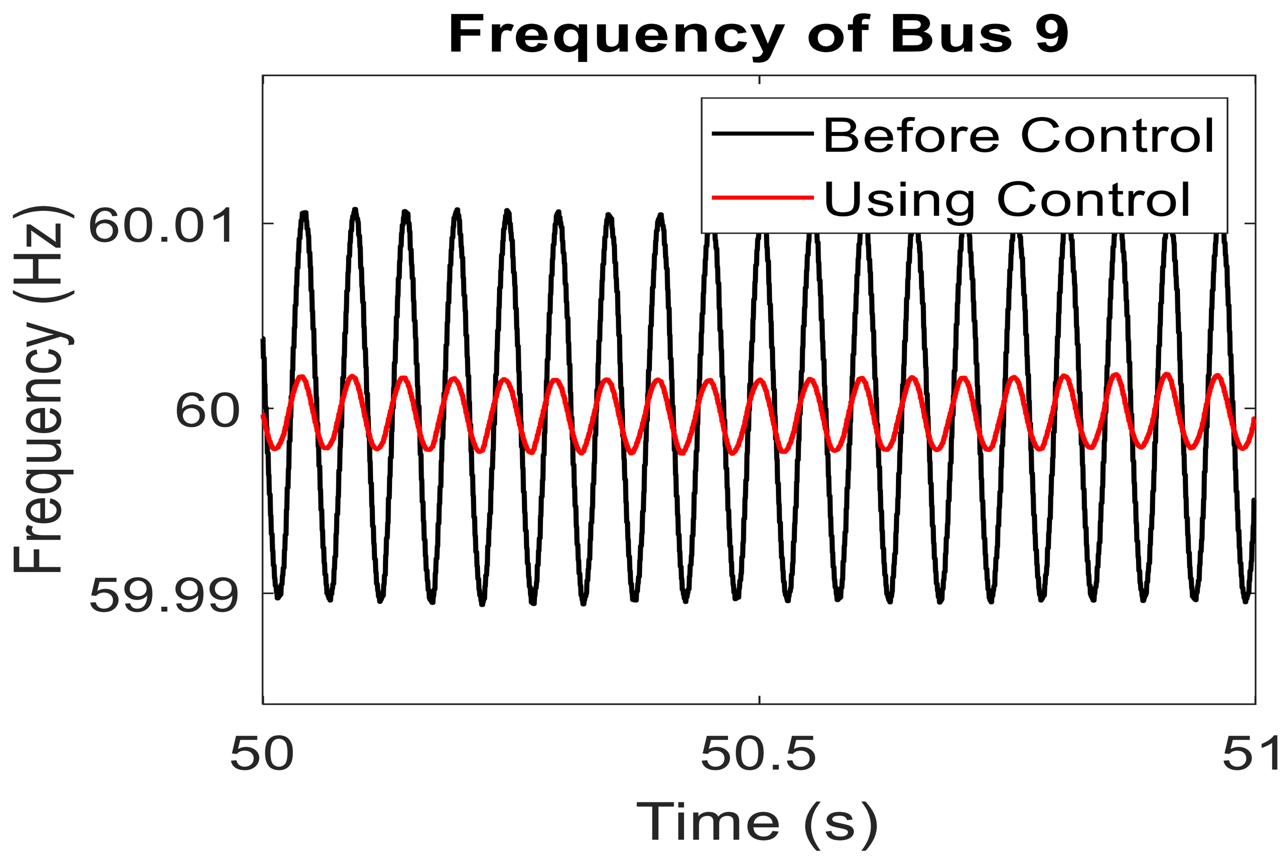

Fig 4: Proposed damping controller performance

Conclusion

This paper proposed a innovative control structure to better improve the damping performance of high frequency oscillations in power grid. The proposed controller performance has been validated through a 13-bus power grid model in PSCAD. All of the buses in the system could achieve 81%-84% damping with the proposed controller, compared to 60% damping with the conventional controller.