Abstract- Using time-synchronized phasor measurements, a new signal processing approach for estimating the electromechanical mode shape properties of a power system is proposed. In this method, based on low frequency oscillation modal frequencies and damping ratios identified by the autoregressive moving average (ARMA) models using Bayesian information criterion and ARMA(2n,2n-1) modeling procedure to automatically select the optimal model order, Prony models of ambient signals are further presented and the mode shape information of multiple dominant interarea oscillation modes can be simultaneously estimated. The approach is applied to both a simulation system and measured data from China Southern Power Grid. Its advantages are demonstrated compared with the current spectral density analysis method.
Index Terms- electromechanical dynamics, mode shape, ambient signal, model order selection, ARMA-P method

I. Introduction

Knowledge of the electromechanical modal properties of a power system is of great importance for safe and reliable operation[1]. Similar to modal frequency and damping information, near real-time operational knowledge of the mode shape properties of a power system provides critical information for control decisions. The mode shape information may also be used to optimize the process of generators and/or loads shedding to improve the damping of a dangerously low-damped mode; i.e. only those generators and/or loads that are most actively participating in the mode would be shed.

Estimating the mode shape properties can be accomplished using two basic approaches: eigenanalysis of a small signal model [1], or as shown in this paper, signal processing of time-synchronized measurements. Wide area measurement system (WAMS) that can collect signals all over the power system is used as the data platform. An important advantage of this method is that the mode shape identifications are based directly upon the system measurements, without depending on a large, complex system model. In this approach, Prony algorithm is widely used, which is often applied to ringdown signals [2-3]. However, under practical conditions, ambient signals caused by low-level stochastic disturbances, including a lot of information about the system, are more easily collected.