An Insight to the Performance of Estimation of Distribution Algorithm for Multiple Line Outage Identification

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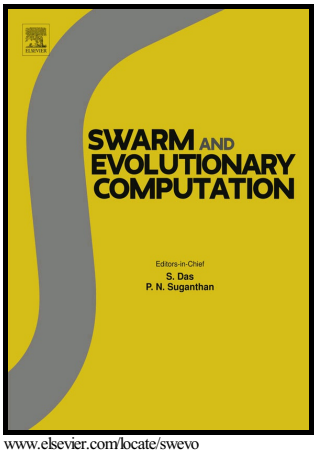

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***Abstract*—Realtime information relating to line outages has significant importance to pre-empt against the the power system blackouts. Realtime information can be obtained by using phasor measurement units (PMUs) facilitating the realtime synchronized observations of voltage and current phasors at buses being monitored. Different optimization formulations including but not limited to linear, integer, stochastic, mixed integer and NP hard combinatorial optimization have been used to manipulate these phasor measurements for the detection of line outages. Single and double line outages can be addressed using combinatorial optimization but these are infeasible to apply for the detection of multiple line outages as the increased number of lines increases computational complexity. To alleviate the exponentially increased complexities of these combinatorial optimization problems, while investigating for multiple line outage, evolutionary, Estimation of Distribution Algorithm is used. This method gives near optimal solution in which computational complexity and time is reduced efficiently. In this paper we scrutinize the use of phasor angle measurements to detect multiple power line outages. The proposed EDA is compared with binary particle swarm optimization (BPSO) algorithm, adaptive BPSO and genetic algorithm (GA) in terms of line outage detection performance, fitness convergence w.r.t. iterations and time consumption. The simulation results depict that the proposed EDA outperforms the other state of the art algorithms.**

***Index Terms*—Estimation of Distribution Algorithm, Multiple Line Outage Detection, Smart Grid**

I. Introduction

Power systems represent the networks of various electrical devices namely, power plants, transformers, transmission lines and distribution lines aimed to provide the electricity to the consumers. Utility companies are striving to provide interruption free and ample supply of electricity to their customers at the lowest possible rates [1]. When line outage occurs, the power flow in the system is changed, and some the of lines become overloaded which results in line failures. These line failures further cause cascaded failures, if not properly maintained in time. This situation can culminate the blackout of the whole power system, or some major part of the system.

It is critically important to have a mechanism of precise and swift observation of the system states to achieve power system stability and reliability [2]. Timely detection and restoration of line outage requires accurate identification of the fault location using realtime measurements of various transmission line parameters. This will enable the utilities to minimize the outage time, operational expenses and to increase the customer satisfaction [3]–[5]. Phasor measurement units can be used to facilitate GPS-synchronized more precise, time correlated observations relating to voltage and current phasors [6]. PMUs have the capability to furnish various phasor quantities namely, magnitude and angles of the bus voltages along with the time of observation of each measurement. These measurements are time synchronized as each PMU uses common time source [7].

In order to realize a cost effective identification of power line outages, the first step relies on an optimal PMU placement. The objective of this step is to obtain a complete network observability with minimum number of PMUs. In the next step, the rich phasor data is exploited to identify the individual lines in outage. The literature proposes a number of solutions to both steps. Some remarkable works are discussed as follows. In [8], a Support Vector Machine (SVM) classification tool based on artificial intelligence has been suggested to find the health of the transmission line. A single line outage identification technique has been proposed in [9] employing PMUs phasor angle measurments and the other topological information relating to power system. The double line outage identification was addressed by the authors using system topology information before and after the line outage in addition to the knowledge of the PMUs measurements. In [10], preventive integrated equipment maintenance scheduling problems in power systems are discussed. Teaching Learning Based Optimization (TLBO) has been used as a prime optimization tool, as it has been proven to be very effective optimization algorithm when applied to various practical optimization problems and its implementation is simple involving less computational effort. The model for unit commitment considering generator outages is formulated in [11], where the reliability requirement is incorporated into the spinning reserve constraint in the optimization design. An intelligent technique based on cascade neural network (CNN) is presented in [12] for identification of the overloaded transmission lines in a power system and for prediction of overloading amount in the identified overloaded lines. The task of security enhancement is formulated as a multi-objective optimization problem with minimization of fuel cost and minimization of FACTS device investment cost as objectives in [13].

A binary particle swarm optimization (BPSO) based methodology for the optimal placement of PMUs is proposed

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