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Hierarchical Agglomerative Clustering Algorithm method for distributed generation planning

K. Vinothkumar [a], M.P. Selvan [b,*]

[a] ABB Global Industries and Services Limited, Chennai, Tamil Nadu 600 089, India
[b] Department of Electrical and Electronics Engineering, National Institute of Technology, Tiruchirappalli, Tamil Nadu 620 015, India

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ABSTRACT

Planning of distributed generator (DG) units in the distribution system employing Hierarchical Agglomerative Clustering Algorithm (HACA) is proposed in this paper. The proposed method overcomes the dependency of existing methods of DG placement, either on the entire global preference information or on the experience of the distribution system planner. The proposed method is validated with weighted sum method and its effectiveness is tested using two distribution systems of different size and configuration. The results of the simulation study demonstrate the suitability of proposed method in solving the problem involving multiple objectives in DG planning studies.

1. Introduction

Escalating electricity demand, diminishing fossil fuel reserves and increasing concern about environmental pollution have motivated the researchers in employing clean and green renewable energy technologies as distributed generators (DGs) for electric power generation. Such DGs should be appropriately placed in the distribution system so that their beneficial effects are properly utilized. In the past, several methods for optimal placement of DG units in the distribution system were proposed [1–18]. In [1], a set of possible locations for DG placement were identified based on the spatial distribution of voltage and loss sensitivity indices. Ghiani Celli et al., transformed the multi-objective function into master and slave objective functions for identification of grid integration points of DG units in the distribution system [2]. Carpinelli et al., employed genetic algorithm for evaluation of multiobjective problem. Later, double trade-off method was utilized to reduce the size of generated non-inferior solution set [3]. An algorithm based on tabu search was proposed by Hemadani Golshan and Arefifar [4]. A multiobjective programming based on non-dominant sorting genetic algorithm for placement of DG units was proposed by Ochoa et al. [5], utilizing time varying behaviour of load and wind speeds. Though these methods do not require the formulation of an explicit utility function, the algorithms are usually complicated and computationally intensive. In all the above approaches, a set of desirable and efficient solutions are generated which are then presented to the distribution system planner to choose the best compromise solution based on his preferences. However, in practice, it is very difficult for the distribution system planner to choose the best compromise solution if many efficient solutions are generated [19].

In order to overcome this shortcoming, weighted sum method was employed in [6–13] for transforming the multi-objective function into single objective so that a single definite solution can be presented to the distribution system planner. Though this method is computationally less intensive, it requires entire global preference information of the distribution system planner for the formulation of exact utility function. However, in many decision situations, it is very difficult to extract the entire global preference information of the distribution system planner to construct an explicit utility function [19]. Hence, a simple, yet effective DG planning method is proposed in this paper employing Hierarchical Agglomerative Clustering Algorithm (HACA) to overcome the dependency of existing methods of DG planning on the experience of the distribution system planner for either problem formulation or solution identification.

Given the set of data points, each having a set of attributes and a distance measure, clustering is the process of grouping the data set into subsets, called clusters, so that the data in each subset share some properties in common. Usually, the common properties are quantitatively evaluated by some measures of optimality such as minimum intra cluster distance, maximum inter cluster distance because of the huge variety of the problems and data distributions,

* Corresponding author. Tel.: +91 4312503262.
E-mail address: selvanmp@nitt.edu (M.P. Selvan).

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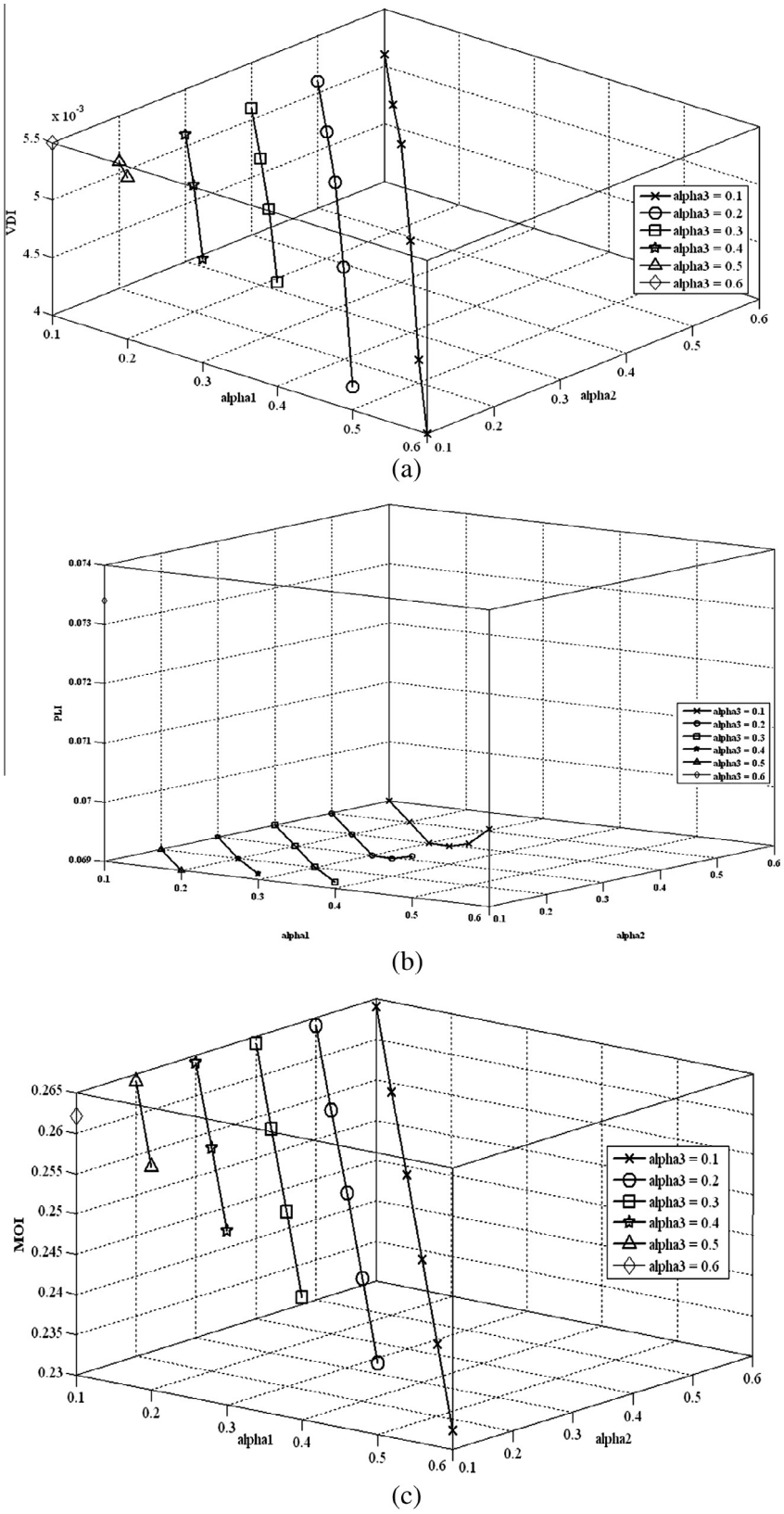

(a) Effect on VDI (b) Effect on PLI (c) Effect on MOI

Fig. 1. Effect of value of weighting factors on performance indices.

different techniques, such as hierarchical, partitional, and density-and model-based approaches were developed [20,21]. Of all above, Hierarchical Clustering algorithm is very simple and most popular [22–24]. Furthermore, as the number of data set in