Engineering Applications of Artificial Intelligence, vol.139, no.Part B, pp.109617-1-109617-11, January, 2025.

Data-driven estimation of the amount of under frequency load shedding in small power systems

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Abstract-

This paper presents a data-driven methodology for estimating under frequency load shedding (UFLS) in small power systems. UFLS plays a vital role in maintaining system stability by shedding load when the frequency drops below a specified threshold following loss of generation. Using a dynamic system frequency response (SFR) model we generate different values of UFLS (i.e., labels) predicated on a set of carefully selected operating conditions (i.e., features). Machine learning (ML) algorithms are then applied to learn the relationship between chosen features and the UFLS labels. A novel regression tree and the Tobit model are suggested for this purpose and we show how the resulting non-linear model can be directly incorporated into a mixed integer linear programming (MILP) problem. The trained model can be used to estimate UFLS in security-constrained operational planning problems, improving frequency response, optimizing reserve allocation, and reducing costs. The methodology is applied to the La Palma island power system, demonstrating its accuracy and effectiveness. The results confirm that the amount of UFLS can be estimated with the mean absolute error (MAE) as small as 0.179 MW for the whole process, with a model that is representable as a MILP for use in scheduling problems such as unit commitment among others.

Index Terms- Novel regression tree; Tobit model; Data-driven model; Island power systems; Machine learning; Under frequency load shedding

Citation:
Kazemtabrizi, B.; Lobato, E.; Rajabdorri, M.; Sarvarizadeh, M.; Sigrist, L.; Troffaes, M. "Data-driven estimation of the amount of under frequency load shedding in small

power systems", Engineering Applications of Artificial Intelligence, vol.139, no.Part B, pp.109617-1-109617-11, January, 2025.