Discussion and Closure

Discussion on "A New Framework for Detection and Identification of Network Parameter Errors"

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THE AUTHORS present an interesting method on Normalized Lagrange Multiplier test for network parameter errors identification. The authors state that validation has so far been solely based on extensive simulations. They also state that the paper presents a new framework by which: (1) the normalized Lagrange multiplier test is re-formulated from the perspective of hypothesis testing, enabling proper handling of missing bad parameter cases; (2) formal proofs are given for the combined utilization of normalized Lagrange multiplier test and normalized residual test for simultaneous handling of measurement and parameter errors; and (3) the concepts of detectability and identifiability for measurement errors are extended to parameter errors, and a systematic approach for identifying critical parameters and critical k-tuples is provided. However, in the paper section II, they present in the problem formulation:

$$z = h(x, p_e) + e \tag{1}$$

where z is the measurement vector, x is the state vector, e is the measurement error vector, and h is the nonlinear function linking x and p_e to z. Also,

$$p_e = p - p_t$$

p_t being the true parameter value, not known, and p the parameter available from the data.

They say the Weighted Least Square (WLS) state estimation problem can be formulated as:

$$Min\ J(x, p_e) = \frac{1}{2} r^T R^{-1} r \quad s.t.\ \ p_{e=0} \tag{2}$$

where r is the residual vector $(z - h(x, p_e))$ and R is the covariance matrix of the measurements.

To eliminate the previous constraint, they say they will form the Lagrangian of the previous equation.

That is:

$$L\big(x, p_{e,} \lambda\big) = \frac{1}{2} r^T R^{-1} r + \lambda^T p_e \tag{3}$$

where λ is the Lagrange multiplier vector associated with p_e.

Then applying the first-order necessary condition for optimality will yield:

$$\frac{\partial L}{\partial p} = H_p^T R^{-1} r + \lambda = 0. \tag{4}$$

The **questions** are: (i) in the problem formulation, equation (1), the function $h(x, p_e)$ is not available, but $h(x, p)$. (ii) in equation (2) the minimization of $J(x, p_e)$ where the residual is $r = z - h(x, p_e)$ is not possible to be calculated, since $h(x, p_e)$ is not available. (iii) The covariance matrix R is said to be of the measurements, should it be the covariance of the residuals? For normalization purposes, it must be the residual covariance, instead. (iv) I am afraid, equation (4), the derivative of the Lagrangian L in relation to p is not correct, for example: $\frac{\partial L}{\partial p}(\lambda p_e) = \lambda$. (v) When applying the first-order necessary condition for optimality of (3) it appears H_p, the Jacobian of $h(x, p)$, but in the formulation problem one has $h(x, p_e)$? As far as we know, the Kushner-Kuhn-Tucker conditions is the first order necessary condition for optimality guaranteeing that in the SE solution $p_e = 0$. Equation (4) does not guarantee $p_e = 0$ in the solution. It needs to be clarified. We believe the rest of the paper will be harmed, in case a solid answer to the raised questions does not appear.

Could the authors, please, clarify why they do not minimize the measurement error instead, in place of the residual? The residual does not have much meaning since it is just a distance between the measurement vector z and the function vector h.

It has been proved that the error has a unique decomposition: (i) one component orthogonal to the Jacobian range space; and (ii) the other error component that is in that space. Then the error can be composed and estimated. The measurement with error then can be corrected bringing big advantages to power industry since no measurement needs to be deleted anymore, as they do in these days. For that purpose, please see [1]–[3] below.

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References

[1] N. G. Bretas, S. A. Piereti, A. S. Bretas, and A. C. P. Martins, "A geometrical view for multiple gross errors detection, identification, and correction in power system state estimation," *IEEE Trans. Power Syst.*, vol. 28, no. 3, pp. 2128–2135, Aug. 2013.

[2] N. G. Bretas, A. S. Bretas, and S. A. Piereti, "Innovation concept for measurement gross error detection and identification in power system state estimation," *IET Gener. Transm. Distrib.*, vol. 5, no. 6, pp. 603–608, Jun. 2011.

[3] N. G. Bretas and A. S. Bretas, "A two steps procedure in state estimation gross error detection, identification, and correction," *Int. J. Elect. Power Energy Syst.*, vol. 73, pp. 484–490, Dec. 2015.