Skoltech

Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Sajjad Asefi

PhD Program: Engineering Systems

Title of Thesis: Advancements in power system state estimation: innovative algorithms and solutions for enhanced reliability and efficiency

Supervisor: Assistant Professor Elena Gryazina

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	 **Date: 20-11-2023**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

The thesis work focuses on sate estimation aspect of power systems. This problem is prominent due to a wide variety of reasons: changes of meters, or communication systems, planned manipulations form the attacker etc.

The thesis consists of 7 chapters. Chapter 1 introduces the problem of state estimation. Chapter 2 covers the existing results on the thesis topic. Chapter 3 includes modeling approach of system components, problem statement for weighted least squares and challenges of state estimation: bad data, loss of generation or load and data injection attacks. The solution weighted least squares problem is then considered in the next chapter. Chapter 4 describes state estimation algorithm. The author considers centralized and then distributed approaches gradually increasing complexity, which allows easy understanding of the thesis ideas. Chapter 5 contains results of numerical simulations. Finally, Chapter 6 covers the possible applications of the developed approaches. Despite the variety of methods presented in Chapter 4, their description is clear and well-supported by numerical results. Description of the thesis reflects a good degree of investigation of both physical mechanism of electrical grids and possibilities of bad data or attack events. The thesis is logically constructed and reflects candidate ability to use analytical models and perform numerical simulations.

Key results of this thesis are novel and appeared in a number of good quality publications.

There are no fundamental weaknesses that require further attention. However, upon close reading the problem statements and equation I came across a couple of relatively minor issues that should be corrected or considered prior to the defense. They are the following:

1. Section 3.1 is dedicated to power system modelling. Transformers are not considered in this section (which is a logical assumption for this work). However, figures 3-2 and 5-3 have transformers in them.
2. Formula (3.2). No explanation is given for the entities x_t, z, h and R. What dimensions do they have? Is matrix R positive/negative definite? What does index t mean? If h is a mapping, is it continuous, differentiable etc.?
3. Text would benefit from the reference for the formula (4.1).
4. In formula (4.6) and other optimization problems what are optimization variables? What sets do these variables belong to (i.e. can x be positive or complex etc.)
5. In formulas (4.10) and (4.11) should it be "×" instead of "."?
6. In some formulas (i.e. (4.7)) product is denoted by "×" and in some (i.e. (4.36)) no symbol is used. It is a bit confusing, since "×" symbol is often used for element-wise product. I suggest using one type of notations throughout the thesis.
7. Equations (4.13), (4.14) do not have line shunt elements, but equations (4.15), (4.16) do. Please check, model is correct.
8. In (4.10) H is a function of x. In (4.36) after transition to DC equations it does not have any arguments. Please add a brief explanation.
9. In (4.41) $\forall k$ should be $\forall k \in K$.
10. In (5.21) elements can elements $c_{i,j}$ be equal only to 0 or 1, or can there be weights associated with them?
11. In (5.22) what W_L is equal to if $c_{i,j} \neq 1$ and $i \neq j$?

Provisional Recommendation

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*
☑ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*
☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*