REVIEW ON PHASOR MEASUREMENT UNIT NOISE REDUCTION

Soumitra Kumar Sarker[1], Dr. Anand Monha Sharma[2]
[1, 2] *Department: Electrical Engineering, AP Goyal Shimla University, Shimla, Himachal Pradesh, INDIA*

Abstract- First scenario, noise is added to the PMU input signal. The test runs a sweep of Signalto-Noise Ratios (SNR) and the accuracy versus the noise level is obtained. The second scenario injects multiple harmonics with the input to test the influence on accuracy. The last scenario focuses on instrument transformer saturation which leads to a modified waveform injected in the PMU. This test goes through different levels of Current Transformer (CT) saturation and analyzes the effect of saturation on the accuracy of PMUs. The test results show PMU measurements will be degraded when the input signal is distorted by high noise or a saturated current waveform, but is not particularly affected by multiple harmonics. This information can be used when selecting a PMU to ensure it will provide a reliable measurement for the intended use. It can also be used for developing more robust PMUs and applications resistant to degraded measurements.

I. INTRODUCTION

Estimation of different variables of power system has been an important problem which needs to be addressed. Various researchers and industries have attempted this problem over the years as it helps to estimate improve the power quality and security [1] [2]. The problem has gained importance further since the inception of smart grids. The concept of smart grids has drawn the attention of researchers because of their improved performance in terms of quality of power and efficient management of resources. But along with the loads of advantages brought by smart grids, there are some inherited challenges which need to be addressed [3]. The whole idea of making our grids smart is achieved through combining the IT sector with the Power System. This means prediction of loads and power system parameters in advance which makes accurate decision making.

1.1 Parameters in power system

The problem of load flow in power system forms an example of classic engineering problems in power system. In most of the cases of circuit analyses, the network components are limited to known value of impedances with current and voltage source [4] [5]. But the load flow problem is different in the sense that instead of impedances, the known quantities are active and reactive powers at most network buses, because behavior of most of the load in a lot of cases are as constant power loads, assuming that voltages applied on them remains within acceptable ranges. The set of unknowns producing power balance at all of the specified buses in the system is solved by the load flow algorithm. The power balance equation is given by equation.

$$P_i^{given} + jQ_i^{given} = P_i^{comp} + jQ_i^{comp}$$

Where,

$$P_i^{comp} + jQ_i^{comp} = V_I I_i^*$$

Stated otherwise, the specified power at a particular bus must be same as that of the power flowing into the system. The power which is generated is taken as positive power, which makes it consistent with KCL equation YV=I.

1.2 Need for estimation of these parameters

All the stated parameters need to be estimated in the power system in real time. One of the major parameter is the phase magnitudes which are constantly monitored by the phase measurement units. The power flow analysis techniques do provide the solution to the system but requires a prior knowledge of all the other system variables. Also they are quite computationally intensive [6] [7]. Therefore, there is a need to an alternative scheme of prediction of these variables in real time which are more accurate than the measurements of the PMU's and other sensors.

1.3 Bayesian filters

Kalman Filter has become one of the basic tools for most of the state estimation problems. In its most basic form as developed in 1960 by R.E. Kalman, [8] it is for discrete time systems where we have a process which follows its dynamics in time domain and then we have a measurement which is used to correct the estimated obtained from the propagation of the process. The Kalman filter described above is an optimal filter for estimation problems involving linear process and measurement dynamics [9] [10]. Though many of the engineering problems can be approximated as linear to some extent, the ground truth is that in reality there exists no perfectly linear systems. For example, even a simple resistor follows linear Ohm's law only up to acertain range [11]. Though the assumptions of approximating systems as linear can be valid in certain cases, it may not provide acceptable performance in many real world applications. Hence there is a high demand of non-linear estimators for many engineering applications.

II. RELATED WORK

This section of literature survey represents the most common section of the thesis. The research based on the study includes the material from various books, articles, journals, and research papers at the national and the international levels.Based on the existing scheduling model as represented in table.1, the experts have analyzed the literature on the basis of the mentioned summary.

Table.1 Existing Scheduling Model.

Year of Publication	Author/s	Title	Source	Summary
2017	Wickramaarachchi, Charith	PReSS towards a secure smart grid: Protection recommendations against smart spoofing	IEEE	The major issues with these devices is to protect the data from unauthorized parties and the occurrence of noise in data. Smart device reader acts as the bridge which connects the smart grid devices with smart grid clouds
2017	Sha, Kewei, NaifAlatrash, and Zhiwei Wang	A secure and efficient framework to read isolated smart grid devices	IEEE	In most of the cases of circuit analysis, the network components are limited to the known value of impedances with a current and voltage source, but the load flow problem is different in the sense that instead of impedances, the known quantities are active and reactive powers at most network buses, because the behavior of the load in most of the cases is as a constant power load, assuming that voltages applied on them remain within acceptable ranges
2015	Zhang, Jinghe	Kalman filters for dynamic and secure smart grid state estimation	IEEE	There are various methods which are used to solve these problems. Kalman filters are proposed to achieve - optimal performance on - smart grid devices. This filter identifies - device failures, unusual disturbances, and malicious data attacks
2015	Liu, Ting,	Abnormal traffic-indexed state estimation: A cyber–physical fusion approach for smart grid attack detection	IEEE	The smart grid attack detection method proposed is named as cyber-physical fusion approach. It detects the attack by merging traffic flow features with physical laws in power system
2015	Yu, Zong-Han, and Wen-Long Chin	Blind false data injection attack using PCA approximation method in smart grid.	IEEE	To ensure the integrity of the state estimation, bad data detection system is used. In this paper, the author proposed the principal component analysis method which detects the blind false data injection attack
2015	Rawat, Danda B., and Chandra Bajracharya	Detection of false data injection attacks in smart grid communication systems	IEEE	The author proposed a method of false data detection in smart grid by using Chi-square detectors and cosine similarity matching methods. Kalman filter estimation method is used to measure the variation from actual measurement. To detect the attacks and find the robustness of the proposed system, cosine similarity matching approach is used.
2015	Sharma, Konark, and Lalit Mohan Saini	Performance analysis of smart metering for smart grid: An overview	IEEE	In this paper, the author analyzed the performance of smart meters for smart grids. In this method, firstly it identifies the channel 1 and 3 of metrology and then harmonics of metrology which has an impact on reliability. The author described the issues related to the security in smart grid networks

III. CONCLUSION

The use of dynamic state estimation methods such as the Kalman filter provides an optimal solution to the process of real-time data prediction and reduces the problem based on non-linearity. Various extensions such as unscented and the extended forms of Kalman filter have also been developed that specifically work on non-linear systems. The analysis of real-time data depends on Phasor Measuring Units (PMU) which plays a significant role in power transmission and distribution processes due to their ability to monitor the power flow within a network. The process of PMU-based monitoring improves the quality of the smart grid research tested and compared one of the most popular-Kalman filter technique against a novel method Kalman filter with Bayesian learning. In this Research, we also used the Taylor expansion of Kalman, which reduces the nonlinearity and improves the mean square

error and noise. The concrete logic behind this research is to reduce the nonlinearity and find the latent features which help in reducing.

IV. REFERENCES

[1]. Wickramaarachchi, Charith, et al. "PReSS towards a secure smart grid: Protection recommendations against smart spoofing." *Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), 2017 IEEE*.IEEE, 2017.

[2]. Sha, Kewei, NaifAlatrash, and Zhiwei Wang. "A secure and efficient framework to read isolated smart grid devices." *IEEE Transactions on Smart Grid* (2017).

[3]. Zhang, Jinghe, et al. "Kalman filters for dynamic and secure smart grid state estimation." *Intelligent Industrial Systems* 1.1 (2015): 29-36.

[4]. Liu, Ting, et al. "Abnormal traffic-indexed state estimation: A cyber–physical fusion approach for smart grid attack detection." *Future Generation Computer Systems* 49 (2015): 94-103.

[5]. Yu, Zong-Han, and Wen-Long Chin. "Blind false data injection attack using PCA approximation method in smart grid." *IEEE Transactions on Smart Grid* 6.3 (2015): 1219-1226.

[6]. Rawat, Danda B., and Chandra Bajracharya. "Detection of false data injection attacks in smart grid communication systems." *IEEE Signal Processing Letters* 22.10 (2015): 1652-1656.

[7]. Sharma, Konark, and Lalit Mohan Saini. "Performance analysis of smart metering for smart grid: An overview." *Renewable and Sustainable Energy Reviews* 49 (2015): 720-735.

[8]. Li, Shang, YasinYılmaz, and Xiaodong Wang. "Quickest detection of false data injection attack in wide-area smart grids." *IEEE Transactions on Smart Grid* 6.6 (2015): 2725-2735.

[9]. Chaojun, Gu, PanidaJirutitijaroen, and MehulMotani. "Detecting false data injection attacks in ac state estimation." *IEEE Transactions on Smart Grid* 6.5 (2015): 2476-2483.

[10]. Diamantoulakis, Panagiotis D., Vasileios M. Kapinas, and George K. Karagiannidis. "Big data analytics for dynamic energy management in smart grids." *Big Data Research* 2.3 (2015): 94-101.

[11]. Karimipour, Hadis, and VenkataDinavahi. "Extended Kalman filter-based parallel dynamic state estimation." *IEEE transactions on smart grid* 6.3 (2015): 1539-1549.