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[Kaur * *et al.*, 6(7): July, 2017] ISSN: 2277-9655
IC™ Value: 3.00 Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN OF 24 BUS SYSTEM USING MINIMUM PHASE MEASUREMENT UNIT IN POWER SYSTEM ANALYSIS TOOLBOX

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DOI: 10.5281/zenodo.829817

ABSTRACT

The Blackouts are nightmare of Power distribution systems. An efficient and reliable system should have a real time process implemented in the distribution system which looks after the discrepancies in systems such as Phase differences in amongst the Voltages and Currents in the Power flow. PMUs are such units that provide a solution for the same. In this paper the minimization of PMUs using optimum placement techniques is implemented. For the same, Power System Analysis Toolbox in MATLAB is used and results are found better by 10-12% of cost saving.

KEYWORDS: PMUs, Phasor, PSAT.

I. INTRODUCTION

In Past it is seen that many countries around the world were affected by power failures such as blackouts, which are caused by several reasons that may be inadequate power distribution system infrastructure and its maintenance or exponential electricity consumption growth that overstresses the power transmission and distribution system. Consequently, the power supply companies suffer from heavy losses and also impose inconveniency to private users and business customers. In order to prevent the frequent and blackouts, there is a dire need to invent such a technology that may be helpful in real time estimation of the state of a network. These technologies may be helpful in achievement of highly controllable and reliable networks for a greater stability of the power system network. A similar device that may be introduced for such a purpose is a Phasor Measurement Unit (PMU). PMU basically works on the synchronization of voltages and currents with a continuously available click frequency signal, that may be received from a global network such as geo – satellite or GPS systems. Integrating with the GPS receiver the base station may be able, to receive the synchronous data from each PMU in real time. A system may be of such a design that the location of the defect and problem over transmission can be identified in a real time and phase differences between different PMUs are detected.

PMU: Phasor measurement unit is a unique combination of both hardware and software. The applications of PMUs were first published in 1980s. Virginia Technology developed first ever prototype of Phasor Measurement Unit (Phadke and Thorp, 2008), Macrodyne fostered the former PMU i.e. model ‘1690’ in the year 1992. The growth in the concern of governments over and around the world for climate changes and environmental alterations has forcedthem to make decisions on to produce, consume, and store energy. More specifically in view of existing framework and infrastructure established already in transmission, the requirement is on the transformation of our present electricity grids into smart grids, a step crucial for the successful uptake of renewable energy sources into the grid while reducing in the same time carbon dioxide emissions in the atmosphere. A smart electricity grid could be viewed as a copy of a traditional electricity grid (the attention is more focused here on the distribution grid compared to both production and transport grids as the former is more concerned with the uptake of renewable energy sources) with a communication structure capable of help maintaining the stability, the reliability and the quality of the grid in a context of interconnecting wide-area electricity networks

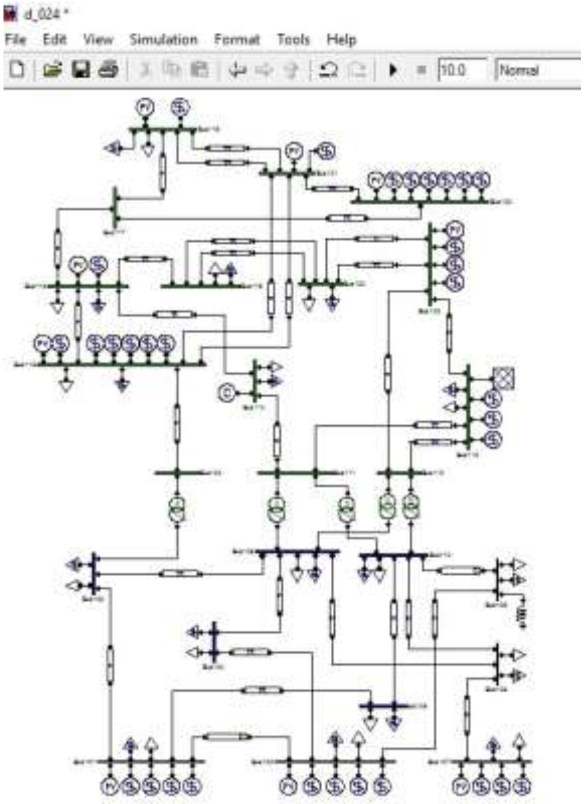
II. METHODOLOGY

In this research IEEE 24 bus test systems are taken for studying the various optimal PMU placement methods and comparing their results. Ideal number of PMUs & their location will be detected in the test bus system. To fulfill purpose different bus test systems used are 6 bus system, 9 bus system, IEEE- 14 bus system and IEEE-24 bus system. The different systems are modeled & simulated using PSAT. Then different techniques and algorithms such as depth first method, annealing method, graph theoretic method and spanning tree methods were applied. Then the results of all the above said methods are compared with one another to find the best method among all of the methods. In literature survey, it was seen that the also there are number of optimization techniques to know least no. of PMUs. First of all PMU placement rules, algorithms for different methods are discussed and then models are simulated in PSAT.

Optimal location of PMUs is found exercising the following methods. Algorithms for different methods are given below:-

1. **Depth First Search:** In this method zero injections are not taken into account. Following steps are taken:-
- In the beginning PMU is employed at the bus having maximum number of coupled buses/branches.
- The process can be further repeated till the complete system becomes observable.
2. **Graph Theoretic Procedure:** Graph Theoretic method is similar to Depth First search method (DeFS), except that it takes into account zero injections. The process and flow of methods is very much similar to that of depth first method.
3. **Simulated Annealing method:** In this method solution is obtained using random changes/ variations in the current solution. Speed of this technique is affected by number of branches coupled to each node. There are certain more modifications of simulated annealing method discussed in the literature.
4. **Spanning method:** ine outage is considered for determining the optimal no of PMU.

III. RESULTS



The values and measurements of **P, Q, V, ϴ**are plotted for each bus and the results are as below

ISSN: 2277-9655
Impact Factor: 4.116
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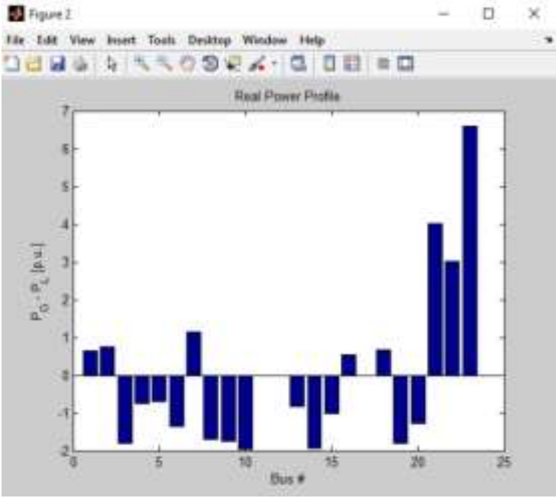

Figure : Graphical Representation of Real Power (P)

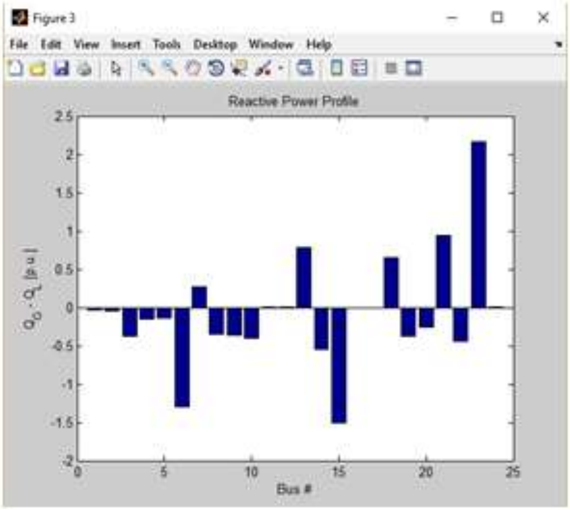

Figure : Graphical Representation of Reactive Power (Q)

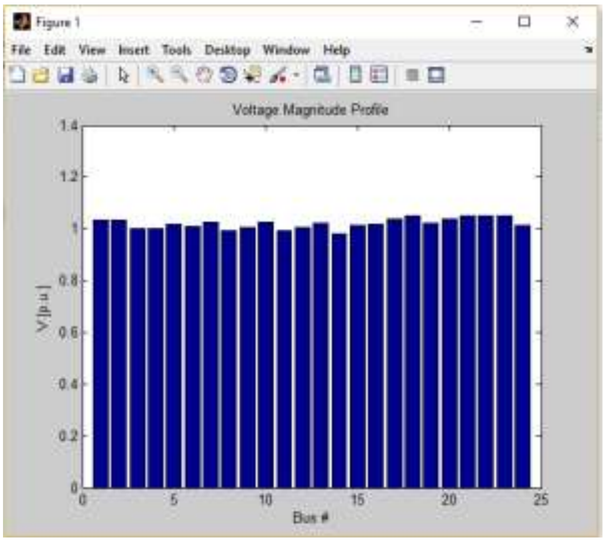

Figure : Graphical Representation of Voltage Magnitude (V)

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Impact Factor: 4.116
CODEN: IJESS7

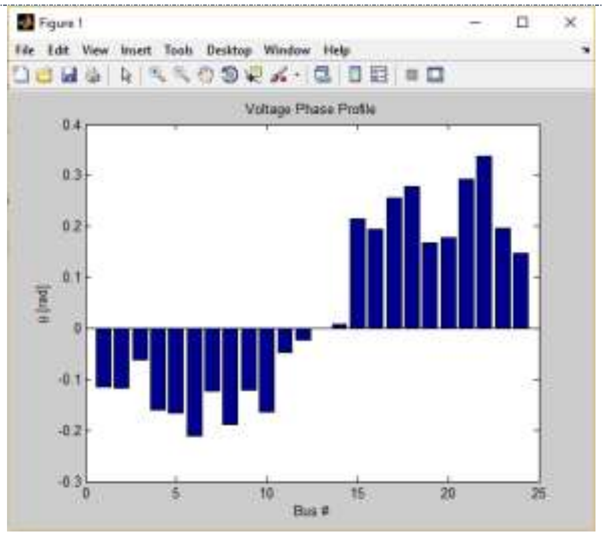

Figure : Graphical Profile of Voltage Phase (θ)

phase differences from different sources may be minimized such that the number of Phase Measurement Units (PMU) that may be used for efficient transmission are reduced hence reducing the installation cost. The table below compares the results of this research with the literature.

Method	Depth First	Graph Theory	Annealing	Spanning
BASE PAPER	8	8	7	12
OURs	7	6	6	11

NETWORK STATISTICS	
Buses:	24
Lines:	35
Transformers:	5
Generators:	11
Loads:	17

POWER FLOW RESULTS

Bus	V [p.u.]	phase [rad]	P gen [p.u.]	Q gen [p.u.]	P load [p.u.]	Q load [p.u.]
Bus01	1.035	-0.1141	1.72	0.187702	1.08	0.22
Bus02	1.035	-0.1165	1.72	0.159759	0.97	0.2
Bus03	1.001	-0.0622	1.801E-13	8.2E-13	1.8	0.37
Bus04	0.999	-0.1592	1.313E-13	8.35E-15	0.74	0.15
Bus05	1.017	-0.1659	1.533E-13	2.33E-14	0.71	0.14
Bus06	1.01	-0.2119	1.188E-13	4.29E-14	1.36	1.3004
Bus07	1.025	-0.1231	2.4	0.520937	1.25	0.25

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Bus08	0.993	-0.1882	2.076E-13	3.23E-14	1.71	0.35
Bus09	1.003	-0.1219	1.539E-13	2.45E-13	1.75	0.36
Bus10	1.026	-0.163	2.887E-15	3.7E-13	1.95	0.4
Bus11	0.992	-0.0471	-2.55E-13	1.43E-13	0	0
Bus12	1.003	-0.0222	-2.41E-13	2.96E-13	0	0
Bus13	1.02	0	1.8196527	1.31733	2.65	0.54
Bus14	0.98	0.0071	6.661E-15	-0.149482	1.94	0.39
Bus15	1.014	0.2145	2.15	-0.863838	3.17	0.64
Bus16	1.017	0.1939	1.55	0.188789	1	0.2
Bus17	1.039	0.2563	-2.3E-16	-1.91E-14	0	0
Bus18	1.05	0.2791	4	1.331563	3.33	0.68
Bus19	1.023	0.1674	8.882E-16	1.78E-14	1.81	0.37
Bus20	1.038	0.1783	2.887E-15	-1.55E-14	1.28	0.26
Bus21	1.05	0.2931	4	0.940925	0	0
Bus22	1.05	0.3371	3	-0.446867	0	0
Bus23	1.05	0.1966	6.6	2.160632	0	0
Bus24	1.013	0.1469	-2.02E-13	7.2E-14	0	0

Above is detail of the power flow detail of 24 BUS system. These values shown are of Real Power, Reactive Power, Voltage and Phase profile of each bus in the system. These values are calculated for error free transmission of the power and hence in real time, these values are helpful in maintaining minimum phase difference at each bus to avoid blackouts.

TOTAL GENERATION			
REAL POWER [p.u.]			28.9597
REACTIVE POWER [p.u.]			5.34745
TOTAL LOAD			
REAL POWER [p.u.]			28.5
REACTIVE POWER [p.u.]			6.8204
TOTAL LOSSES			
REAL POWER [p.u.]			0.45965
REACTIVE POWER [p.u.]			-1.47295

IV. CONCLUSION

As per the results obtained after application of different algorithms, it is concluded that highest number of PMUs are to be implemented when Minimum (N-1) Spanning Tree method is used. It is also seen that the Graph Theory method and Annealing methods provide similar results and these are better than Depth first method as number of PMUs for both methods are lesser than Depth first method. Thus it is concluded that for a cost effective implementation of PMUs, Graph Theory and Annealing methods provide good deal of stability in system. However, it is seen while simulation that the ability to observe overall flow of power is better using Annealing method. Hence it is further concluded that the best method for placement of PMU is Annealing method.

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CITE AN ARTICLE

Kaur, Sukhdeep , and Baljeet Singh. "DESIGN OF 24 BUS SYSTEM USING MINIMUM PHASE MEASUREMENT UNIT IN POWER SYSTEM ANALYSIS TOOLBOX." ***INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*** **6.7 (2017): 651-56. Web. 15 July 2017.**