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Contingency Analysis using Power System Analysis Toolbox

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Abstract- Voltage stability problems are becoming increasingly evident since large amount of power are being transferred from long distance and bulk power systems operate close to their stability limits. Accurate recognition of voltage collapse point and contingency analysis of load voltage stability make it possible for procedures to prevent voltage collapse during contingency. In this paper, IEEE 14 Bus system is taken and load flow is conducted using Power System Analysis Toolbox (PSAT).A static capacitor is connected to bus to make the voltage never drop one p.u. It will control the voltage when a transmission line is removed, like a emergency contingency, and generate the reactive power. Even a load is increased; still the static capacitor will control the voltage.

Keywords- Voltage collapse, voltage stability, Power System Analysis Toolbox.

I. INTRODUCTION

Most of the large power system blackouts, which occurred worldwide over the last twenty years, which are caused by heavily stressed system with large amount of real and reactive power demand and low voltage condition. When the voltages at power system buses are low, the losses will also to be increased. This study is devoted to develop a technique for improving the voltage and eliminate voltage instability in a power system. Application of static capacitor devices are currently pursued very intensively to achieve better control over the transmission lines for manipulating power flows. They can provide direct and flexible control of power transfer and are very helpful in the operation of power network. The power system performance and the power system stability can be enhanced by using static capacitor They also helps to reduce flows in heavily loaded lines, resulting in an increased load ability, low system loss, improved stability of the network, reduced cost of production and fulfilled contractual requirement by controlling the power flows in the network. They provide control facilities, both in steady state power flow control and dynamic stability control. The possibility of controlling Power flow in an electrical power system without generation rescheduling or topological changes can improve the performance considerably.

II. POWER SYSTEM ANALYSIS TOOLBOX

PSAT is a Matlab toolbox for electric power system analysis and control. The command line version of PSAT is also GNU Octave compatible. PSAT includes power flow, continuation power flow, optimal power flow, and small signal stability analysis and time domain simulation. All operations can be assessed by means of graphical user interfaces (GUIs) and a Simulink-based library provides an user friendly tool for network design. PSAT core is the power flow routine, which also takes care of state variable initialization. Once the power flow has been solved, further static and/or dynamic analysis can be performed. The power flow data contains a complete and advanced set of models of power system components. It can be imported from (and exported to) commonly used power flow data formats such as the PSS/E Raw data (versions 26-32), GE EPC data (version 16), etc. The Single Line Diagram (SLD) is created easily by dragging and dropping the symbols of buses, generators, lines, etc., on the diagram. The Bus View diagram graphically shows all components at a selected bus. Several diagrams can be created from a power flow data, each representing a different part of the system or different level of details. These diagrams can be saved in individual files and used with another (similar) power flow data.

In addition to its own macro, PSAT supports scripting in Python. A separate user's guide described the features and functionalities of this option.

PSAT core is the power flow routine, which also takes care of state variable initialization. Once the power flow has been solved, further 'static and/or dynamic analysis can be performed. These routines are:

1. Continuation power flow;
2. Optimal power flow;
3. Small signal stability analysis;
4. Time domain simulations;
5. Phasor measurement unit (PMU)

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III. NEWTON METHOD

In numerical analysis, Newton's method (also known as the Newton–Raphson method or the Newton–Fourier method) is perhaps the best known method for finding successively better approximations to the zeros (or roots) of a real-valued function. Newton's method can often converge remarkably quickly; especially if the iteration begins "sufficiently near" the desired root. Just how near "sufficiently near" needs to be and just how quickly "remarkably quickly" can be depends on the problem.

Unfortunately, far from the desired root, Newton's method can easily lead an unwary user astray with little warning. Thus, good implementations of the method embed it in a routine that also detects and perhaps overcomes possible convergence failures.

IV. FAST DECOUPLED METHOD

The Fast decoupled power flow solution requires more iterations than the Newton-Raphson method, but requires considerably less time per iteration and a power flow solution is obtained rapidly. This technique is very useful in contingency analysis where numerous outages are to be simulated or a power flow solution is required for on-line control.

For large scale power system, usually the transmission lines have a very high X/R ratio. For such a system, real power changes ΔP are less sensitive to changes in voltage magnitude and are most sensitive to changes in phase angle $\Delta\delta$. Similarly, reactive power is less sensitive to changes in angle and most sensitive on changes in voltage magnitude.

The voltages at different buses in a IEEE 14 bus system is find out using Newton Raphson program and Power System Analysis Toolbox. It has been found that the voltages are same in both the method and voltages are mentioned in the table. This confirms that analysing a power system using the PSAT is as accurate as NR program.

Table no.1 comparison of voltages at different buses using NR method and PSAT.

Bus No.	NR method	PSAT
01.	1.06	1.06
02.	1.045	1.045
03.	1.010	1.010
04.	1.011	1.011
05.	1.015	1.015
06.	1.070	1.070
07.	1.048	1.048
08.	1.090	1.090
09.	1.030	1.030
10.	1.029	1.029
11.	1.046	1.046
12.	1.053	1.053
13.	1.046	1.046
14.	1.019	1.019

SIMULATION DIAGRAM

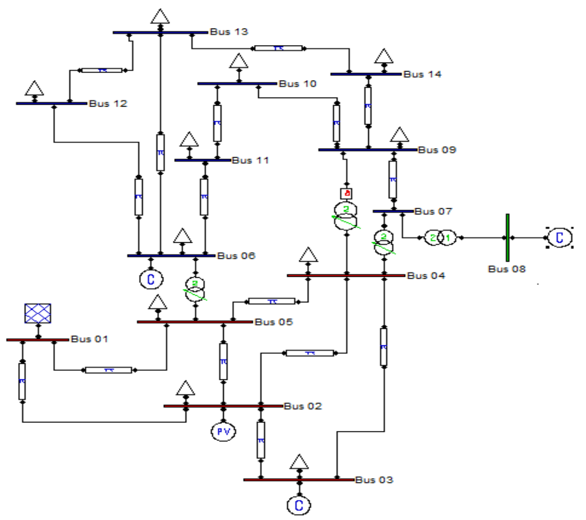

Fig.1 Designed simulink model in PSAT

In PSAT,the power flow analysis is done using the Fast Decoupled method. The power flow is done when a line is removed between any two buses and power flow analysis is done.

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Table 2: Bus voltages when line between two buses are removed:

Bus No	Normal	02-04	03-04	01-05
1	1.060	1.060	1.060	1.060
2	1.045	1.045	1.045	1.045
3	1.010	1.010	1.010	1.010
4	1.011	0.999	1.012	1.002
5	1.015	1.006	1.016	1.001
6	1.070	1.070	1.070	1.070
7	1.048	1.042	1.048	1.044
8	1.090	1.090	1.090	1.090
9	1.030	1.024	1.031	1.027
10	1.029	1.024	1.030	1.027
11	1.046	1.043	1.046	1.044
12	1.053	1.053	1.053	1.053
13	1.046	1.045	1.046	1.046
14	1.019	1.015	1.019	1.017

Bus No	01-02	02-05	04-05	06-11
1	1.060	1.060	1.060	1.060
2	1.045	1.045	1.045	1.045
3	1.010	1.010	1.010	1.010
4	0.995	1.004	1.004	1.009
5	0.989	1.004	1.018	1.014
6	1.070	1.070	1.070	1.070
7	1.039	1.045	1.042	1.040
8	1.090	1.090	1.090	1.090
9	1.021	1.028	1.021	1.016
10	1.022	1.028	1.021	1.006
11	1.041	1.045	1.041	0.999
12	1.052	1.053	1.053	1.052
13	1.045	1.046	1.044	1.044
14	1.013	1.017	1.012	1.009

Bus No	06-12	06-13	07-09	09-10
1	1.060	1.060	1.060	1.060
2	1.045	1.045	1.045	1.045
3	1.010	1.010	1.010	1.010
4	1.011	1.01	1.011	1.012
5	1.015	1.014	1.013	1.015
6	1.070	1.070	1.070	1.070
7	1.047	1.014	1.064	1.048
8	1.090	1.090	1.090	1.090
9	1.029	1.021	0.980	1.031
10	1.029	1.021	0.987	1.025
11	1.045	1.041	1.023	1.043
12	1.022	1.026	1.049	1.053
13	1.038	0.984	1.038	1.046
14	1.015	0.986	0.986	1.020

Normal	09-11	10-11	12-13	13-14
1.06	1.060	1.060	1.060	1.060
1.045	1.045	1.045	1.045	1.045
1.010	1.010	1.010	1.010	1.010
1.011	1.012	1.009	1.009	1.010
1.015	1.015	1.014	1.014	1.014
1.070	1.070	1.070	1.070	0.070
1.048	1.050	1.042	1.042	1.043
1.090	1.090	1.090	1.090	1.09
1.030	1.034	1.020	1.020	1.022
1.029	1.033	1.012	1.012	1.022
1.046	1.047	1.063	1.063	1.041
1.053	1.051	1.052	1.052	1.057
1.046	1.040	1.044	1.044	1.055
1.019	0.996	1.012	1.012	0.988

V. RESULT

To compensate the voltage drop in the particular line when a contingency occurs, adding a simple static capacitor will be enough to regulate the voltage to one per unit. For instance a static capacitor is added at a bus 13 when voltage drops beyond limits when line connecting bus 6 and bus 13 are removed. The voltage at various condition is determined in table

Table 3: Bus Voltage at different conditions:

Bus no	Normal	Line between 6-13 buses	Line removed and static capacitor added	load increased by 50%	Line removed and load increased by 50% and static capacitor added
1	1.06	1.06	1.06	1.06	1.06
2	1.04	1.045	1.04	1.045	1.045
3	1.01	1.10	1.010	1.01	1.01
4	1.011	1.01	1.010	1.008	1.009
5	1.015	1.014	1.014	1.013	1.013
6	1.07	1.07	1.07	1.07	1.07
7	1.048	1.04	1.043	1.041	1.045
8	1.09	1.09	1.09	1.09	1.09
9	1.030	1.02	1.024	1.018	1.026
10	1.029	1.02	1.024	1.019	1.025
11	1.046	1.04	1.042	1.040	1.043
12	1.053	1.02	1.035	1.016	1.040
13	1.046	0.98	**1.000**	**0.961**	**1.007**
14	1.019	0.98	**0.999**	**0.974**	**0.998**

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VI. CONCLUSION

In this paper, contingency analysis is done for the IEEE 14 bus system and necessary precautions are taken to stand at emergency conditions by using a static capacitor. A novel approach based power system Analysis Toolbox is made to load flow studies with an ease GUI and easy formation of the Simulink model.

REFERENCES

[1] MojtabaKhanabadi, Hassan Ghasemi, *Senior Member,IEEE*, and MeysamDoostizadeh "Optimal Transmission Switching Considering Voltage Security and N-1 Contingency Analysis" IEEE Transactions on power systems, vol. 28, no. 1, February 2013.

[2] Alexander J. Flueck and Jayabharath R. Dondeti "**A** New Continuation Power Flow Tool forInvestigating the Nonlinear Effects of Transmission Branch Parameter Variations" IEEE transactions on power systems**,** vol.15 no. 1, February 2000.

[3] Amit Kumar RoyAsst.Professor, Department of Electrical Engineering's Academy of Technical Education, Noida, India, Sanjay Kumar Jain , Associate Professor, Department of Electrical & Instrumentation Engineering, Thapar University, Patiala, India " Improved transmission line contingency analysis in power system using fast decoupled load flow**"** International Journal of Advances in Engineering & Technology, Nov. 2013.

[4] Dharamjit**,** Department of Electrical Engineering, BIT Sindri, Dhanbad, Jharkhand, India, D.K.Tanti Department of Electrical Engineering, BIT Sindri, Dhanbad, Jharkhand, India "Load Flow Analysis on IEEE 30 bus System"International Journal of Scientific and Research Publications, Volume 2, Issue11, November 2012.

[5] Kip Morison, Lei Wang and PrabhaKundur "Power system security assessment" IEEE september/october 2004.

[6] S. Kalyani, Member, IEEE, and K. Shanti Swarup, Senior Member, IEEE"Classification and Assessment of Power System SecurityUsing Multiclass SVM"IEEE transactions on systems, man, and cybernetics—part c: applications and reviews, vol. 41, no. 5, september 2011.

[7] D. S. Javan*, H. RajabiMashhadi* and M. Rouhani "Fast Voltage and Power FlowContingencies Ranking using Enhanced Radial Basis Function Neural Network" Iranian Journalof Electrical & ElectronicEngineering, Vol. 7, No. 4, Dec. 2011.

[8] M. A. Ríos, *IEEE member*, C. J. Zapata, *IEEE member*, O. Gómez e, J. L. Sánchez, IEEE Student member "Voltage Stability assessment with Ranking of Contingencies using QV.sensibility" IEEE latinamerica transactions, vol. 7, no. 6,december 2009.