



Enhanced Voltage Stability of the Nigerian 330kv Transmission Network Using ANN Controller

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ABSTRACT

The instability in power supply in the transmission network has solely arisen as a result of the per unit volts not falling within the range of 0.95 through 1.05. This consistence instability in transmission power supply is resolved by introducing enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller. It is done in this manner, characterizing 330kv transmission network by running load flow on the network, designing a conventional SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network, training ANN in the five faulty buses that did not fall within range of voltage stability to attain stability and designing a SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller. The results obtained are the conventional per unit volts of bus 9 is 0.944 which is out of stability range. On the other hand, when ANN controller is incorporated in the system the per unit volts is 1.047. With these results the per unit volts has attained an ideal per unit volts of transmission voltage stability.

Keywords: Enhanced Voltage Stability, 330KV Transmission Network, Fuzzy Controller

Introduction

Power system stability is an important part of carrying out an assessment in transmission system security with a view to ensuring systems ability to withstand sudden disturbances under load application, switching operations, three phase short-circuit(symmetrical) faults, rotor angle swing/power frequency oscillations and loss of system elements when relay switch off affects some part of the network. In the electrical grid of today, there are many challenges ranging from changing generation landscape to increasing renewable energy inputs as well as remote power generations and aging AC transmission infrastructure with respect to ever increasing need for global demand for electricity. It is in the light of the foregoing that the need to enhance voltage stability of the Nigeria 330kv transmission network using ultra-capacitor has become expedient in this research. (Braide,2018), Power system stability has to do with the study of the dynamics of the power system under surge conditions or disturbances. When looking at it from the point of classical approach, power system instabilities can be seen as loss of synchronizing power coefficient or synchronism (i.e. some synchronous machines running out of in-phase condition; when the system is subjected to a particular disturbance.

A lot of reputable authors have done their utmost best to enhance power system stability in transmission network. Some of these renowned authors are (Ayodele, 2016), (Olaiga,2019), (Nkan, 2019), (Okakwu, 2019) and (Egido, 2019). None of these egalitarian authors trained ANN in the per unit volts that did not fall within range.

Methodology

To Characterize 330kv Transmission Network by Running Load Flow on the Network

Table 3.1 330KV transmission Network Characterized Data Collected from Newhaven Enugu Transmission

Bus No	Bus code	P.U	Ang Deg	Load MW	Load Mvar	Gen MW	Gen Mvar	Inject Min	Inject Max	Inject Mvar
1	1	0.94	0	00.0	0.0	0.0	0.0	0	0	0
2	0	0.91	0	00.0	0.0	0.0	0.0	0	0	0
3	0	1.0	0	150.0	120	0.0	0.0	0	0	0
4	0	1.0	0	0.0	0.0	0.0	0.0	0	0	0
5	0	1.0	0	120.0	60	0.0	0.0	0	0	0
6	0	1.0	0	140.0	90	0.0	0.0	0	0	0
7	0	1.0	0	0.0	0.0	0.0	0.0	0	0	0
8	0	1.0	0	110.0	90.0	0.0	0.0	0	0	0
9	0	1.0	0	80.0	50.0	0.0	0.0	0	0	0
10	2	1.025	0	0.0	0.0	200	0.0	0	180	0
11	2	1.05	0	0.0	0.0	160	0.0	0	120	0

To run the load flow of the characterized data to find the faulty buses that their P.U volts did not fall within the range of 0.95 through 1.05 thereby making the voltage unstable.

basemva = 1000; accuracy = 0.0001; maxiter = 10;

%characterized330KV transmission network

% The impedances are expressed on a 1000 MVA base.

% In the base is mistakenly stated as 100 MVA.

```
% Bus Bus |V| Ang ---Load--- ---Gen--- Gen Mvar Injected
% No. code p.u. Deg MW Mvar MW Mvar Min Max Mvar
```

```
busdata=[1 1 0.94 0 00.0 0.0 0.0 0.0 0 0 0
2 0 0.91 0 00.0 0.0 0.0 0.0 0 0 0
3 0 0.81 0 150.0 120.0 0.0 0.0 0 0 0
4 0 1.0 0 0.0 0.0 0.0 0.0 0 0 0
5 0 1.0 0 120.0 60.0 0.0 0.0 0 0 0
6 0 0.6 0 140.0 90.0 0.0 0.0 0 0 0
7 0 1.0 0 0.0 0.0 0.0 0.0 0 0 0
8 0 1.0 0 110.0 90.0 0.0 0.0 0 0 0
9 0 1.0 0 80.0 50.0 0.0 0.0 0 0 0
10 2 1.025 0 0.0 0.0 200.0 0.0 0 180 0
11 2 1.05 0 0.0 0.0 160.0 0.0 0 120 0];
```

```
% Bus Bus R X 1/2B
```

```
% No. No. p.u. p.u. p.u.
```

```
linedata=[1 2 0.00 0.06 0.0000 1
2 3 0.08 0.30 0.0004 1
2 6 0.12 0.45 0.0005 1
3 4 0.10 0.40 0.0005 1
3 6 0.04 0.40 0.0005 1
4 6 0.15 0.60 0.0008 1
4 9 0.18 0.70 0.0009 1
4 10 0.00 0.08 0.0000 1
5 7 0.05 0.43 0.0003 1
6 8 0.06 0.48 0.0000 1
7 8 0.06 0.35 0.0004 1
7 11 0.00 0.10 0.0000 1
8 9 0.052 0.48 0.0000 1];
```

```
% Gen. Ra Xd'
```

```
gendata=[1 0 0.20
```

```

10 0 0.15
11 0 0.25];

lfybus          % Forms the bus admittance matrix

lfnewton        % Power flow solution by Newton-Raphson method

busout          % Prints the power flow solution on the screen

Zbus=zbuildpi(linedata, gendata, yload)%Forms Zbus including the load

symfault(linedata, Zbus, V) % 3-phase fault including load current

```

Fig 1 the load flow program that detects the fault buses did not fall within the stability range of 0.95 through 1.05P.U. Volts.

Power Flow Solution by Newton-Raphson Method							
Maximum Power Mismatch = 7.66819e-008							
No. of Iterations = 10							
Bus No.	Voltage Mag.	Angle Degree	-----Load-----		---Generation---		Injected
			MW	Mvar	MW	Mvar	Mvar
1	0.940	0.000	0.000	0.000	251.879	-15.338	0.000
2	0.941	-0.979	0.000	0.000	0.000	0.000	0.000
3	0.933	-3.642	150.000	120.000	0.000	0.000	0.000
4	0.993	-3.173	0.000	0.000	0.000	0.000	0.000
5	0.965	-9.271	120.000	60.000	0.000	0.000	0.000
6	0.934	-4.530	140.000	90.000	0.000	0.000	0.000
7	0.999	-6.380	0.000	0.000	0.000	0.000	0.000
8	0.947	-6.695	110.000	90.000	0.000	0.000	0.000
9	0.944	-6.447	80.000	50.000	0.000	0.000	0.000
10	1.015	-2.264	0.000	0.000	200.000	277.500	0.000
11	1.020	-5.480	0.000	0.000	160.000	215.327	0.000
Total			600.000	410.000	611.879	477.489	0.000

Fig 2 the load flow program results

Fig 2 shows the load flow program results that detects the faulty buses that cause voltage instability. These faulty buses are 1, 2, 3, 6 and 9 that the per unit volt does not fall within 0.95 through 1.05 P.U volts. Their respective per unit volts are 0.940, 0.9441, 0.933, 0.934 and 0.944 P.U volts.

To design a conventional SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network.

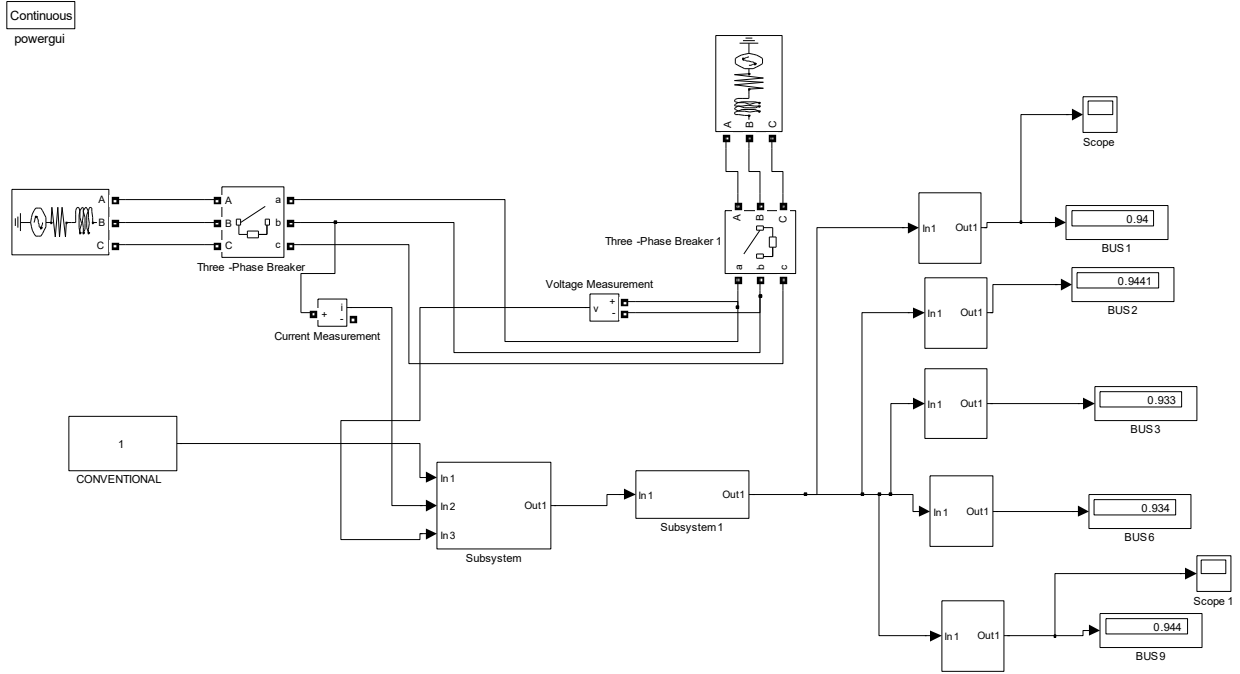


Fig 3 shows designed conventional SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network

Fig 3 shows designed conventional SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network. The results obtained are unstable voltage that their per unit volts did not fall within the range of 0.95 through 1.05. These five faulty buses that their per unit volts are out of range will be trained in ANN to attain voltage stability.

To train ANN in the five faulty buses that did not fall within range of voltage stability to attain stability.

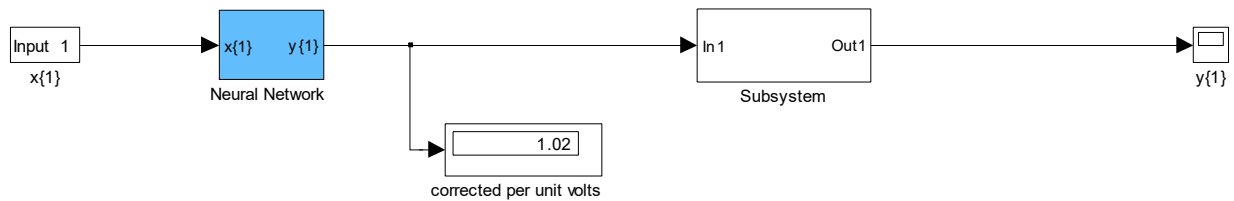


Fig 4 trained ANN in the five faulty buses that did not fall within range of voltage stability to attain stability.

Fig 4 shows trained ANN in the five faulty buses that did not fall within range of voltage stability to attain stability.

Fig 2. Fuel Cell Power Plant (Prabha R, A., 2014).

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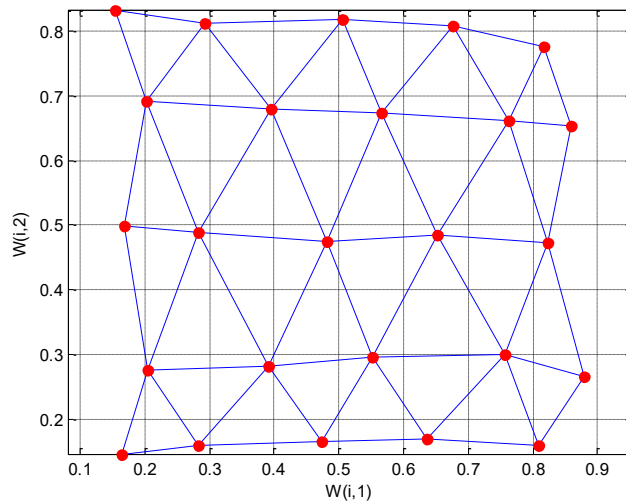


Fig 5 trained ANN in the five faulty buses that did not fall within range of voltage stability to attain stability.

In fig 5 the five faulty buses were trained five times to give twenty-five neurons that look like human brain and mimics human intelligence.

To design a SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller

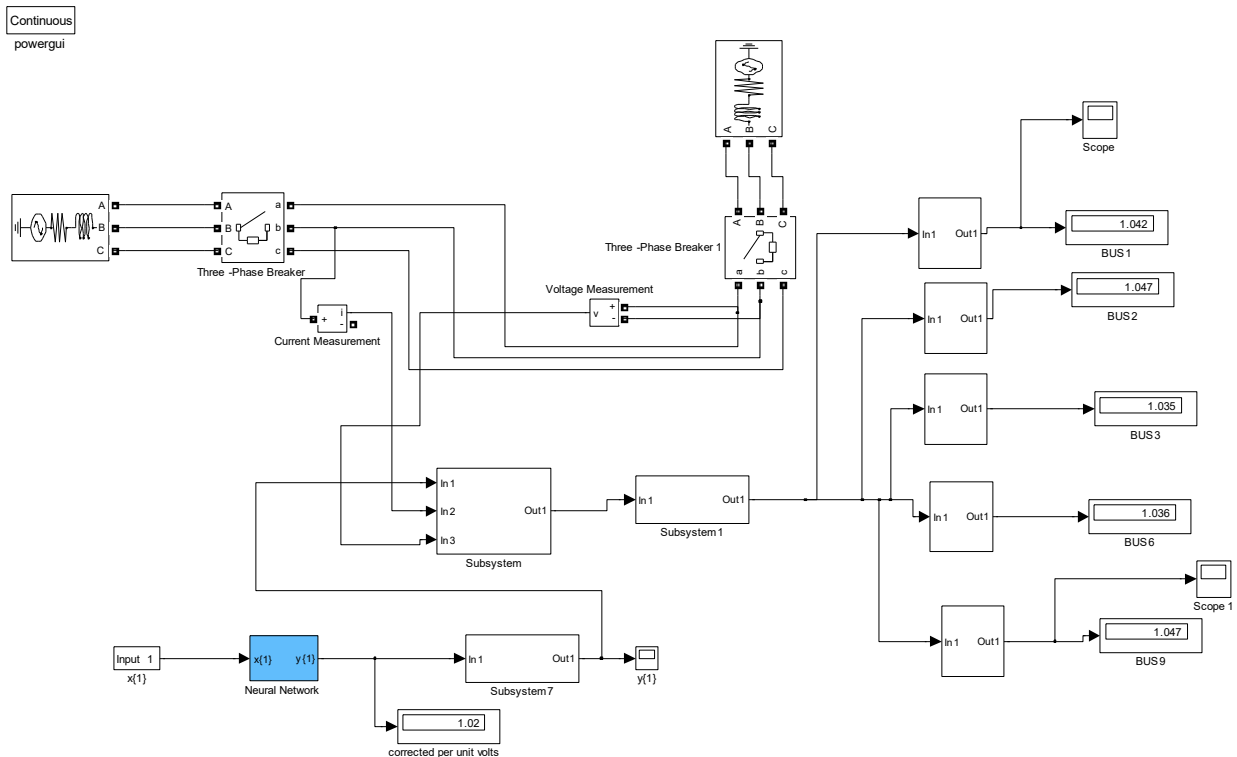


Fig 7 designed SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller

Fig 7 shows designed SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller. The results obtained are as shown in figure 8.

Discussion of Result

Table 1 Comparing conventional and ANN controller volts in improving frequency stability of the Nigerian 330kv transmission network in bus 9

<i>Time(s)</i>	<i>Conventional BUS9 volts (P.U)</i>	<i>ANN controller BUS9 volts (P.U)</i>
0	0	0
1	0.6	0.65
2	0.8	0.9
3	0.9	1
4	0.944	1.047
10	0.944	1.047

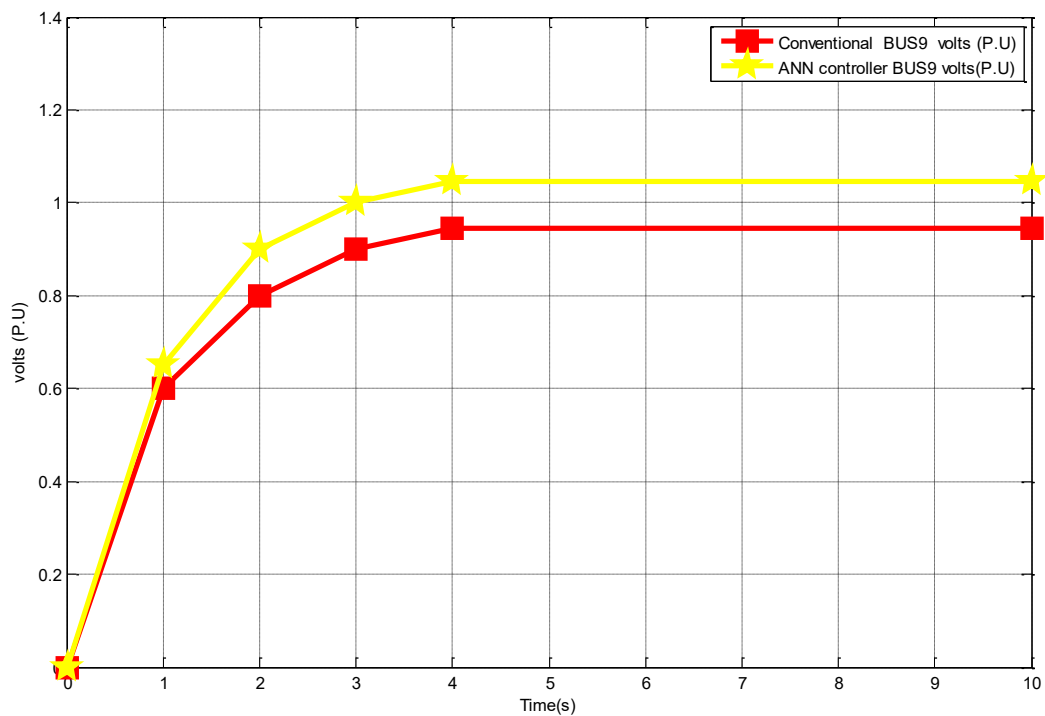


Fig 8 Comparing conventional and ANN controller volts in improving frequency stability of the Nigerian 330kv transmission network in bus 9

Fig 8 shows that the conventional per unit volts of bus 9 is 0.944 which is out of stability range. On the other hand, when ANN controller is incorporated in the system the per unit volts is 1.047. With these results the per unit volts has attained an ideal per unit volts of transmission voltage stability.

Conclusion

The core cause of intermittent power supply in our transmission network is when the per unit volts could not attain voltage stability. This intermittent power supply experienced in the transmission network is overcome by enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller. It is done in this manner, characterizing 330kv transmission network by running load flow on the network, designing a conventional SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network, training ANN in the five faulty buses that did not fall within range of voltage stability to attain stability and designing a SIMULINK model for enhanced voltage stability of the Nigerian 330kv transmission network using ANN controller. The results obtained

are the conventional per unit volts of bus 9 is 0.944 which is out of stability range. On the other hand, when ANN controller is incorporated in the system the per unit volts is 1.047. With these results the per unit volts has attained an ideal per unit volts of transmission voltage stability

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