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IMPROVING THE STABILIATION OF OVER VOLTAGE AND UNDER VOLTAGE PROTECTION SYSTEM IN NIGERIAN 11KV TRANSMISSION NETWORK USING INTELLIGENT TELEMETRIC TECHNIQUE

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Abstract: **The constant power failure observed in our country has occurred as a result of under voltage and over voltage observed in the Nigerian 11KV transmission network. This occurred because the per unit voltage in some of the transmission buses could not meet the thresh hold of 0.95 through 1.05. This inconsistent power failure observed in our transmission network is surmounted by introducing improving the stabilization of over voltage and under voltage protection system in Nigerian 11kv transmission network using intelligent telemetric technique. To achieve this, it is done in this manner, characterizing Nigerian 11KV transmission network, running the load flow of the characterized data to establish over voltage and under voltage in the network,design a telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system, training ANN in these rule base for effective stabilization and protection, developing an algorithm that will implement the process, designing a telemetric SIMULINK model, developing an algorithm that will implement the process and designing a SIMULINK model for improving the stability of over and under voltage protection system of the Nigerian 11KV transmission network using intelligent telemetric. The results obtained are the conventional voltage is 0.93 P.U.V signifying that the voltage is under voltage because it did not fall within the thresh hold of voltage stability of 0.95 through 1.05 per unit volts. Meanwhile, when an intelligent telemetric technique is incorporated in the system it stabilized the voltage in bus 1 to 0.973 thereby making it to attain the thresh hold of 0.95 through 1.05 thereby enhancing consistent power supply in the country and the conventional voltage is 107 per unit volt which is over voltage that destroys a lot of electrical appliances in the homes, industries and factories. On the other hand, when an intelligent telemetry is integrated in the system, it stabilized the voltage to 0.9768 P.U.V thereby protecting all the electrical appliances in homes, companies, industries and factories from damaging.**

Keywords: **improving stabilization,, overvoltage, under voltage, protection, system, Nigerian, transmission, network, intelligent, telemetric, technique.**

1. INTRODUCTION

*Power system instability is anchored by under voltage and over voltage (*Acharya, 2006*). It is an axiomatic that the core cause of power system in stability and protection is when there is inadequate protecting and stabilizing mechanism that detects and prevents under voltage and over voltage before it occurs (*Dong,2016*). Generally power system analysis will help to minimize under voltage and over voltage in power system network (*Andersson,2012*).*

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These transmission lines are vulnerable to fluctuations in the electrical power supply, particularly over voltage conditions. Overvoltage occurs when the supply voltage exceeds the normal operating range, while under voltage refers to a drop in voltage below the recommended levels. Both overvoltage and under voltage can have detrimental effects on electrical power system, ranging from reduced performance and premature aging to complete failure and safety hazards. To safeguard our valuable power, over and under voltage protection mechanisms are employed.

Overvoltage protection is designed to limit the voltage supplied to transmission lines, ensuring it remains the safe operating range. It is achieved through the use of devices such as surge protectors, voltage regulators and voltage clamping circuits. Surge protectors detect sudden spikes in voltage caused by lightning strikes or power surges and divert the excess energy away the connected transmission lines, preventing damages. Voltage regulators maintain a stable output voltage by automatically adjusting the incoming voltage, compensating for fluctuation and maintaining a constant supply. On the order hand, under voltage protection is implemented to address situations where the voltage drops below the acceptable level, which can occur due to factors like power grid failure or faulty transmission systems. Under voltage protection devices, such as voltage monitors and under voltage relays, monitor the incoming voltage and trigger protective actions when it falls below the predetermined threshold. This actions can include disconnecting the transmission lines from the power source or activating back-up power system to ensure continuous operation.

The significance of over and under voltage protection extends beyond the preservation of electrical power system. It also play a vital role in ensuring the safety of users and protecting electrical fires. Unregulated overvoltage conditions can cause electrical components to overheat and potentially ignite, leading to hazardous situations.

So generally, over and under voltage protection is crucial for the reliable operation and longevity of electrical power system by implementing appriopate protection mechanism, we can mitigate the risks associated with voltage fluctuation and ensure the safety and durability of our appliances. Whether through surge protectors voltage regulators or other devices, this protective measures contributes to a more secure and efficient electrical system, providing peace of mind to users and reducing the potential for damage an accident.

2. METHODOLOGY

The digital model of the Nigerian IIKV power system will be created in MATLAB/SIMULINK software for the evaluation of the performance of the neural network based telemetric technique. Simulation studies be carried out to evaluate the ability if the telemetric technique to ensure that there be stabilize over and under voltage in Nigeria IIKV transmission network.

Genetic Algorithm will be used to improve the stability of the over and under voltage protection system of the Nigeria IIKV transmission network.

Design Strategy used for improving the stabilization of over voltage and under voltage protection system

The key focus of the work in terms of methodology is the performance evaluation of transmission network for improving the stabilization of over voltage and under voltage protection system using ANN-based intelligent telemetric technique the core strategy is ile improving the stability of over and under voltage protection system in the power flew as carried out using telemetric technique such that there will be effectively managing voltage fluctuations and reduce the potential for damage of transmission lines. The neural network that controls the telemetric technique has to be trained to control power flow in order to stability over and under voltage protection in the transmission line. The key control concept is the modeling and training of the telemetric technique to control power flow such that power is transmitted at voltage that is very close to the critical disruptive voltage. This would ensure the improving the stability of over and under voltage protection.

To characterize Nigerian 11KV transmission network

Table 1: 11KVtransmission 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	0.93	0	00.0	0.0	0.0	0.0	0	0	0

2	2	0.81	0	21.70	12.7	40.0	0.0	-40	50	0
3	0	1.0	0.0	2.4	1.2	0.0	0.0	0	0	0
4	0	1.27	0.0	7.6	1.6	0.0	0.0	0	0	0
5	2	1.01	0.0	94.2	19.0	0.0	0.0	-40	40	0
36	0	1.0	0.0	0.0	0.0	0.0	0.0	0	0	0
7	0	0.98	0.0	22.8	0.0	10.9	0.0	0	0	0
8	2	1.08	0.0	30.0	30.0	0.0	0.0	-30	40	0
9	0	1.0	0	0	0	0.0	0.0	0	0	0
10	0	1.12	0.0	5.8	2.0	0.0	0.0	-6	24	19
11	2	1.082	0	0.0	0.0	0.0	0.0	0	0.0	0

To run the load flow of the characterized data to establish over voltage and under voltage in the network.

```
disp('')
basemva = 1000;  accuracy = 0.0001;  maxiter = 10;
% The impedances are expressed on a 1000 MVA base.
%     Bus  Bus|V|  Ang   ---Load---      ---Gen---   Gen Mvar Injected
%      No.codep.u.  Deg   MW   Mvar   MW   Mvar   Min   Max    Mvar
busdata=[1    1  0.93    0    0.0    0.0     0.0  0.0    0    0    0
2    0  0.81    0    20.0    0.0     0.0   0.0    0     0    0
3    0  1.0    0   50.0    120.0    0.0   0.0    0     0    0
 4    0  1.27   0     0.0       0.0    0.0   0.0    0     0    0
5    0  1.01    0   0.0     60.0    0.0   0.0    0     0    0
6    0  1.0    0   20.0   90.0    0.0   0.0    0    0    0
7    0  0.98    0     0.0       0.0    0.0  0.0    0     0    0
 8    0   1.08   0   10.0   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   1.12  0     0.0    0.0   200.0  0.0    0    180   0
11   2   1.082   0     0.0       0.0   160.0   0.0    0    120   0];

%       Bus   BusR       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 load flow program of improving the stabilization of over voltage and under voltage protection system in Nigerian 11KV transmission network

Power Flow Solution by Newton-Raphson Method

Maximum Power Mismatch = 8.46646e-008

No. of Iterations = 10

Bus No.	Voltage Mag.	Angle Degree	------Load------ MW	Mvar	---Generation--- MW	Mvar	Injected Mvar
1	0.930	0.000	0.000	0.000	-166.704	-84.538	0.000
2	0.936	0.659	20.000	0.000	0.000	0.000	0.000
3	0.960	2.233	50.000	120.000	0.000	0.000	0.000
4	1.042	3.934	0.000	0.000	0.000	0.000	0.000
5	1.009	8.349	0.000	60.000	0.000	0.000	0.000
6	0.965	2.986	20.000	90.000	0.000	0.000	0.000
7	1.034	8.185	0.000	0.000	0.000	0.000	0.000
8	0.986	5.446	10.000	90.000	0.000	0.000	0.000
9	0.991	3.752	80.000	50.000	0.000	0.000	0.000
10	1.070	4.757	0.000	0.000	200.000	381.910	0.000
11	1.052	9.028	0.000	0.000	160.000	185.938	0.000
Total			278.900	458.800	193.296	493.716	4.300

Fig 2 results of the load flow program of improving the stabilization of over voltage and under voltage protection system in Nigerian 11KV transmission network

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The results obtained in fig 2 shows that under voltage are the buses that their per unit volts could not attain stable per unit volts of 0.95 through 1.05. The buses that are under voltage are buses 1 and 2 that have per unit volts of 0.930 and0.936 respectively. On the other hand the buses that experienced over voltage are buses 10 and 11 that have per unit volts of 1.07 and 1.052.

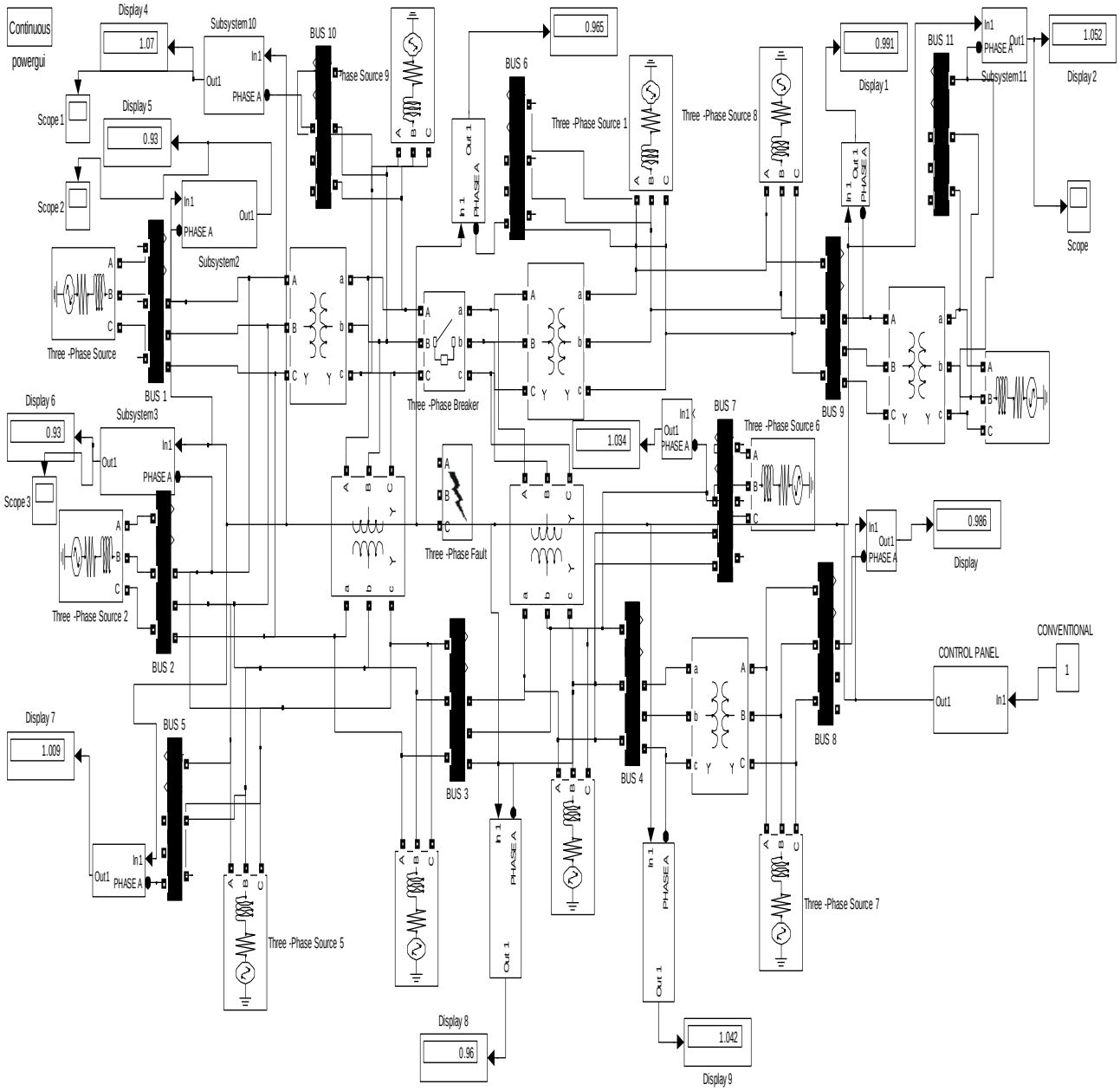

Fig 3 conventional SIMULINK model for stabilization of over voltage and under voltage protection system in Nigerian 11KV transmission network

The results obtained are as shown in figures 10 and 11

To design a telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system.

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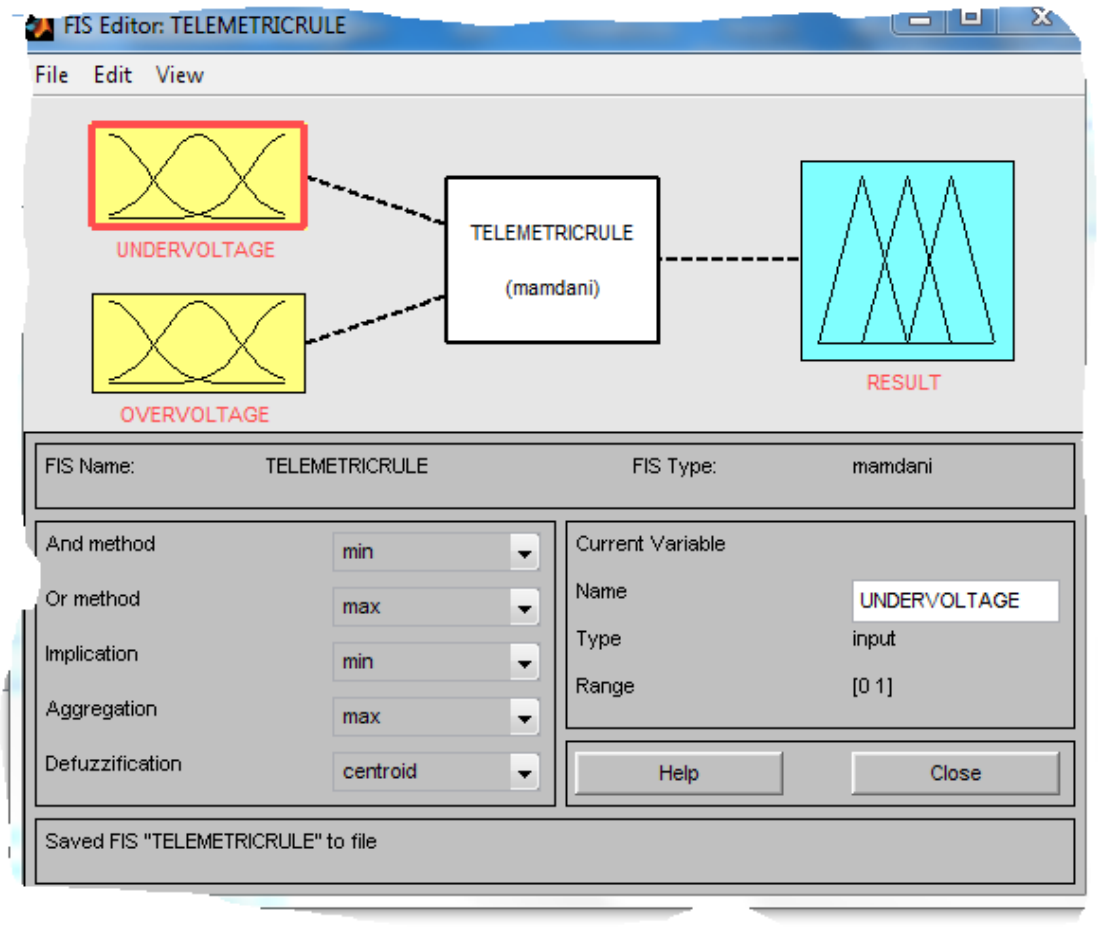

Fig 4 designed telemetric fuzzy inference system (FIS) that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system

Fig 4 has two inputs of under voltage and over voltage. It also has an output of result.

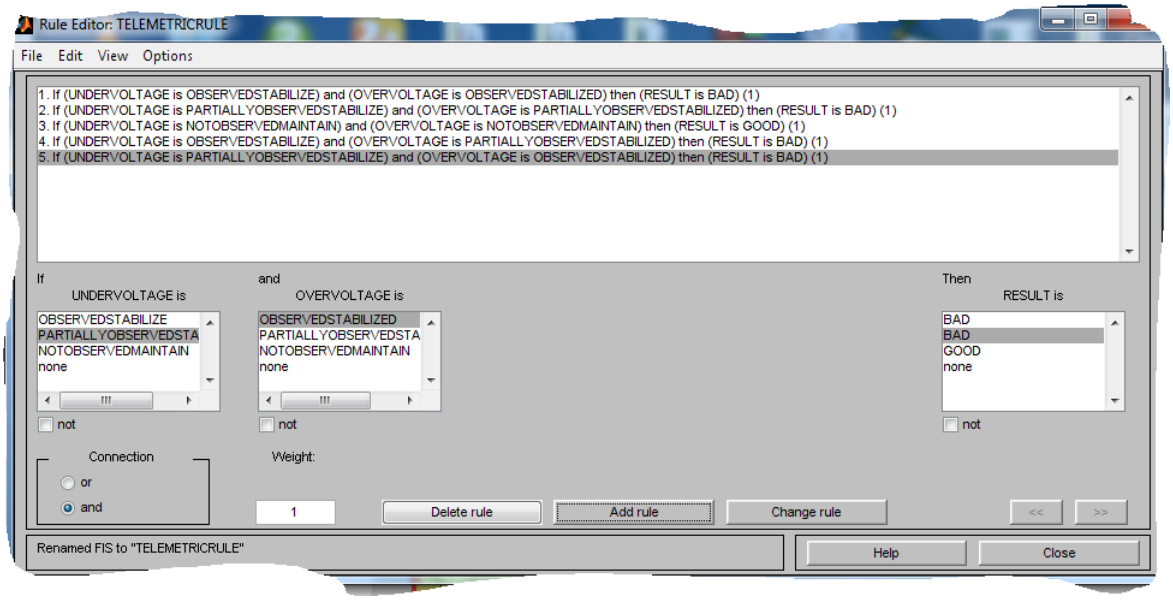

Fig 5 designed telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system

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It has five rules that protects and stabilizes the under voltage and over voltage. It is comprehensively detailed in table 2

Table 2 designed telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system

1	IF UNDER VOLTAGE IS OBSERVED STABILIZED	AND OVER VOLTAGE IS OBSERVED STABILIZED	THEN RESULT IS BAD
2	IF UNDER VOLTAGE IS PARTIALLY OBSERVED STABILIZED	AND OVER VOLTAGE IS PARTIALLY OBSERVED STABILIZED	THEN RESULT IS BAD
3	IF UNDER VOLTAGE IS NOT OBSERVED MAINTAIN	AND OVER VOLTAGE IS NOT OBSERVED MAINTAIN	THEN RESULT IS GOOD
4	IF UNDER VOLTAGE IS OBSERVED STABILIZED	AND OVER VOLTAGE IS PARTIALLY OBSERVED STABILIZED	THEN RESULT IS BAD
5	IF UNDER VOLTAGE IS PARTIALLY OBSERVED STABILIZED	AND OVER VOLTAGE IS PARTIALLY OBSERVED STABILIZED	THEN RESULT IS BAD

To train ANN in these rule base for effective stabilization and protection.

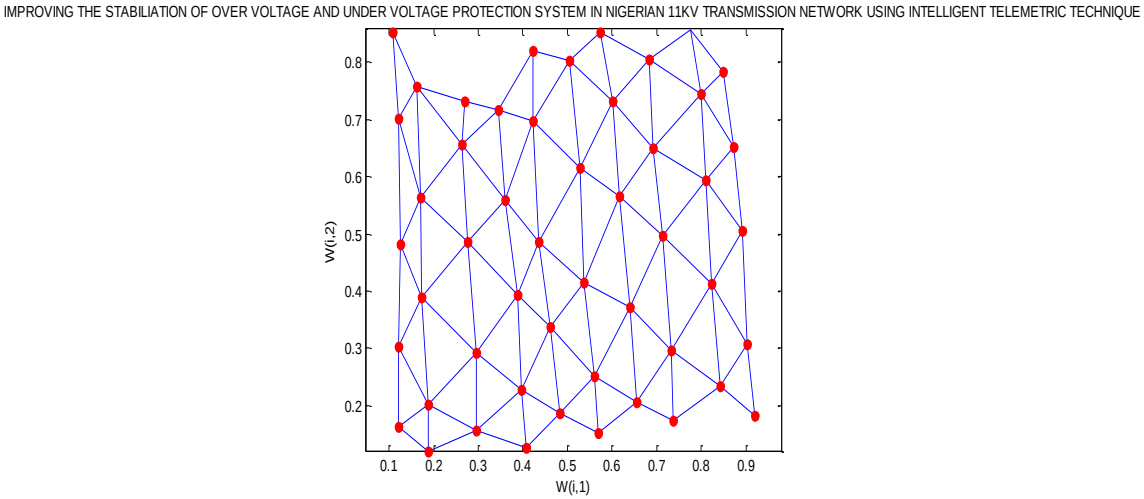

Fig 6 trained ANN in this rule base for effective stabilization and protection.

In fig 6 ANN was trained in the five rules 5 x 10 =50 to have fifty neurons that looks exactly like human brain. This is specifically trained to adhere strictly to the five stipulated rules as shown in table 2. The result obtained at the course of training ANN in the rule is as shown in fig 7.

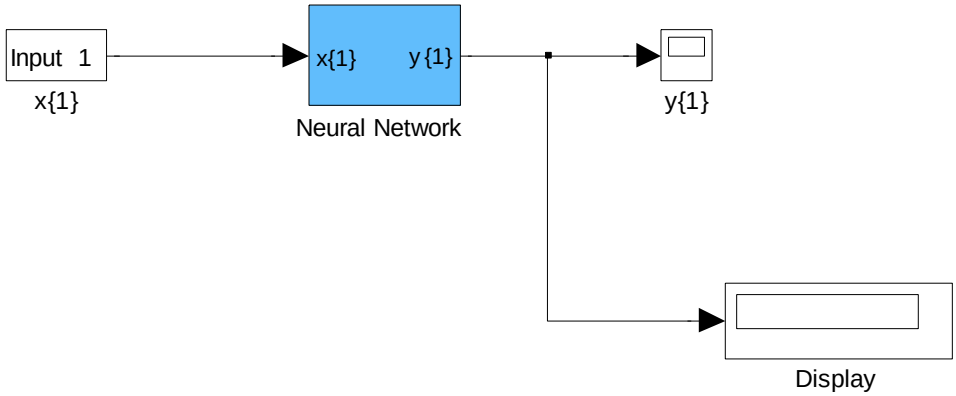

Fig 7 Result of training ANN in the five rules of improving the stabilization of over voltage and under voltage protection system in Nigerian 11kv transmission network. This result will be incorporated to the telemetric SIMULINK model to boost the efficacy of stabilizing and protecting under voltage and over voltage in Nigerian 11kv transmission network.

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To design a telemetric SIMULINK model

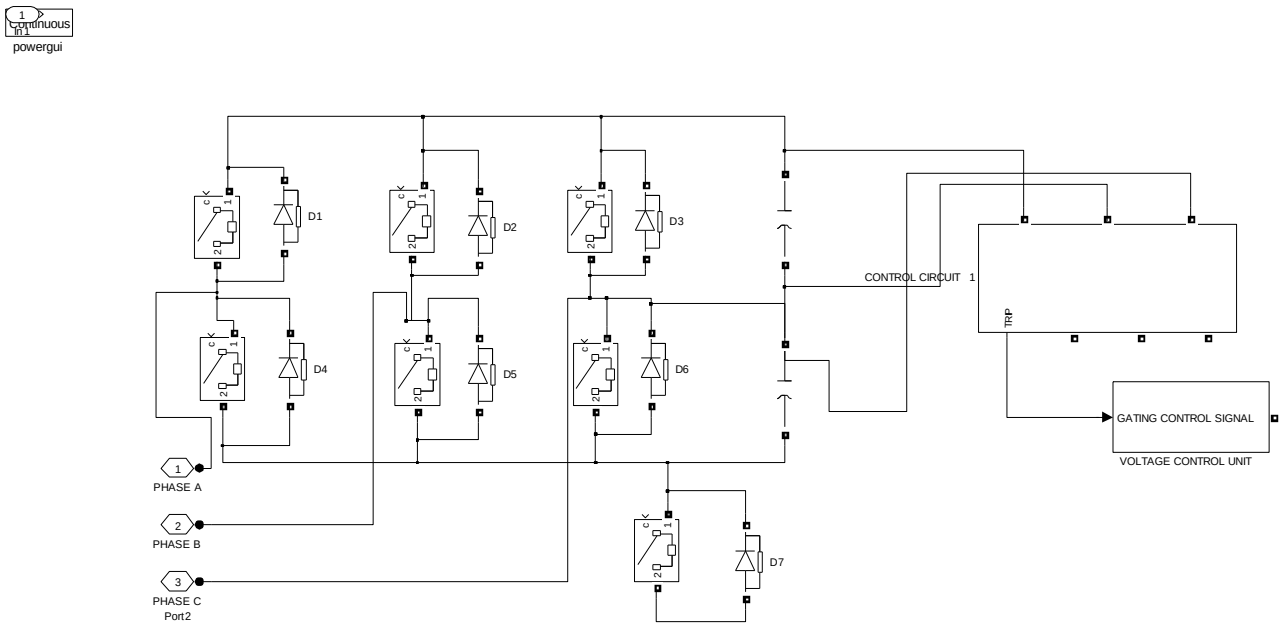

Fig 8 designed telemetric SIMULINK model

Fig 8 shows designed telemetric SIMULINK model that will facilitate the stabilization of under voltage and over voltage observed in Nigerian 11kv transmission network.

To develop an algorithm that will implement the process.

1. Characterize 11KV Nigerian transmission network
2. Run the load flow to identify under voltage the per unit volts is below 0.95.
3. Identify over voltage from the load flow. The per unit volts is above 1.05
4. Design a conventional SIMULINK model for stabilization of over voltage and under voltage protection system in Nigerian 11kv transmission network and integrate 2 and 3
5. design a telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system
6. Train ANN in this rule base for effective stabilization and protection.
7. Design a SIMULINK model for telemetric.
8. Integrate 5, 6 and 7.
9. Integrate 8 in 4
10. Do the under and over voltages stabilized in 9
11. If No go to 9
12. If yes go to 13
13. Improved stabilization of over voltage and under voltage protection system in Nigerian 11kv transmission network
14. Stop
15. End

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To design a SIMULINK model for improving the stability of over and under voltage protection system of the Nigerian 11KV transmission network using intelligent telemetric

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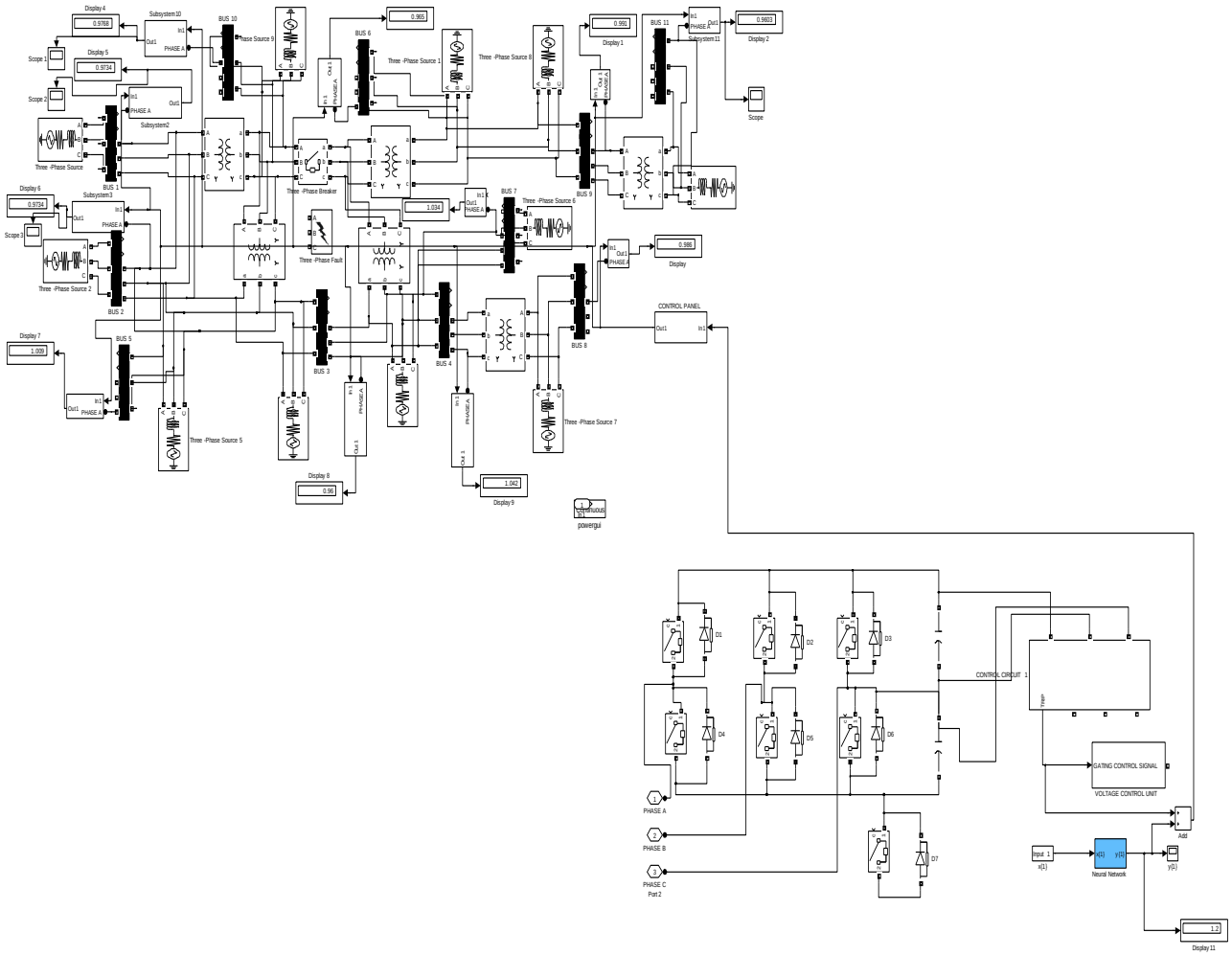

Fig 9 design ed SIMULINK model for improving the stability of over and under voltage protection system of the Nigerian 11KV transmission network using intelligent telemetric

The results obtained after simulation are as shown in figures 10 and 11.

3. DISCUSSION OF RESULT

Table 3 comparison of Conventional unprotected under voltage in bus 1 and Intelligent stabilized and protected voltage in bus1

Time(s)	Conventional unprotected under voltage in bus 1(P.U.V)	Intelligent stabilized and protected voltage in bus1(P.U.V)
1	0.93	0.9734
2	0.93	0.9734
3	0.93	0.9734
4	0.93	0.9734
10	0.93	0.9734

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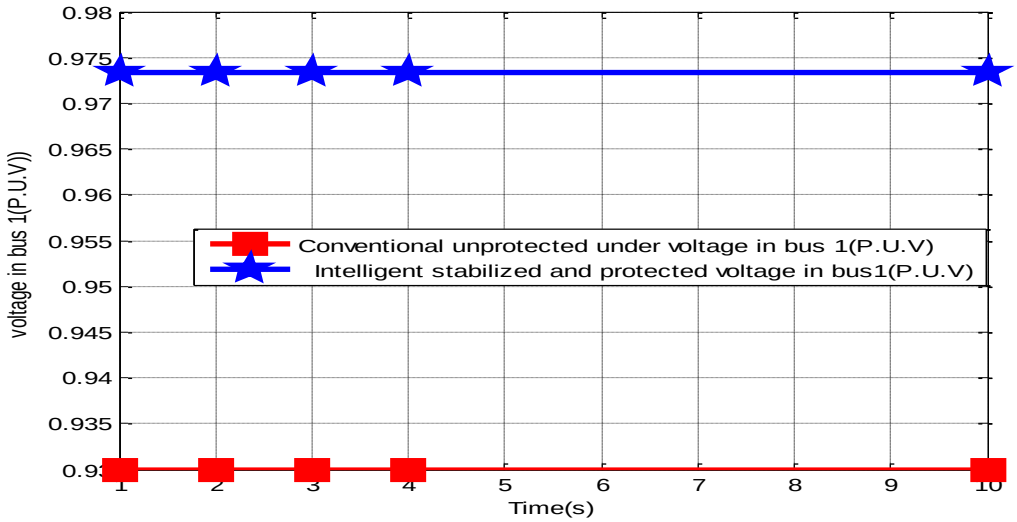

Fig 10 comparison of Conventional unprotected under voltage in bus 1 and Intelligent stabilized and protected voltage in bus1

In fig 10 the conventional voltage is 0.93 P.U.V signifying that the voltage is under voltage because it did not fall within the thresh hold of voltage stability of 0.95 through 1.05 per unit volts. Meanwhile, when an intelligent telemetric technique is incorporated in the system it stabilized the voltage in bus 1 to 0.973 thereby making it to attain the thresh hold of 0.95 through 1.05 thereby enhancing consistent power supply in the country.

Table 4 comparison of Conventional unprotected overvoltage in bus 10 and Intelligent stabilized and protected voltage in bus10

Time(s)	Conventional unprotected overvoltage in bus 10(P.U.V)	Intelligent stabilized and protected voltage in bus10(P.U.V)
1	107	0.9768
2	1.07	0.9768
3	1.07	0.9768
4	1.07	0.9768
10	1.07	0.9768

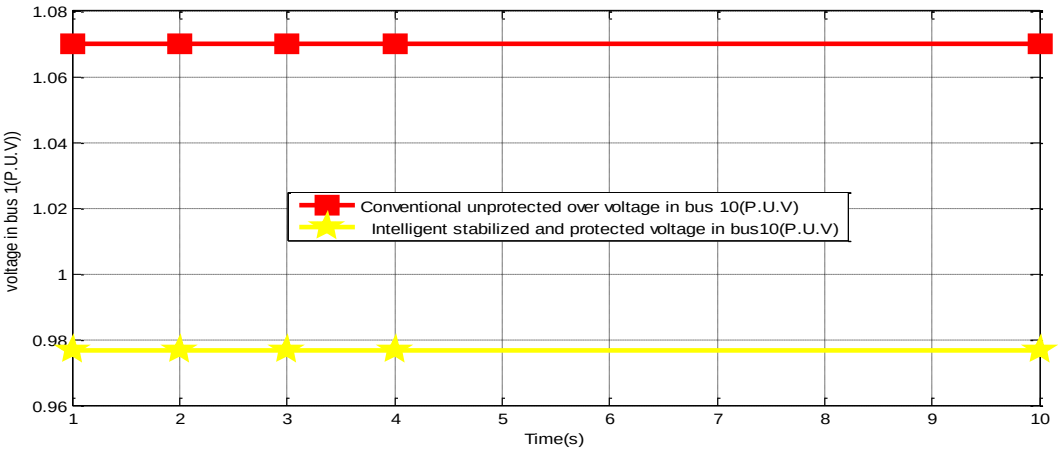

Fig 11 comparison of Conventional unprotected overvoltage in bus 10 and Intelligent stabilized and protected voltage in bus 10

In fig 11 the conventional voltage is 107 per unit volt which is over voltage that destroys a lot of electrical appliances in the homes, industries and factories. On the other hand, when an intelligent telemetry is integrated in the system, it stabilized the voltage to 0.9768 P.U.V thereby protecting all the electrical appliances in homes, companies, industries and factories from damaging.

4. CONCLUSION

The wanton destruction of lives and properties observed in some of the states and the country at large today has arisen as a result of under voltage and over voltage observed in our power systems. This has arisen as a result of not having adequate protecting and stabilizing mechanism that will stabilize under voltage and over voltage experienced in transmission industry. To overcome this chronic social malady observed in transmitted power there is an introduction of improving the stabilization of over voltage and under voltage protection system in Nigerian 11kv transmission network using intelligent telemetric technique. To achieve this, it is done in this manner, characterizing Nigerian 11KV transmission network, running the load flow of the characterized data to establish over voltage and under voltage in the network,design a telemetric rule base that will stabilize over and under voltage in Nigerian 11KV transmission network thereby protecting the system, training ANN in these rule base for effective stabilization and protection, developing an algorithm that will implement the process, designing a telemetric SIMULINK model, developing an algorithm that will implement the process and designing a SIMULINK model for improving the stability of over and under voltage protection system of the Nigerian 11KV transmission network using intelligent telemetric. The results obtained are the conventional voltage is 0.93 P.U.V signifying that the voltage is under voltage because it did not fall within the thresh hold of voltage stability of 0.95 through 1.05 per unit volts. Meanwhile, when an intelligent telemetric technique is incorporated in the system it stabilized the voltage in bus 1 to 0.973 thereby making it to attain the thresh hold of 0.95 through 1.05 thereby enhancing consistent power supply in the country and the conventional voltage is 107 per unit volt which is over voltage that destroys a lot of electrical appliances in the homes, industries and factories. On the other hand, when an intelligent telemetry is integrated in the system, it stabilized the voltage to 0.9768 P.U.V thereby protecting all the electrical appliances in homes, companies, industries and factories from damaging.

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