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Improving the Performance of Transmission Line Using Hybrid Technique

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ABSTRACT

Electric power system stability is always threatened by disturbances. These disturbances emerge in different ways. It can come as loss of generation to switching, change in loads, and fault conditions. These disturbances have caused a shift in the original desire of the utility providers and the consumers which is to maintain in power system a stable voltage at all buses to undesirable voltage instability. The effect of instability in the Nigerian power system can be severe to the network providers and also to the consumers. Untreated instability in the power system leads to a condition involving loss of synchronism of certain generators or some generators falling out of step. Voltage collapse can be caused by voltage instability. It is pertinent to note that, when the system voltage collapses, the utility end-users suffer greatly in such a way that their standard of living diminishes hence many companies seize to operate and a lot of workers lose their jobs, life becomes unbearable. Voltage instability reduces National development in a way that there will be a loss in national economic development. Companies do not thrive in a situation of instability and so the working population is reduced, so also productivity and economy. On another note when the voltage rises and falls indiscriminately, it can damage the plant, and that results in a huge economic loss in the society. Following this, therefore, there is a need to employ an intelligent technique to keep intact power steadiness in electric energy systems. Hybrid technique, that is a combination of thyristor-controlled series compensator (TCSC), Static Var Compensator, and artificial intelligence was adopted to mitigate voltage violation in transmission lines. The result showed that the hybrid technique performs better when using only TCSC or SVC.

Keywords: *Transmission Line, Hybrid Technique, Power System, Voltage*

1. Introduction

Quality and stable electricity supply in any nation bring about national development. Nigeria as a case study lacks a frequent supply of Electricity and so it has multidimensional problems. For instance, looking at the world bank estimated electricity generated capacity in Nigeria and other counties it noted that Nigeria with a capacity of 8,64MW uses only about 3,718MW to service a population of over 180 million people, (World Bank, 2015). This insufficiency in supply affects the economic situation of the country.

South Africa that has a population of only 55 million (World Bank 2015), has an installed electricity capacity generation of 52, 000MW, on a per capita consumption basis.

Nigeria, from the analysis of the world bank, ranked 178^{th} with 106.21 KWh per head, as against Gabon (950.00) kWh per head, Ghana with (283.60) kWh per head; Cameroon (178.02) kWh per head, and Kenya (127.41) kWh per head.

One of the major issues facing the competitive energy market is that one or several disturbances may affect reactive power generated, thereby leading to voltage instability. The need for a fast working electrical system has given rise to better electrical Technological innovations on transmission lines through the use of solid-state devices. The devices are referred to as FACTS meaning not rigid irregular current transmission system. The FACTS device enhances electric power system stability. These entire devices have gone a long way in solving electric power issues like voltage unsteadiness, energy flow control problems, imbalances between reactive power and active power flow. These FACTS are based on power electronics voltage source which is capable of generating internally and absorbing reactive power without the use of AC capacitors or reactors. These devices provide independent control for active and reactive energy flow as they facilitate their power compensation. The main objective of FACTS devices is to enhance power transmission capacity, energy control, power steadiness enhancement, and power system stability enhancement. The idea of FACTS was initiated by N. G. Hingorani, (1988). Since then different FACTS controllers have come into play in the area of transmission voltage stability. These FACTS controllers are dependent on power supply converters and they include devices like Static Var Compensator (SVC), Thyristor Controlled Series Compensator, etc. Artificial Intelligent (AI) was adopted to control the operation of TCSC and SVC in order to achieve maximum results.

2. Model of Hybrid Technique

Hybrid Technique is the combination of TCSC and SVC controlled by Artificial intelligence to ensure stability in transmission networks.

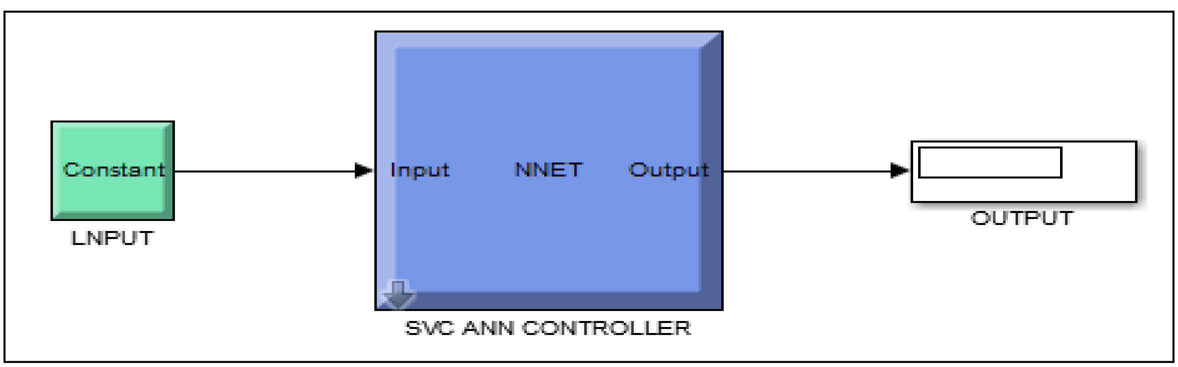

Figure 2.1: SVC ANN Simulink model

This is the input for SVC and incorporated with ANN. This procedure was followed for TCSC.

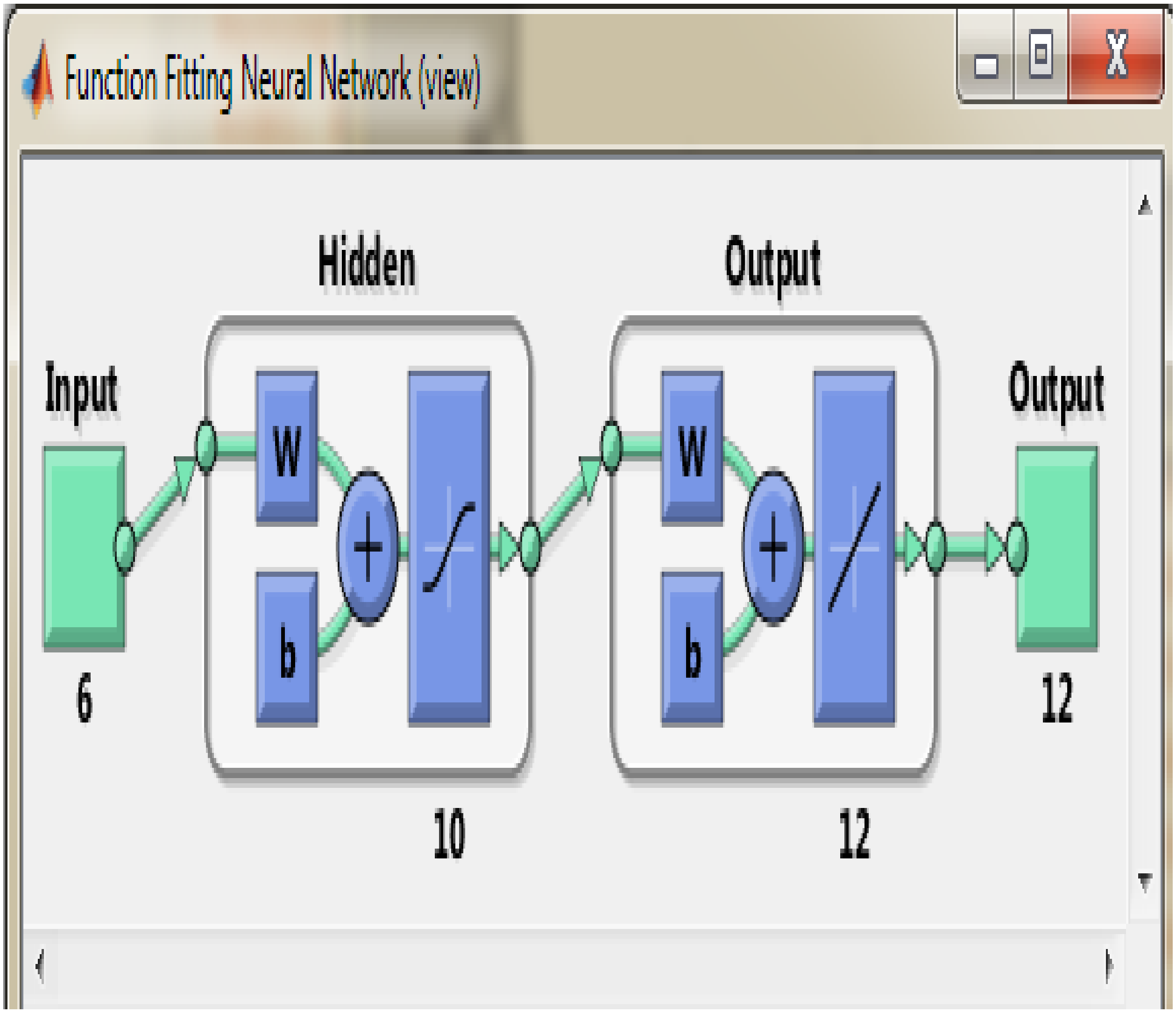

Figure 2.2: SVC ANN Architecture

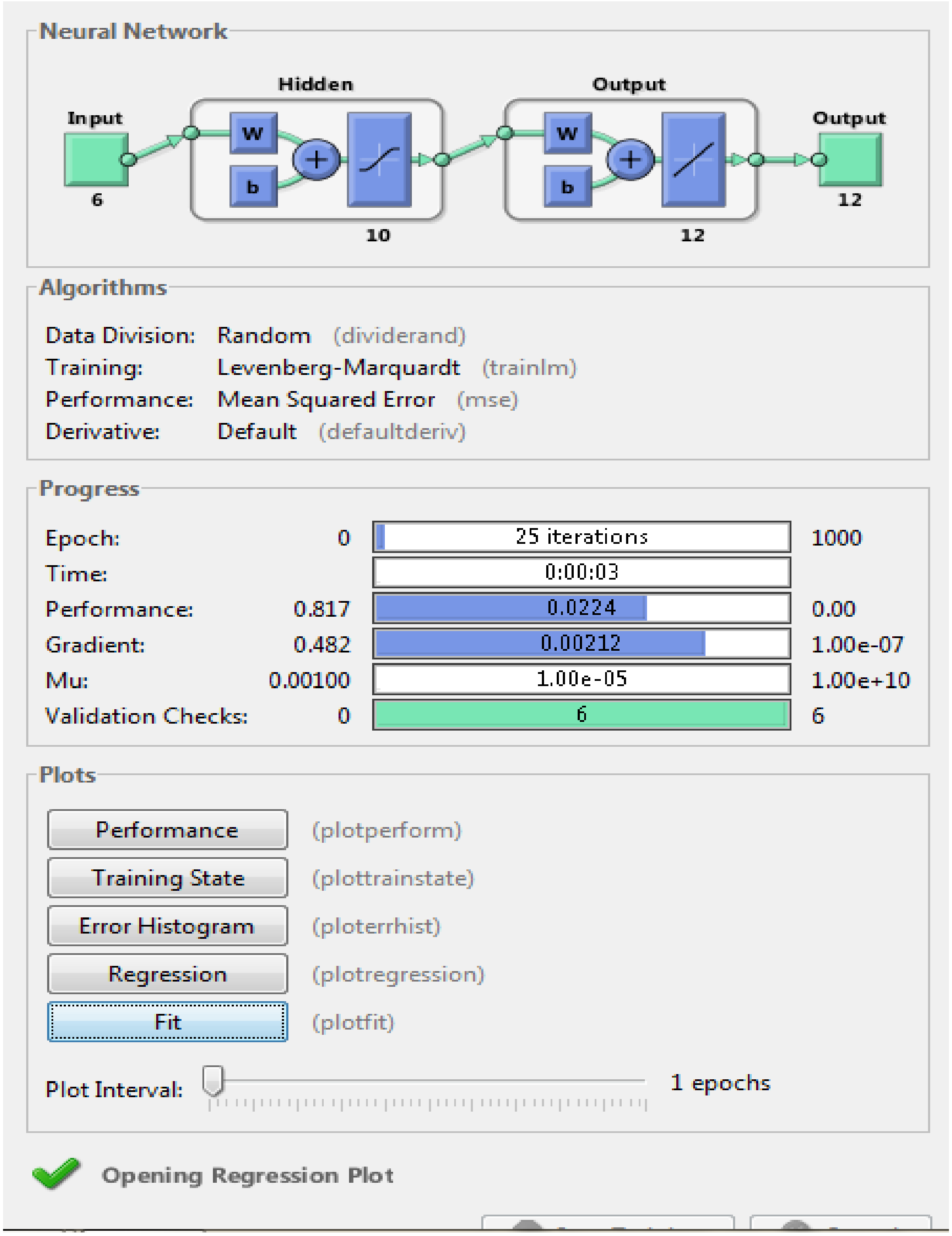

Fig 2.3 ANN SVC Training environment.

ANN SVC model was trained, after undergoing successive training as shown above; it was deployed into 41 bus networks to balance uncertainties in the line thereby ensuring stability.

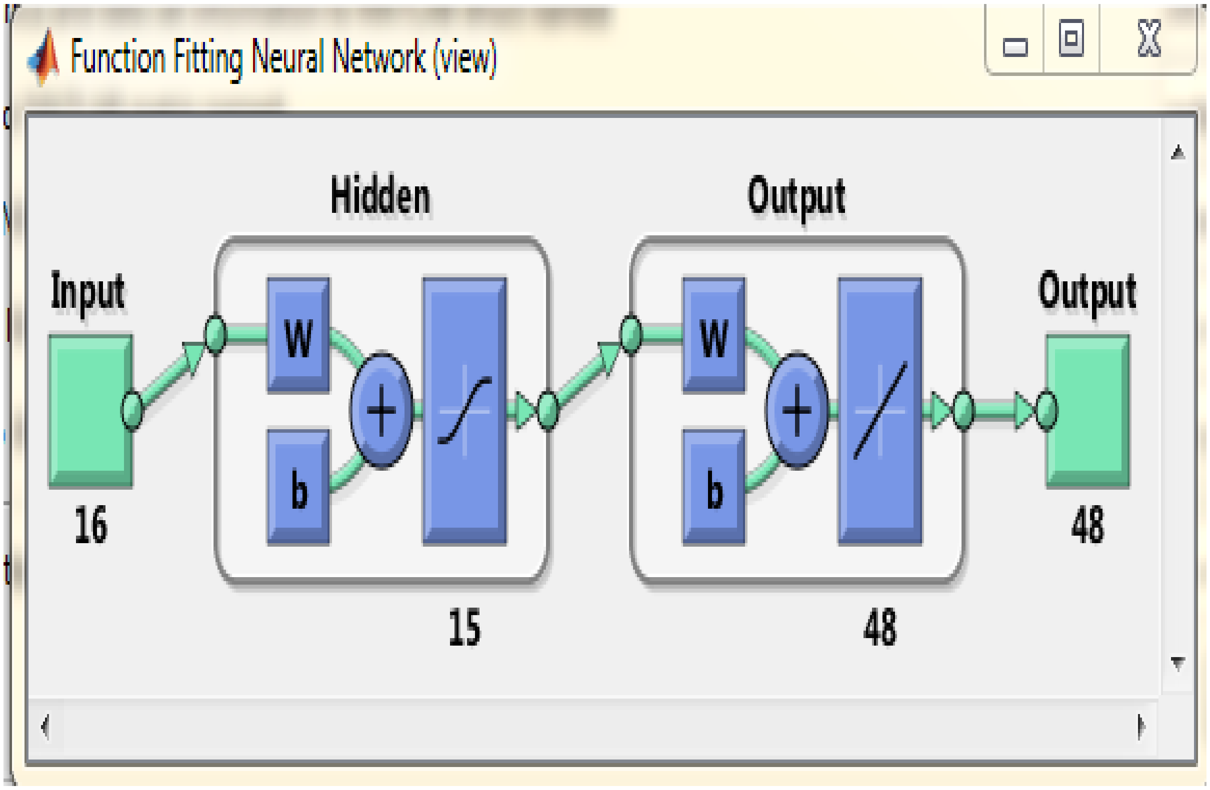

Figure 2.4: TCSC ANN Architecture

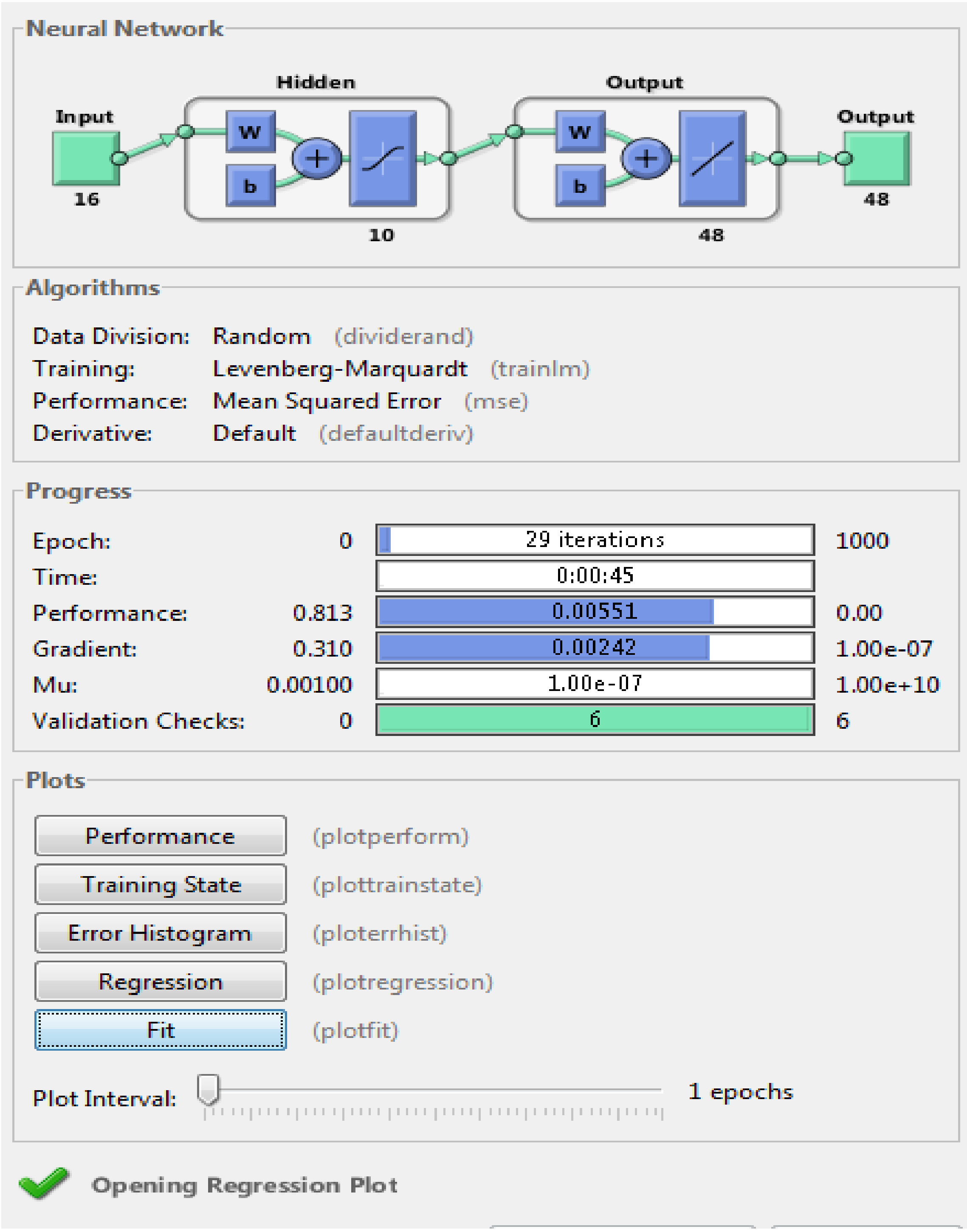

Fig 2.5: ANN TCSC training environment

3. Integration of Hybrid technique into the network

The model developed was integrated into 41 bus transmission networks. Because of the MatLab work environment workspace. The equivalent network of 41 bus networks was modeled in fig 3.1 without a Hybrid device connected to it. Thereafter, an equivalent network of 41 bus networks with hybrid devices was modeled as shown in fig 3.2

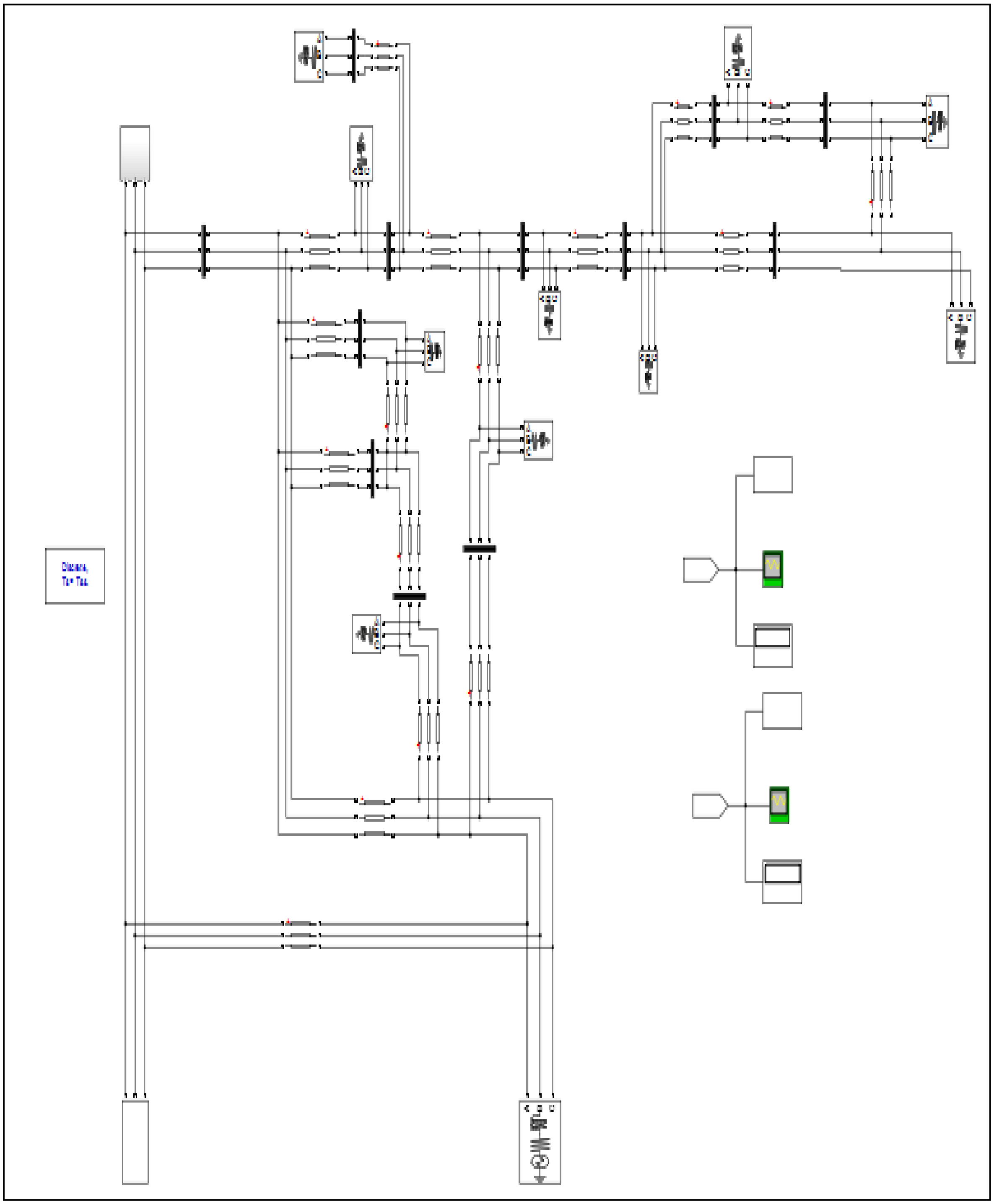

Figure 3.1: Simulink model of the equivalent test network with no hybrid devices connected

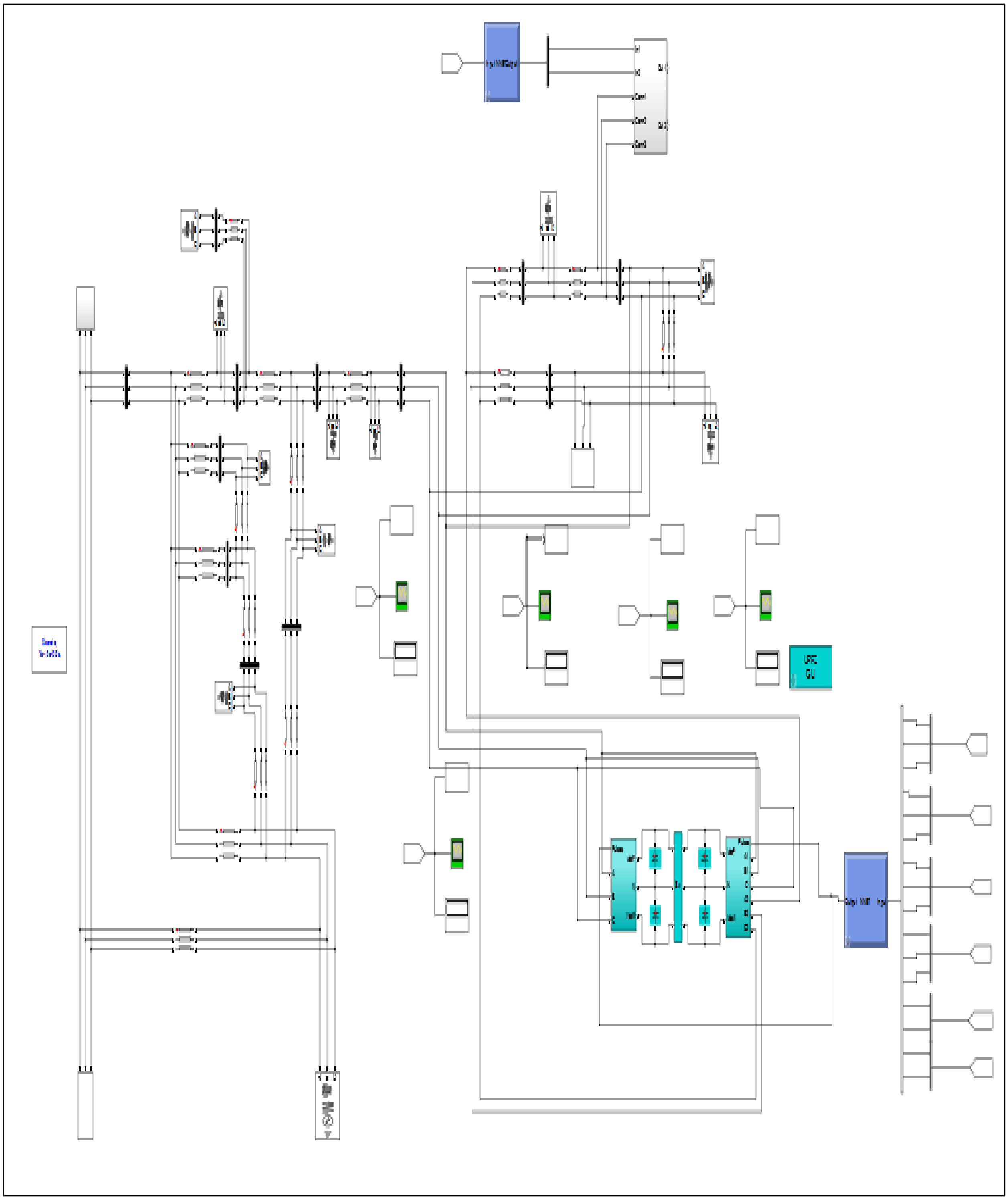

Figure 3.2: Simulink model of the test network with ANN controlled hybrid devices connected

4. Simulation

The simulation was run, first with SVC, later with, TCSC and lastly, Hybrid device, as shown below.

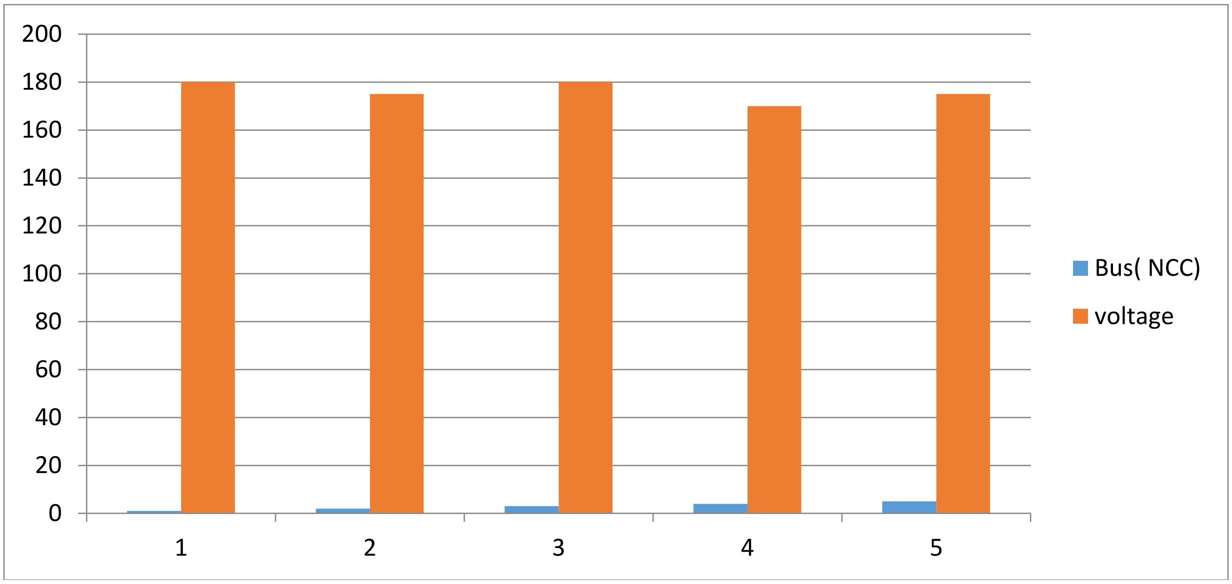

Fig 4.1: NCC Simulation result

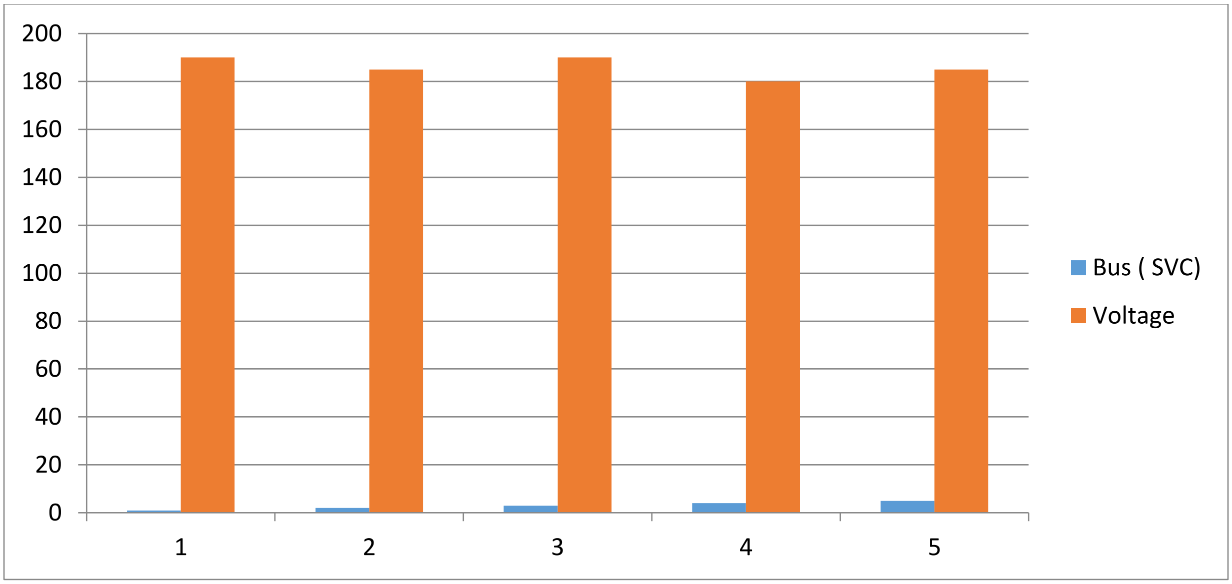

Fig 4.2: SVC Simulation result

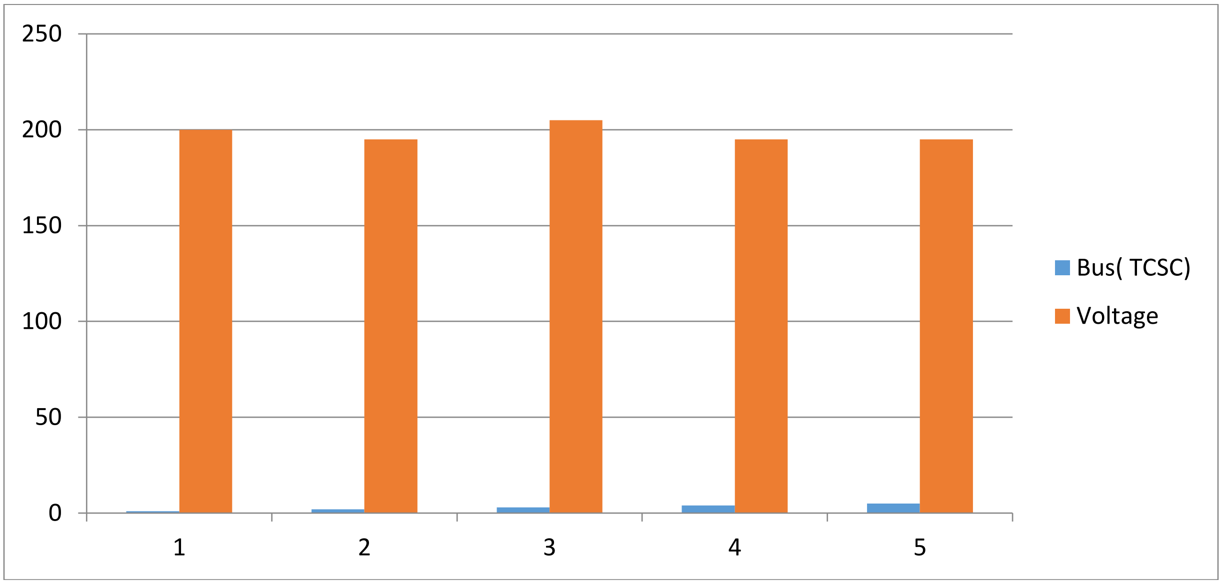

Fig 4.3: TCSC Simulation result

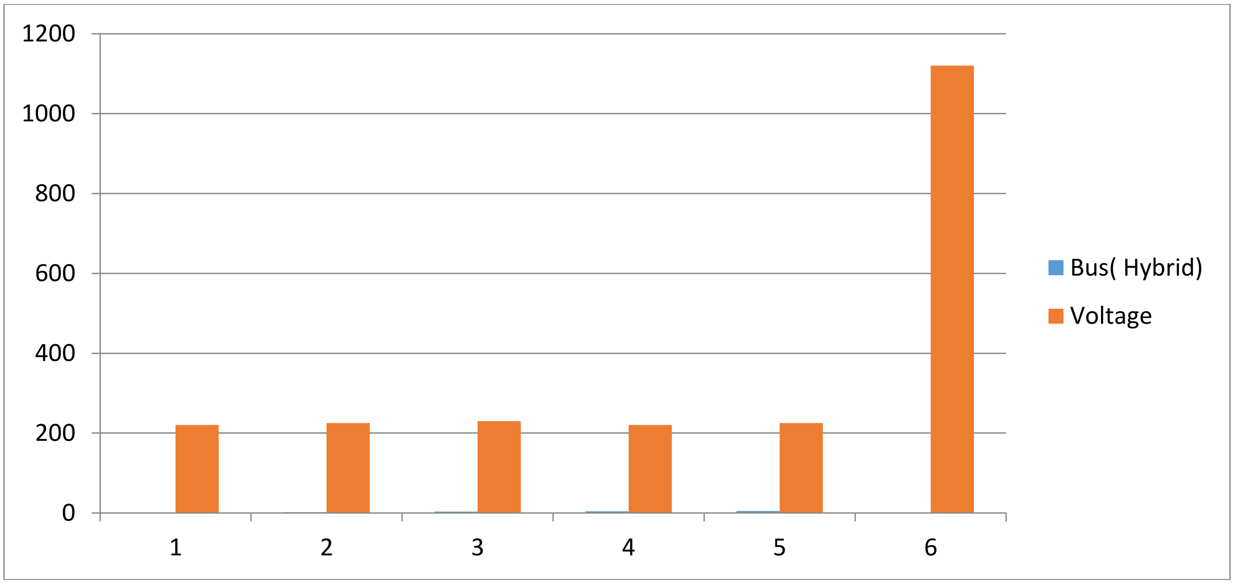

Fig 4.4: Hybrid Simulation result

The result above, from Fig 4.1, Fig 4.2, Fig 4.3, and Fig 4.4 showed that the hybrid technique ensured the stability of voltage when it was introduced into the network.

5. Conclusion

The standard operating voltage condition in a per-unit system ranges from 0.95 to 1.05 and in kilovolt, ranges from 313.5 to 346.5KV. Anything above or below caused instability to the system.

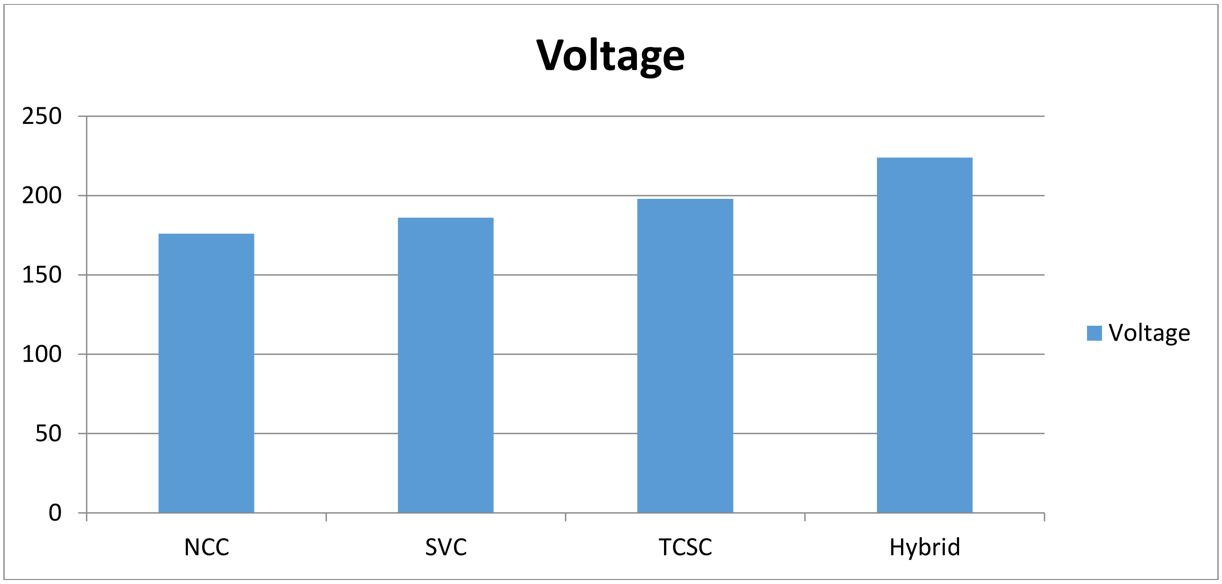

Fig 5.1: Simulation of different technique

Data from the national control center (NCC) from its equivalents, was simulated through load flow analysis, thereafter, SVC was connected into the equivalent network, SVC was removed from the network, TCSC was connected into the network and was simulated. Then, TCSC was removed from the equivalent network and the Hybrid technique connected into the network and was simulated. The results showed that the hybrid technique perform better than SVC and TCSC and kept the voltage with the acceptable operating condition

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