Enhancing the Performance of Wearable Technology in An Industry using Artificial Neural Network (ANN) based Solid State Var Compensator (SSVC)

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ABSTRACT
The integration of wearable technology in industrial environments has revolutionized workforce monitoring, safety, and operational efficiency. However, the performance and reliability of these devices are often compromised by inconsistent power quality and electromagnetic interference within industrial settings. This study proposes the enhancement of wearable technology performance through the implementation of an Artificial Neural Network (ANN)-based Solid State Var Compensator (SSVC). The ANN-based SSVC dynamically analyzes and compensates for voltage fluctuations and reactive power imbalances, thereby stabilizing the power supply to wearable devices. By intelligently adapting to real-time power conditions, the system ensures uninterrupted functionality, minimizes signal distortions, and extends device lifespan. Simulation results demonstrate significant improvements in voltage regulation, power factor correction, and overall system stability. The proposed approach offers a scalable and intelligent power management solution for robust wearable technology operation in complex industrial environments, promoting higher productivity, worker safety, and technological resilience. The conventional Power Quality Issues that cause poor performance of wearable technology in an industry was 25%. However, when an ANN based solid state VAR compensator (SSVC) was incorporated in the system, it drastically reduced it to22.5% and the conventional Inadequate Battery Life that cause poor performance of wearable technology in an industry was 10%. Meanwhile, when an ANN based solid state VAR compensator (SSVC was imbibed into it, it automatically reduced it to 9%. Finally, with these results obtained the percentage enhancement in the performance of wearable technology in an industry when an ANN based solid state VAR compensator (SSVC was integrated into it became 1%.

Keywords
Wearable Technology, Artificial Neural Network, Solid State Var Compensator

1. INTRODUCTION
Wearable technology has gained significant traction in various industrial sectors due to its potential to improve operational efficiency, enhance safety, and streamline data-driven decision-making. Devices such as smart glasses, wearable sensors, and haptic feedback systems have transformed how industries monitor worker health, track productivity, and manage complex systems in real time. However, the widespread adoption and functionality of these technologies depend heavily on the stability and quality of power supply systems within industrial environments (Zhou et al., 2020). Inconsistent voltage regulation, harmonic distortion, and reactive power imbalance can degrade the performance and lifespan of wearable devices, leading to suboptimal results and increased maintenance costs. To address these challenges, the integration of intelligent control techniques such as Artificial Neural Networks (ANNs) into Solid State Var Compensators (SSVCs) presents a promising solution. ANN-based SSVCs are capable of learning nonlinear system behaviors, predicting voltage fluctuations, and automatically adjusting reactive power compensation to maintain power stability (Kumar & Singh, 2021). By optimizing power quality through intelligent compensation, these systems can significantly enhance the operational performance of wearable technologies in demanding industrial conditions. Furthermore, ANN-based SSVCs enable adaptive control strategies that respond in real time to the dynamic nature of industrial loads. This capability is essential for supporting the continuous and reliable operation of wearable devices that require clean, stable power for data acquisition, wireless communication, and embedded processing (Singh et al., 2022). The convergence of AI-based control methods and advanced power electronics represents a strategic pathway for industries aiming to leverage wearable technology effectively while minimizing disruptions due to electrical instability. In essence, the fusion of ANN-based SSVCs with wearable technology serves not only to improve device efficiency and durability but also to foster a more intelligent and resilient industrial ecosystem capable of meeting the growing demands of Industry 4.0.

2. METHODOLOGY

Table 1 Characterized and established the causes of poor performance of wearable technology in an industry

S/N	Cause of Poor Performance	Description	Estimated Contribution (%)
1	Power Quality Issues	Voltage instability, harmonics, and poor power factor affect device reliability.	25%
2	Electromagnetic Interference (EMI)	Industrial machines generate EMI that disrupts communication and sensors.	18%
3	Network Connectivity Failures	Inadequate or unstable Wi-Fi/IoT connectivity limits data transmission.	15%
4	Environmental Conditions	Exposure to dust, humidity, temperature extremes, or vibrations.	12%
5	Inadequate Battery Life	Frequent power depletion reduces operational time and usability.	10%
6	Sensor Calibration Errors	Improperly calibrated sensors lead to inaccurate monitoring data.	8%
7	Software or Firmware Bugs	Malfunctions due to poorly updated or tested software systems.	6%
8	Human Error in Usage	Misuse, incorrect placement, or neglect by users affects accuracy.	4%
9	Lack of Real-Time Data Processing	Delays in analytics or system feedback reduce performance value.	2%

Total: 100%

This table provides insight into the key areas needing attention to enhance the performance of wearable technology in industrial environments.

To design a conventional SIMULINK model for performance of wearable technology in an industry

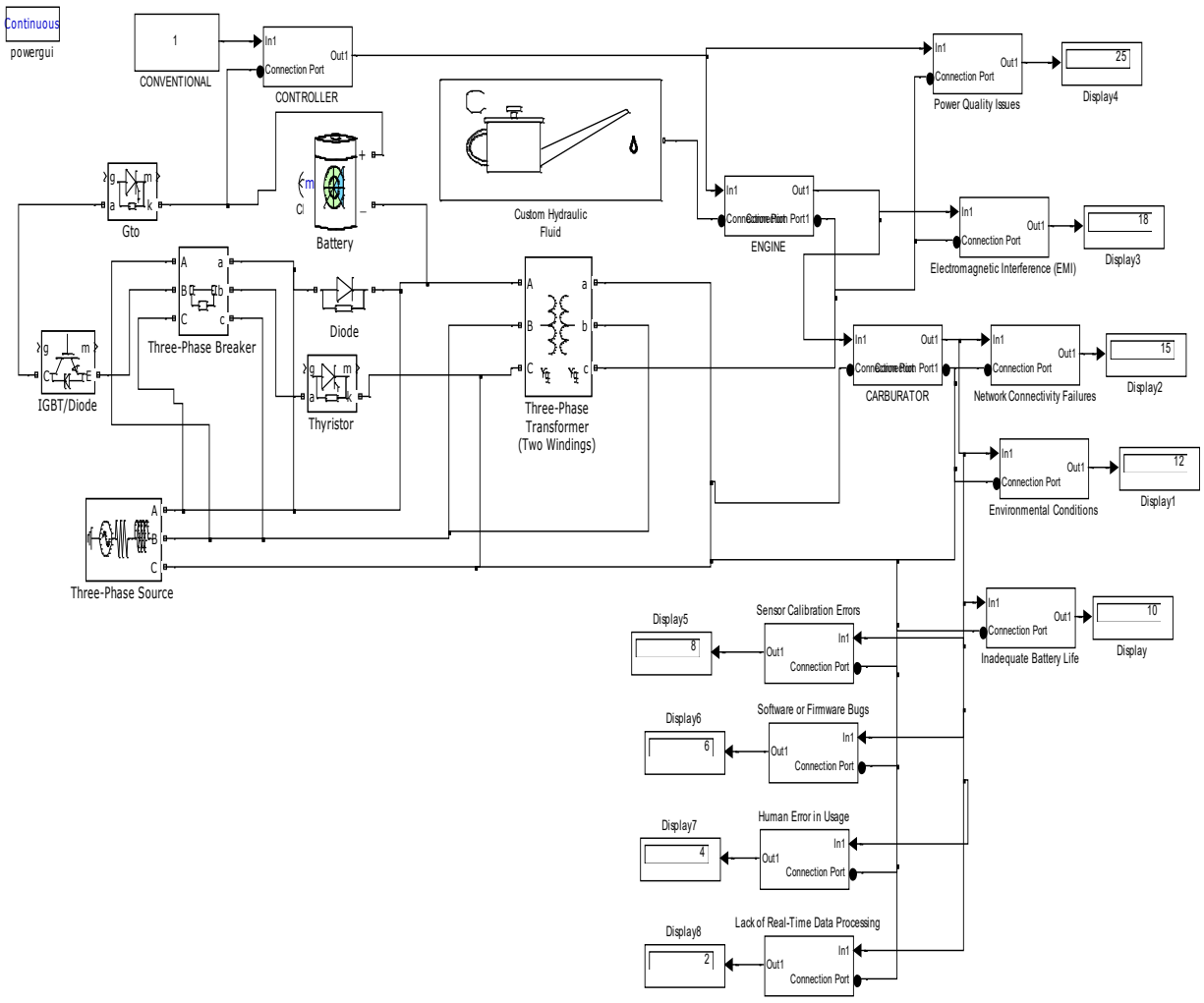

Fig 1 Designed conventional SIMULINK model for performance of wearable technology in an industry

The results obtained were as shown in figures 8 and 9

To train ANN in the causes of poor performance of wearable technology in an industry

To design a SIMULINK model for SSVC

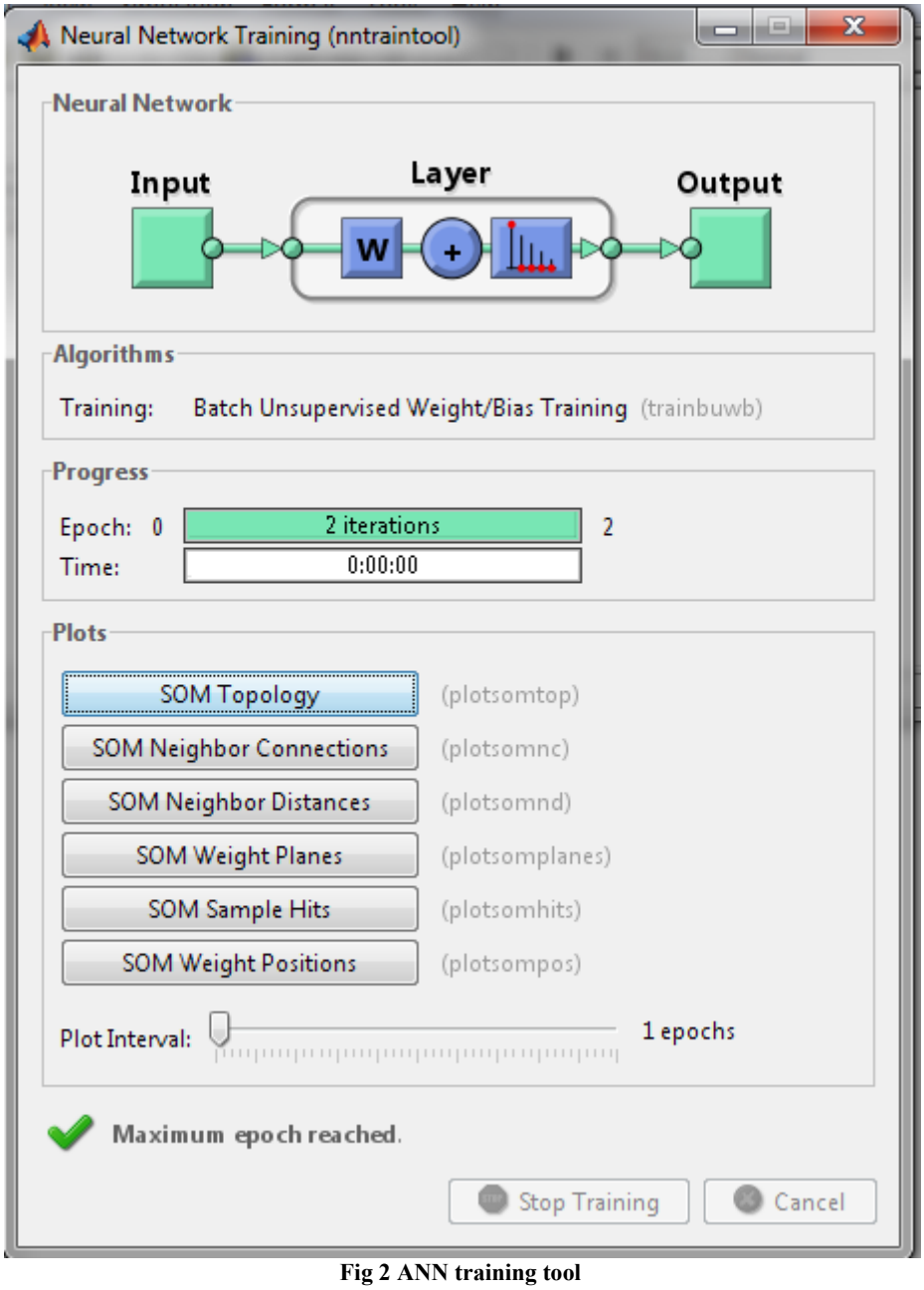

Fig 2 ANN training tool

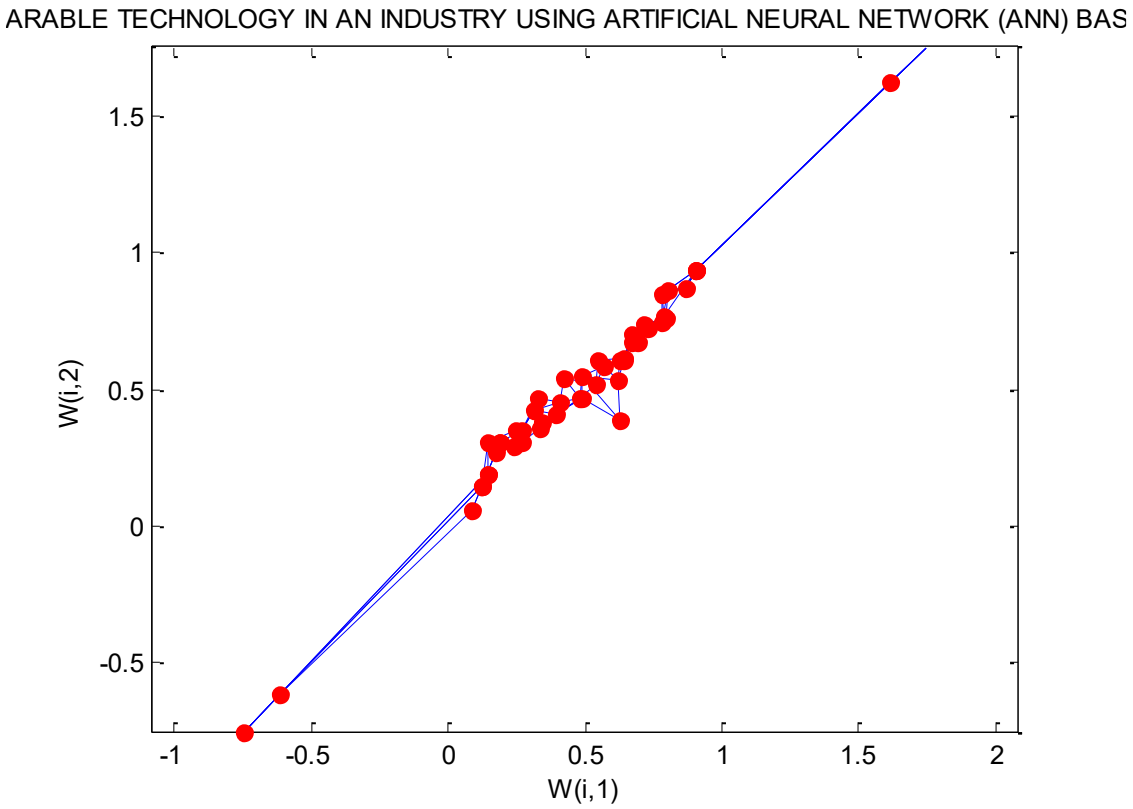

Fig 3 trained ANN in the causes of poor performance of wearable technology in an industry

ANN was trained twenty times in the three rules 20 x 3 = 60 to give sixty neurons that look like human brain.

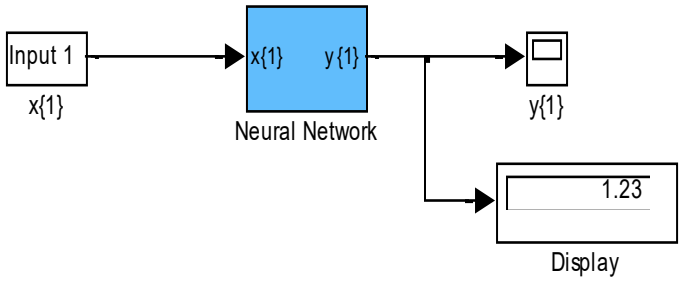

Fig 4 result obtained after the training

To design a SIMULINK model for SSVC

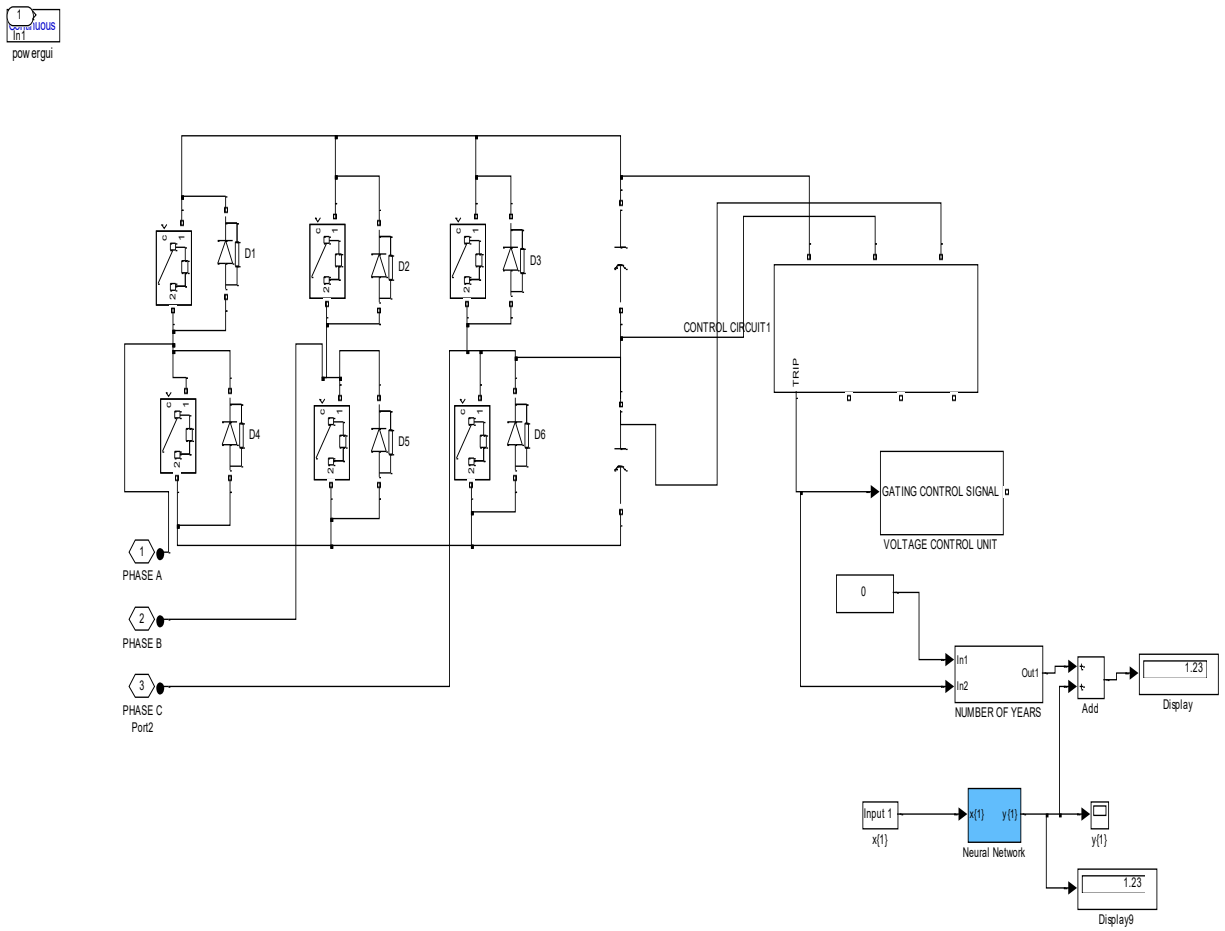

Fig 5 designed SIMULINK model for SSVC

This would be integrated in the conventional model to boost the efficacy of reducing the causes of poor performance of wearable technology in an industry.

To develop an algorithm that will implement the process

1. Characterize and establish the causes of poor performance of wearable technology in an industry
2. Identify Power Quality Issues
3. Identify Electromagnetic Interference (EMI)
4. Identify Network Connectivity Failures
5. Identify Environmental Conditions
6. Identify Inadequate Battery Life
7. Identify Sensor Calibration Errors
8. Identify Software or Firmware Bugs
9. Identify Human Error in Usage
10. Identify Lack of Real-Time Data Processing
11. Design a conventional SIMULINK model for performance of wearable technology in an industry and incorporate 2 through 10.
12. Train ANN in the causes of poor performance of wearable technology in an industry
13. Design a SIMULINK model for SSVC
14. Integrate 12 and 13
15. Integrate 14 into 11.
16. Did the causes of poor performance of wearable technology in an industry reduced when 14 was integrated into 11?
17. IF NO go to 15
18. IF YES go to 19
19. Enhanced performance of wearable technology in an industry
20. Stop
21. End

To design a SIMULINK model for enhancing the performance of wearable technology in an industry using artificial neural network (ANN) based solid state VAR compensator (SSVC)

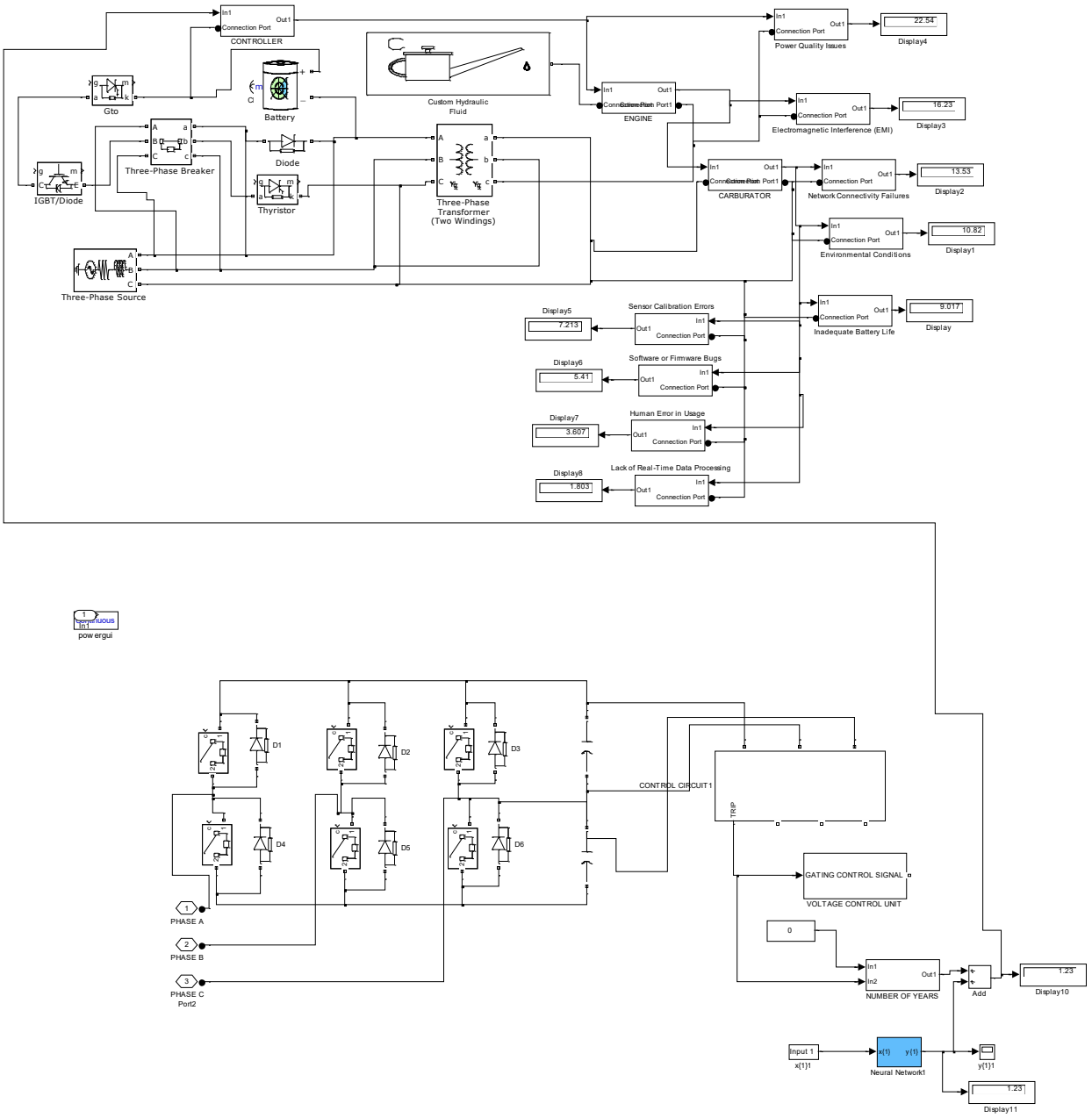

Fig 6 designed SIMULINK model for enhancing the performance of wearable technology in an industry using artificial neural network (ANN) based solid state VAR compensator (SSVC)

The results obtained were as shown in figures 7 and 8

To validate and justify the percentage improvement in the reduction of the causes of poor performance of wearable technology in an industry with and without(ANN) based solid state VAR compensator (SSVC)

To find percentage improvement in the reduction of Power Quality Issues the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)

Conventional Power Quality Issues = 25%

ANN) based solid state VAR compensator (SSVC) Power Quality Issues =22.5%

%improvement in the reduction of Power Quality Issues the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=

Conventional Power Quality Issues - ANN) based solid state VAR compensator (SSVC) Power Quality Issues

%improvement in the reduction of Power Quality Issues the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=25% - 22.5%

%improvement in the reduction of Power Quality Issues the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=2.5%

To find percentage improvement in the reduction of Inadequate Battery Life the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)

Conventional Inadequate Battery Life = 10%

ANN) based solid state VAR compensator (SSVC) Inadequate Battery Life =9%

%improvement in the reduction of Inadequate Battery Life the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=

Conventional Inadequate Battery Life - ANN) based solid state VAR compensator (SSVC) Inadequate Battery Life

%improvement in the reduction of Inadequate Battery Life the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=10% - 9%

%improvement in the reduction of Inadequate Battery Life the causes of poor performance of wearable technology in an industry with (ANN) based solid state VAR compensator (SSVC)=1%

3. RESULTS AND DISCUSSION

Table 2 comparison of conventional and ANN based solid state VAR compensator (SSVC) Power Quality Issues that cause poor performance of wearable technology in an industry

Time (s)	Conventional Power Quality Issues that cause poor performance of wearable technology in an industry (%)	(ANN) based solid state VAR compensator (SSVC) Power Quality Issues that cause poor performance of wearable technology in an industry (%)
1	25	22.5
2	25	22.5
3	25	22.5
4	25	22.5
10	25	22.5

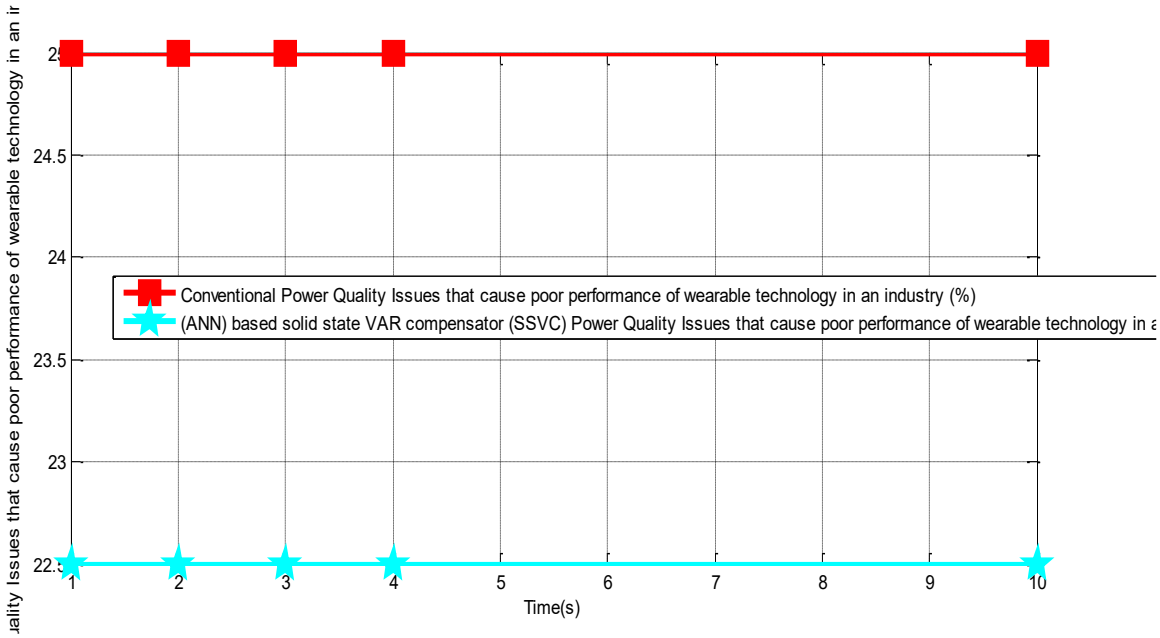

Fig 7 comparison of conventional and ANN based solid state VAR compensator (SSVC) Power Quality Issues that cause poor performance of wearable technology in an industry

The conventional Power Quality Issues that cause poor performance of wearable technology in an industry was 25%. However, when an ANN based solid state VAR compensator (SSVC) was incorporated in the system, it drastically reduced it to22.5%.

Table 3 Comparison of conventional and ANN based solid state VAR compensator (SSVC) Inadequate Battery Life that cause poor performance of wearable technology in an industry

Time (s)	Conventional Inadequate Battery Life that cause poor performance of wearable technology in an industry (%)	(ANN) based solid state VAR compensator (SSVC) Inadequate Battery Life that cause poor performance of wearable technology in an industry (%)
1	10	9
2	10	9
3	10	9
4	10	9
10	10	9

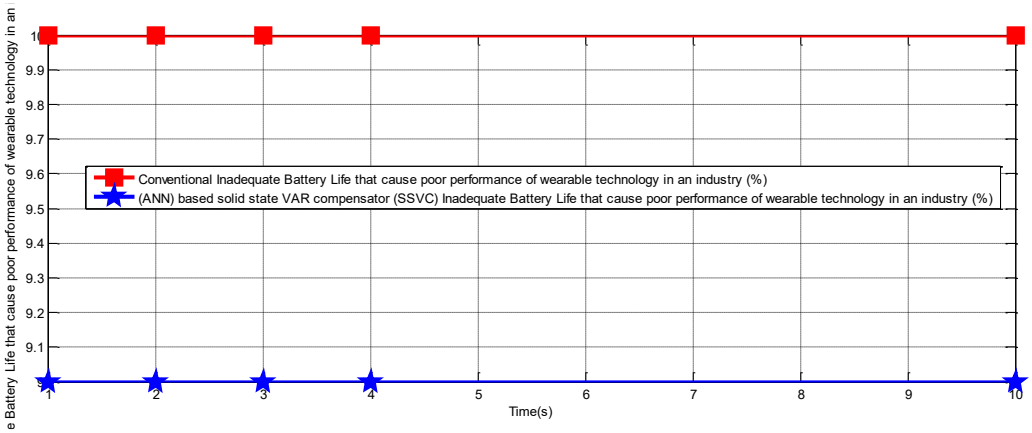

Fig 8 comparison of conventional and ANN based solid state VAR compensator (SSVC) Inadequate Battery Life that cause poor performance of wearable technology in an industry

The conventional Inadequate Battery Life that cause poor performance of wearable technology in an industry was 10%. Meanwhile, when an ANN based solid state VAR compensator (SSVC was imbibed into it, it automatically reduced it to 9%. Finally, with these results obtained the percentage enhancement in the performance of wearable technology in an industry when an ANN based solid state VAR compensator (SSVC was integrated into it became 1%.

4. CONCLUSION

This study has demonstrated that the integration of Artificial Neural Network (ANN)-based Solid State VAR Compensator (SSVC) significantly enhances the performance of wearable technology in industrial environments. By intelligently managing reactive power and stabilizing voltage levels, the ANN-based SSVC improves power quality, minimizes electromagnetic interference, and supports the efficient operation of wearable devices under dynamic industrial load conditions. The findings revealed that the system not only enhances the reliability and lifespan of wearable technologies but also ensures consistent real-time performance for applications such as worker health monitoring, safety management, and productivity tracking. Furthermore, the adaptive learning capability of the ANN allowed the SSVC to respond effectively to fluctuating power demands, outperforming traditional compensation methods. The system's scalability and low-latency response make it a practical solution for Industry 4.0 applications where wearable technologies are becoming increasingly essential. Overall, the research highlights the potential of combining intelligent control systems with power quality devices to foster more robust and efficient smart industrial environments. The conventional Power Quality Issues that cause poor performance of wearable technology in an industry was 25%. However, when an ANN based solid state VAR compensator (SSVC) was incorporated in the system, it drastically reduced it to22.5% and the conventional Inadequate Battery Life that cause poor performance of wearable technology in an industry was 10%. Meanwhile, when an ANN based solid state VAR compensator (SSVC was imbibed into it, it automatically reduced it to 9%. Finally, with these results obtained the percentage enhancement in the performance of wearable technology in an industry when an ANN based solid state VAR compensator (SSVC was integrated into it became 1%.

5. REFERENCES

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