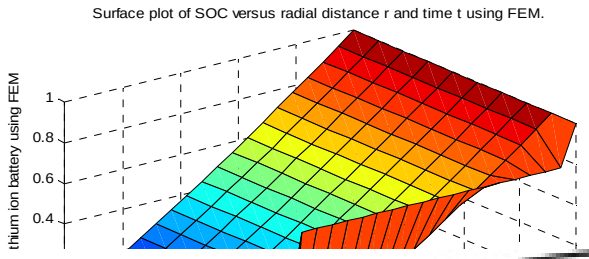
The Fig. 2 below shows a surface of the SOC as a function of the radial distance r and time t.



ii) TRAINING OF THE ANN

In this section, the ANN will be trained so that the initial conditions are satisfied. For convenience, the ANN has been reproduced below:

$$\alpha_1 w_{11}^2 f(w_{11}r + w_{12}t + b_1) + \alpha_2 w_{21}^2 f(w_{21}r + w_{22}t + b_2) + \alpha_3 w_{31}^2 f(w_{31}r + w_{32}t + b_3) - \alpha_1 w_{12} f(w_{11}r + w_{12}t + b_1) - \alpha_2 w_{22} f(w_{21}r + w_{22}t + b_2) - \alpha_3 w_{32} f(w_{31}r + w_{32}t + b_3) - 4.5r = 0 \quad (28)$$

$$\sum_{i=1}^{3} \alpha_i w_{i2} f(w_{i1}r + w_{i2}t + b_i) - 1 = 0 \quad (26)$$

Applying i=1, 2 and 3 to (37) we have:

$$\alpha_1 w_{11}^2 f(w_{11}r + w_{12}t + b_1) + \alpha_2 w_{21}^2 f(w_{21}r + w_{22}t + b_2) + \alpha_3 w_{31}^2 f(w_{31}r + w_{32}t + b_3) - \alpha_1 w_{12} f(w_{11}r + w_{12}t + b_1) - \alpha_2 w_{22} f(w_{21}r + w_{22}t + b_2) - \alpha_3 w_{32} f(w_{31}r + w_{32}t + b_3) - 4.5r = 0 \quad (27)$$

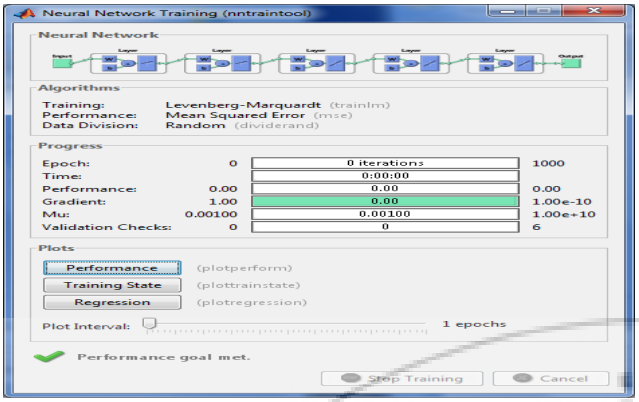


Figure 4: The results for the training exercise

6. Conclusion

To check whether the proposed ANN has been trained without any error, the ANN is simulated in the **Network: pde** dialogue box. The results for simulation are stored in the **Data: pde_errors** dialogue box shown in the Fig. 5 below.

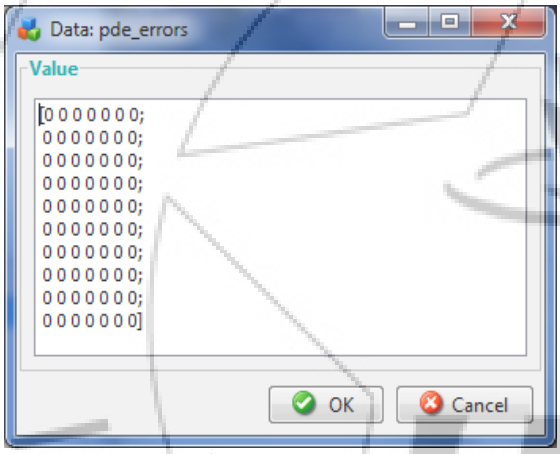


Figure 5: Errors

Fig.6 below shows the graph of error versus r and t.

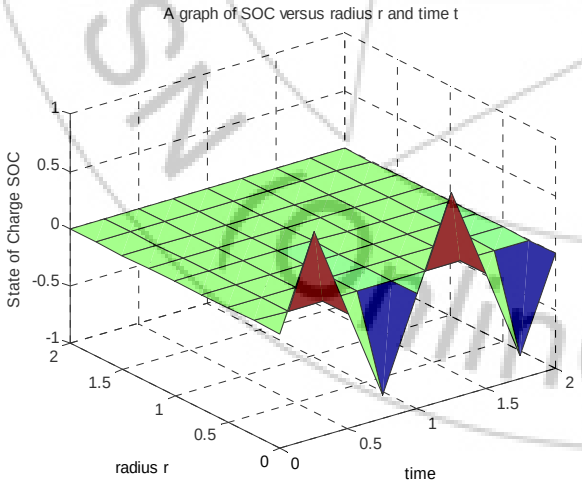


Figure 6: Graph of error versus radius r and time t.

From Fig. 6 above it is evident that the error is almost equal to zero using ANN implying that the ANN has accurately estimated the SOC of the Li-ion battery with a higher degree of accuracy that the Finite Element Method. The paper presented a method to estimate battery SOC of Electric Vehicle using ANN. From the above simulation studies in MATLAB, it is evident that the error for FEM is greater than that of ANNs for the same PDE model. Hence, an ANN provides a more attractive method for estimation of state of charge of a Li-ion battery than the FEM method.

7. Future Scope

SOC can be used as an input to a fuzzy logic controller (FLC) that regulates the distribution of power between a Li-ion battery and a super capacitor for power management in a dual source pure electric vehicle (PEV).

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Authors Profile

Kaburu Wachira Kiragu has been a Master of Science student at Jomo Kenyatta University of Agriculture and Technology, Kenya, since 2012. He is also an assistant lecturer with the Department of Electrical Engineering at Kirinyaga University College. He received the BSc. Degree in Instrumentation and Control Engineering from Egerton University, Nakuru, Kenya, in 2009. His research interests include fuzzy logic control, neural networks, FPGA, observers, electrical machines and digital electronics and control.

Samuel Kang'ethe is an Associate Professor of Electrical Engineering Department, Jomo Kenyatta University of Agriculture and Technology, Kenya.

Stanley Irungu Kamau is a Doctor and Chairman of Electrical Engineering Department, Jomo Kenyatta University of Agriculture and Technology, Kenya.