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USE OF PYTHON, MATLAB, AND R FOR DEVELOPING ARTIFICIAL NEURAL NETWORK FOR IDENTIFICATION TYPE IN OVERHEAD TRANSMISSION LINES OF FAULT

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Abstract: **Due to the increased devouring of electricity by a consumer, generating stations must provide an uninterrupted supply of electricity to load. For that intend, many steps had been taken for the detection of fault locations in overhead lines. Whenever any fault takes place in the transmission line, Fault Passage Indicators quickly detect fault and help the crew for clearing of fault as soon as possible. This will help in maintaining the constant supply of electricity to end-user equipment and increase the reliability of the load. These can be installed at different points for better operation in line. But all these traditional methods for detection of faults are time-consuming, hence with developing trends in Machine Learning and Artificial Neuron networks their concept can be used for the detection of faults in transmission lines. This report deals with the development of Ann for detection and identification a fault type in the 220kv line. As of 2020, python with Keras and Tensor Flow API is considered the best method for developing Ann models, hence a neural network is developed with them for the classification and detection of a fault utilizing Fast Fourier Transform. A Radial Basics Neural Network is formulated in MATLAB utilizing wavelet transform. A network is trained utilizing voltage sag and swell phenomena with a Resilient back propagation network in R language. At last, this report assists in understanding the nature of fault, occurring in transmission lines.**

Keyword's- **Neural Network, Python, MATLAB, 220 kV, Keras, Tensor Flow, fault, dplyr, pandas, R**

I. INTRODUCTION-

Transmission lines play a vital role in delivering the electricity from source to load. As there are many transients in the power system which can cause faults in transmission lines and effecting the power quality. Detection of faults in a transmission line is always the subject of attention to power engineers. There are various methods for that purpose like single-end and double-end traveling-wave methods which determine the fault by velocity and arriving time of traveling-waves [1] but these methods have drawbacks of dispersion effect of traveling wave and problems in the identification of fault near end lines or buses, Support vector machine (SVM) which uses the concept of stationary wavelet transform [2], and fuzzy logic approaches. Distance relays are used in India for fault detection at a particular zone by calculating the impedance to point of fault. These relays just determine whether the fault occurs in a particular zone or not, not giving any information about the nature of fault and the location of the fault[3 4]. Substations above 400 kV and generating plants utilize the SCADA system for assembling more information about the transients. The SCADA system employs fault-passing devices at a remote location for the collection of information. These use an upstream or downstream algorithm for making accurate fault locations [5].But with changing trends in machine learning, their method can be utilized in the detection and classification of faults in a transmission line. Artificial Neuron Network consists of different layers namely as the input layer, hidden layer, and output layer[6]. The input layer receives incoming data and perform no calculations and pass data to the hidden layer where most of the data is optimized and give result to the output layer[6 7].A neural network can be trained in such a way that it will not only generate output on past entries but also learned from new entries by analyzing the pattern of entries. Almost all programming language support environments and libraries for developing and training neural networks. Above of them Python, MATLAB, and R are considered to have a good integrated environment for machine learning and data science due to their simplicity and having a cluster of libraries for data manipulation. MATLAB earns a lot of fame in Electrical Engineering and much research has been conducted in it for fault classification and location in

transmission lines [8 9 10] using the concept of Discrete Fourier Transform and Wavelet Transform for extraction of data from the transmission line and passing it through anti-aliasing filter for further processing. Comparisons between different machine learning techniques like SVM, LR, KNN, and CN2 had been also proposed [11].Herald Kundaeli proposed a recurrent neural network using IoT (internet of things) [12]. Prateem Pan proposed a CNN for fault detection in micro grids, but MATLAB has the disadvantage of interpreted language and its cost.

Till now, almost research done on fault classification is done only in MATLAB, only by training Feed forward and Back propagation neural networks. The main objective of this article is to develop a different type of neural network with different programming languages.

1.2FAULTS IN TRANSMISSION LINE-

Lightning discharge (it can cause the flow of voltage which is much more time than the rated voltage in phase conductor),speed of wind (flow of heavy wind can result in breakage of line conductor) which may include the line-to-line fault, line-to-ground fault, double line-to-ground fault, and damage to all three phase conductors, improper selection and design of line equipment, any type of contact from birds, trees, humans, and animals, and many more factors which may be the reason of fault in the transmission line. It is natural that, if the transmission line is laid between grid and load then the occurrence of fault takes place at the line. With the advancement of technology these faults are minimized but cannot be extinct fully. Hence there is a requirement for the tools that can be used for helping the nature of a fault in lines.

1.3 Importance Of Fault Analysis

With the increasing population of the world there is also a lot of pressure on industries to manage their production in time due to this many industries use automation processes to control their production any fault on line or due to a faulty waveform of voltage or current can lead to the financial risk of damage and production at that time it is of much importance to restore the supply of electricity which cannot be done if anyone does not know the exact location of the fault., To ensure the quality of electricity at the user end equipment, For understanding the process of cause and its effect to give a better understanding of the source of the fault. At last, after the deregulation of electricity takes place, competition between the distributing companies (DISCOM) has increased. So, providing a continuous supply of electricity is a necessity.

1.4 Types Of Faults On Transmission Lines-

Shunt or short circuit failures are classified as unbalanced and balanced disorders, L-G(It involves fault between a single line and ground), L-L(it involves fault between two lines), L-L-G (it involves fault between two lines and ground), L--LL(it involves fault between all three lines), L-L-L-G (it involves fault between all three lines to ground respectively). These are caused by poor insulation and dropped branches and due to some natural event. When any of these faults take place on line current many more times than normal start flowing

II. MATERIALS AND METHOD

2.1 PROGRAMMING LANGUAGES AND DATA EXTRACTION METHOD-

Python is developed in 1991. It is popular due to its simplicity, ease to understand, and can be easily implemented. It gains its popularity with the advancement in Artificial Intelligence .it is object-oriented programming that uses (DRY) Do Not Repeat function to avoid code reusability. Today date many mnc including Apple, and Netflix uses python for their machine learning algorithm. it also includes many libraries for the visualization of data. Tensor Flow is created by Google for making it easy to understand the concept of machine learning and artificial neural network. It is open-to-end source software. it can support many languages like python, c+, java and many others. It was developed in 2015. MATLAB is released in 1984. It contains a variety of toolboxes and applications which can simplify our task. Many visualization libraries for plotting of data in 2D and 3d. Gui OF MATLAB makes it much better than other languages. All the raw data which is used in the training of the network is obtained from Simulink which can be easily imported to it's workspace. R is a language created by statistical for statics and it is released in 1970. It contains more than 10,000 packages for data operation. It is a platform-independent language and can be installed for windows, Linux, and max. R-Studio is an IDE that is used for the training of the network.

2.2 Data Extraction Methods-

FFT (FAST FOURIER TRANSFORM)-It is a method that has very low computing time as compared to discrete Fourier transform. It further decomposes DFT into even and odd. The decomposition of fft depends on the radix and N-point of fft. The smallest decomposition will depend on the radix of fft.

WAVELET TRANSFORM- The drawback of Fourier transform is that it is best for the stationary signal as it cannot provide time when frequency exist. Where wavelet can decompose signal at different frequencies and in different resolution, hence providing better analysis of signal.

VOLTAGE SAG AND SWELL [13]-These are phenomena that can cause a reduction or rise in the rated voltage of line for a momentary time. These are termed as transients and power quality problems. These can be result of discharging of large motors, lightning, arcing, energizing of high-capacity transformers. Depending on time of transient, these can be further divided into 3 types.

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2.3 CASE-STUDY
2.3.1(PYTHON)
The artificial network is developed for a network composed of 220 kV transmission line, three-phase series RLC load, v-I measurement block, fast Fourier transform block, filter and scope.

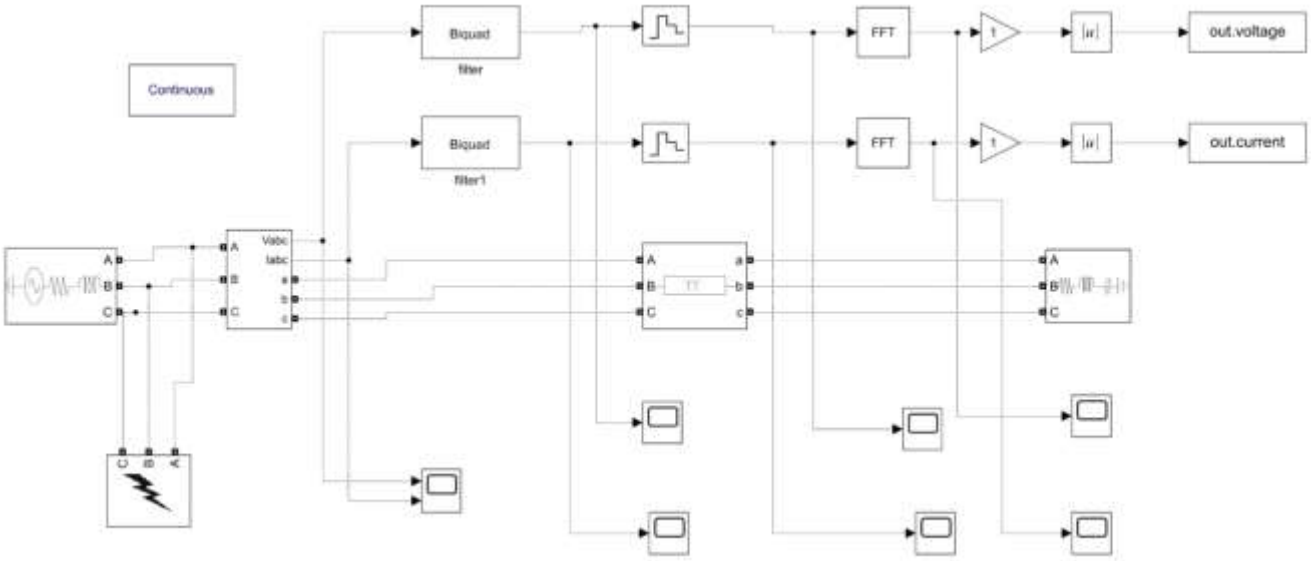

Fig 2.1 (generation of data using FFT)

Generation Of Data
The data for the training of neural network is extracted using simulation of above-discussed line in Simulink (fig 3.1) and importing data to MATLAB through workspace toolbox. All data is exported to excel and labelled as ‘va, ‘vb, ‘vc, ‘ia, ‘ib,’ic’ and the target output is a state of fault. All 10 types of faults are performed in Simulink at multiple locations for the generation of more data. The design of the filter is done by biquad structure. After passing data through filters, FFT is done on data. Then this data is accessed in visual studio code (an ide for python) with the help of pandas library and a neural network is made with the help of Keras and Tensor Flow.

Table 2.1 (labelling of data)

Fault	Target
HEALTHY A-B	0 1
B-C	2
C-A	3
A-G	4
B-G	5
C-G	6
A-B-C	7
A-B-C-G A-B-G	8 9

A, B, C are three phases of Line and G is ground

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Fig2.2 (sequence of data generation)

The accuracy of a neural network totally depends on its input data. Larger the data better it can be trained, but data should be meaningful. the output should depend on all the variables of input data. Sometimes, one variable have much larger impact on output data neglecting the impact from other variables, hence providing low accuracy or meaningless network. So, before giving raw data to network it should be pre-processed first, in such a way that all input variables have same impact on output. To obtain such normalization of raw data is done before giving to network.

2.3.2MATLAB-

Data Generation-

Data is generated by simulation of the given line in Simulink and exporting the result to the MATLAB workspace. All ten types of fault are simulated and the wavelet coefficient of all three-phase current and neutral is extracted. These four currents are input to our network and the output is a state of fault. Different data are collected by changing the ground resistance and location of fault block for obtaining more samples for the training of the neural network. For better efficiency, the radial basics function neural network is trained for the classification of fault.

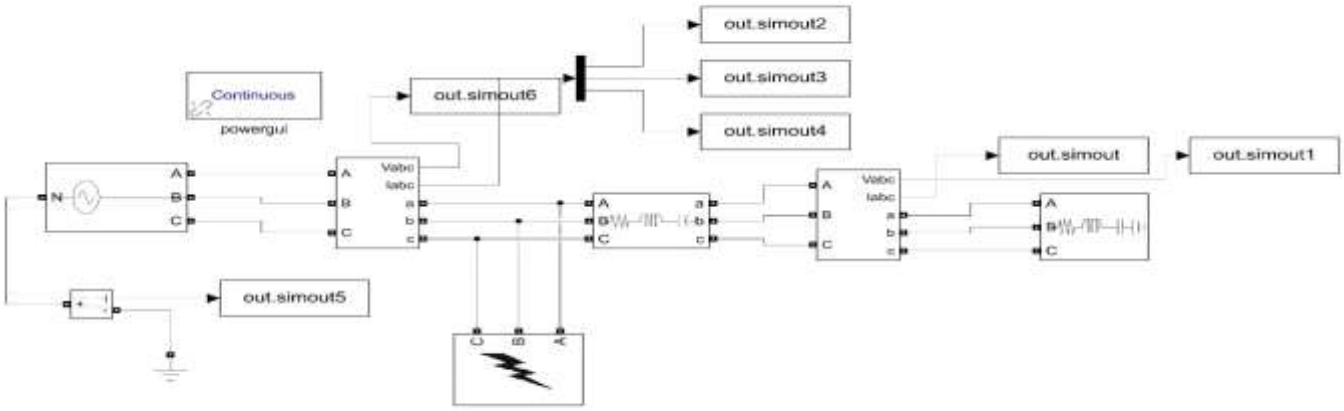
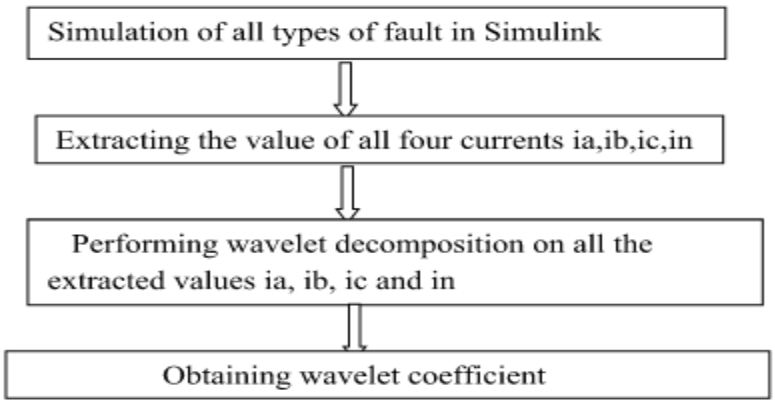


Fig 2.3 (extraction of data using wavelet transform)

FLOWCHART FOR DATA GENERATION-



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2.3.3 R-

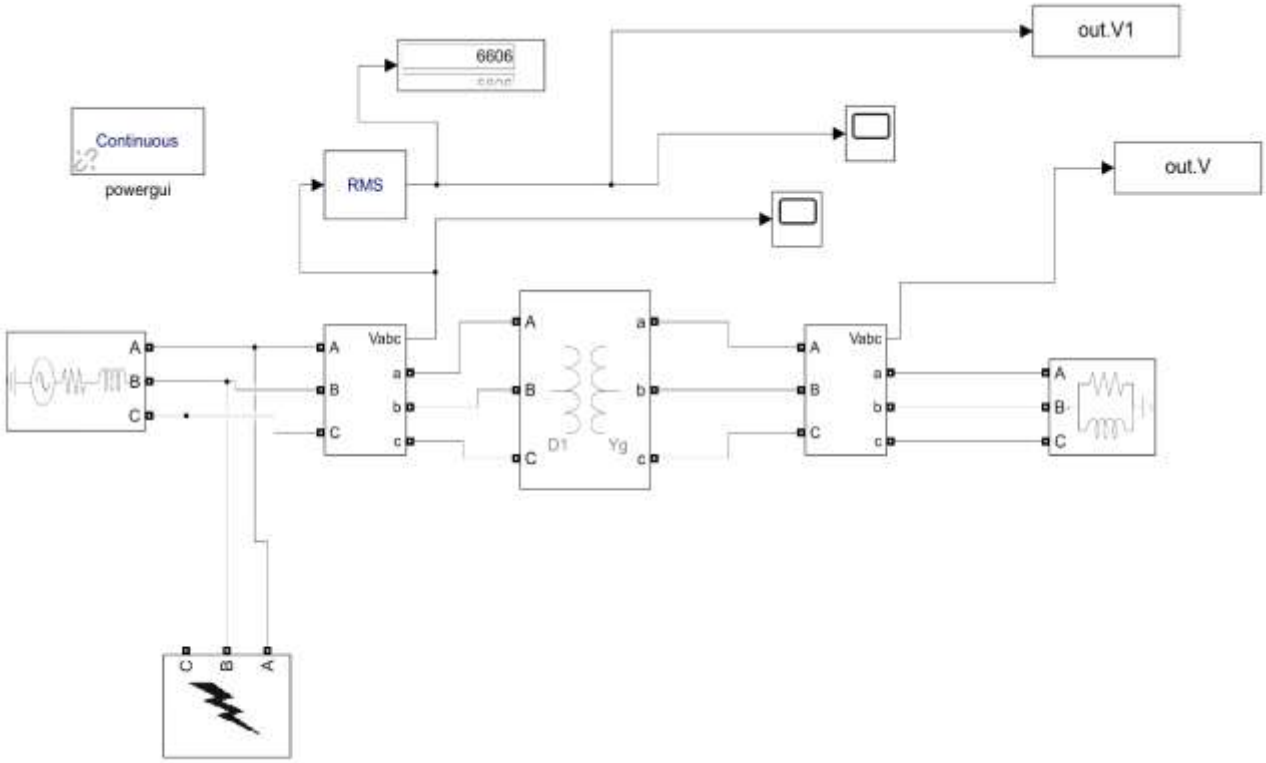

Fig 2.4 (extraction of data using voltage sag and swell)

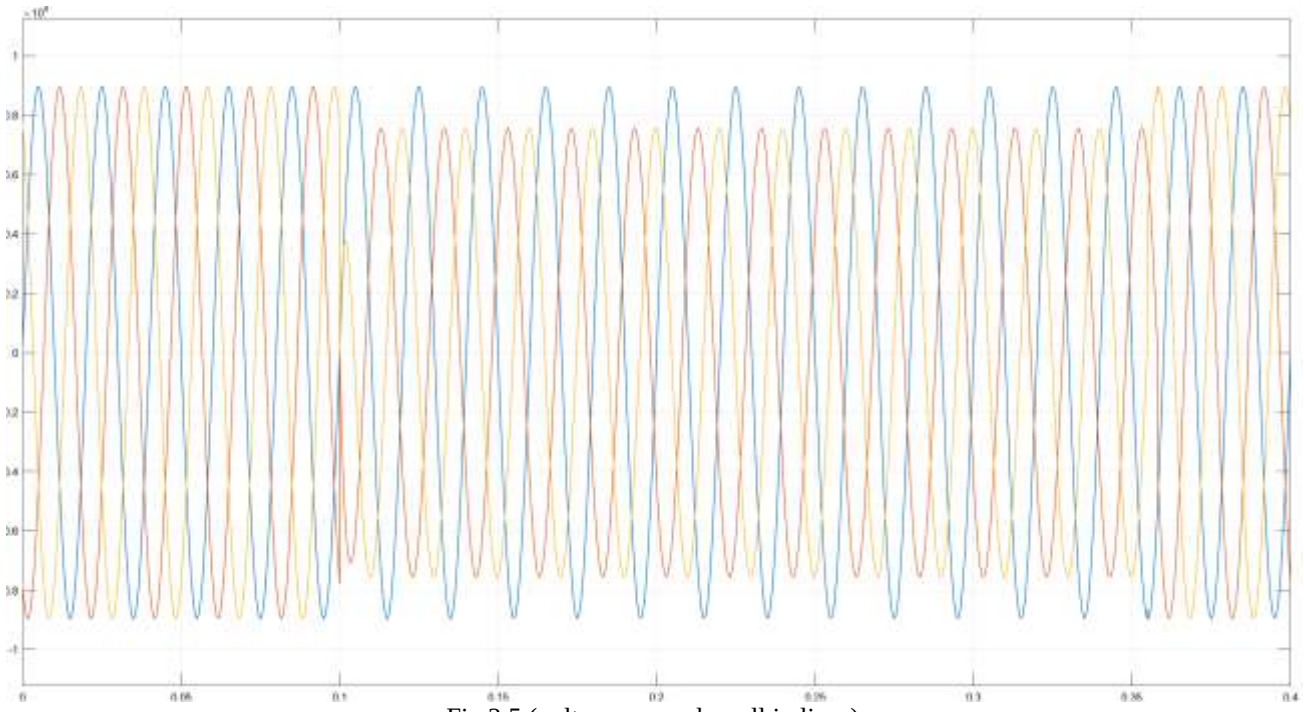

Fig 2.5 (voltage sag and swell in lines)

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Design Of System-A 220 kv line of 100 km length is laid between source and load. With the help of fault block, fault is given to line with a switching time of 0.1 to 0.35 creating a fault between any two lines and ground, causing voltage sag in one line and swell in another two lines.
Sequence For Data Generation-

Fig 2.6 (sequence for data generation)

FAULT STATE	TARGET	CLASSIFICATION
0	HEALTHY	
1 2 3 4	A-G B-G C-G B-C	SLG(SINGLE LINE TO GROUND
5 6 7	B-C-G A-C-G B_C-A	DLG(DOBLE LINE TO GROUND)
8	A-B	
9	A-B-C-G	TLG(TRIPLE LINE TO GROUND)

Table 2.2 (labelling of data in R)

III. RESULTS AND DISCUSSION-

3.1 PYTHON-

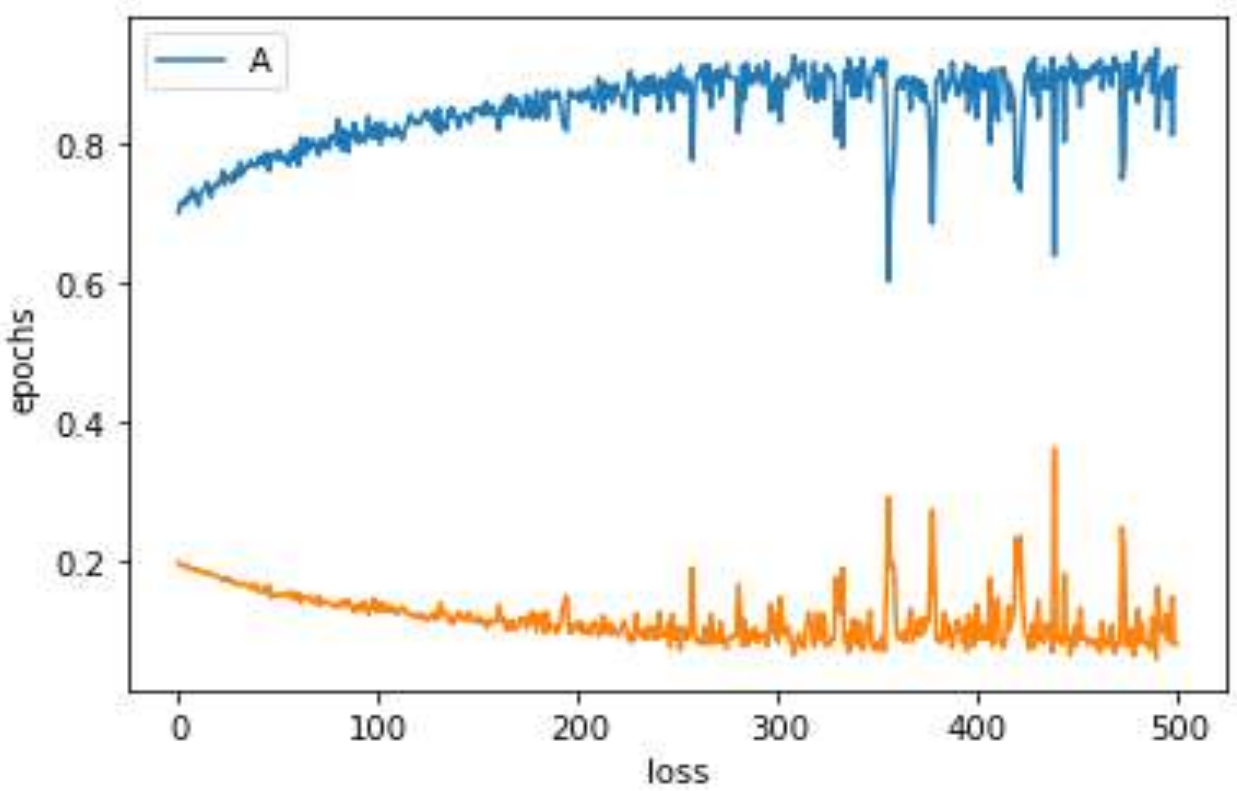

Fig 3.1(Accuracy graph)

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A neural network is developed with 91.3% accuracy for the classification of fault in a 220 kV transmission line. A total of six layers were developed including the dropout layer (to avoid over fitting of data), including more than 50 neurons. This type of network is generally simple straight forward and unidirectional, whereas data can process through multiple hidden nodes.

dense_6_input (InputLayer)	dense_6 (Dense)	dense_7 (Dense)	dropout_2 (Dropout)	dense_8 (Dense)	dense_9 (Dense)
input: [(None, 6)]	input: (None, 6)	input: (None, 6)	input: (None, 12)	input: (None, 12)	input: (None, 24)
output: [(None, 6)]	output: (None, 6)	output: (None, 12)	output: (None, 12)	output: (None, 24)	output: (None, 1)

Fig 3.2 (tabular representation of neural network)

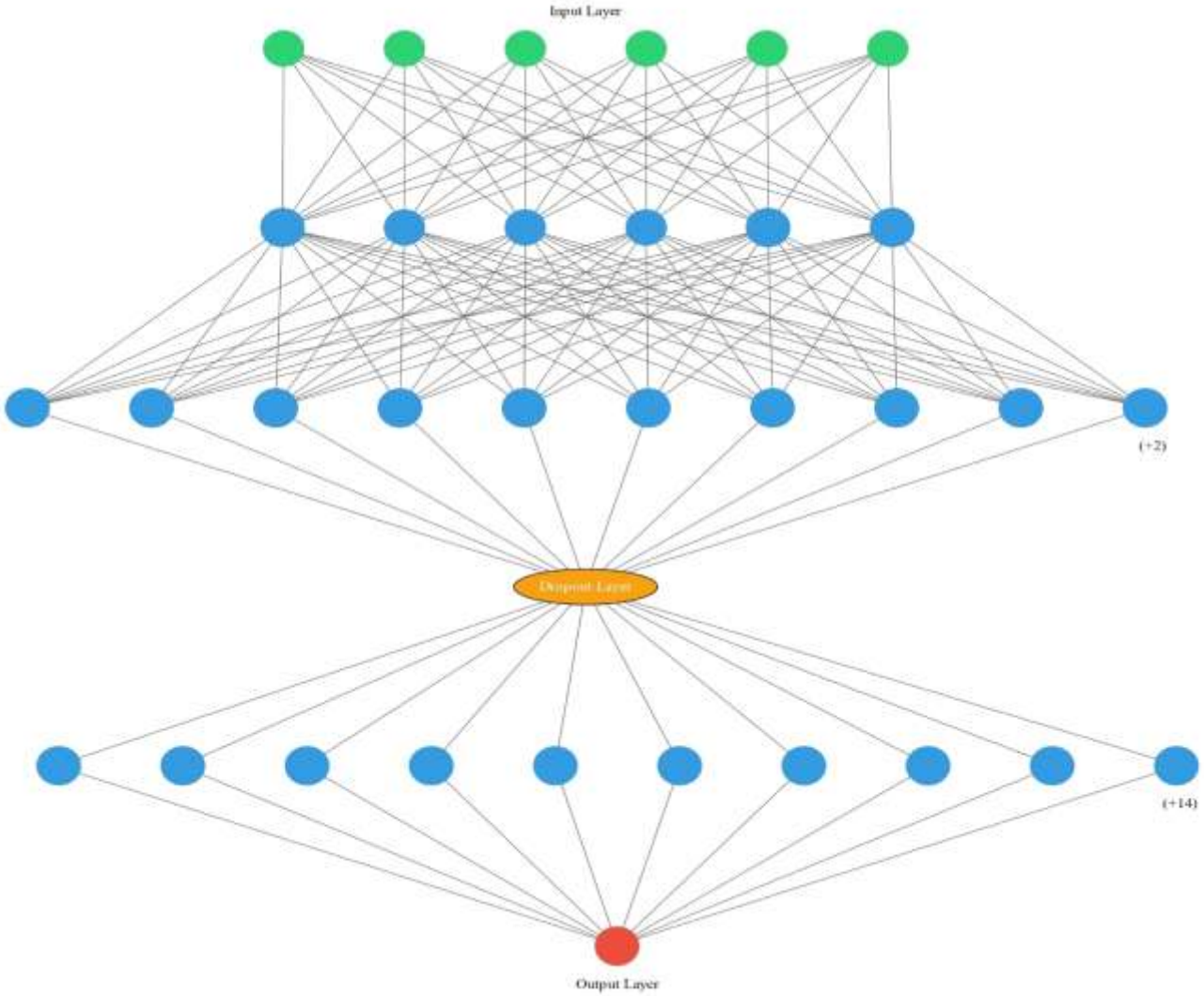

Fig 3.3 (graphical representation of neural network)

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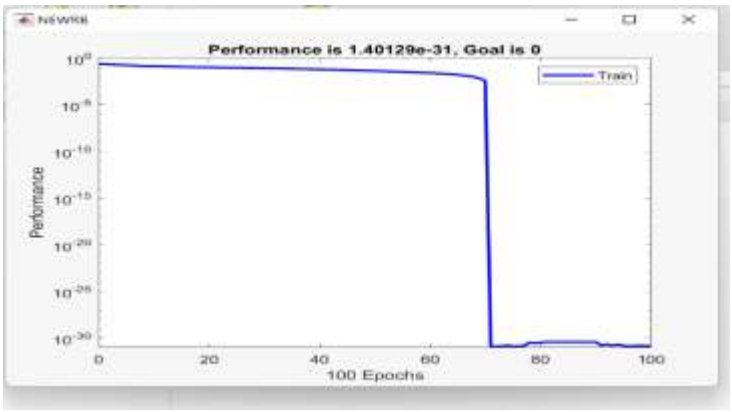
3.2 MATLAB-



NEWRB, neurons = 0, MSE = 0.242314
NEWRB, neurons = 50, MSE = 0.0434753
NEWRB, neurons = 100, MSE = 1.40129e-31

Fig 3.4 (accuracy graph in matlab)

A radial basics neural network is obtained for the classification of fault type. It had been seen that MSE (mean square error) is getting better with, an increased number of neurons 3.3 R-

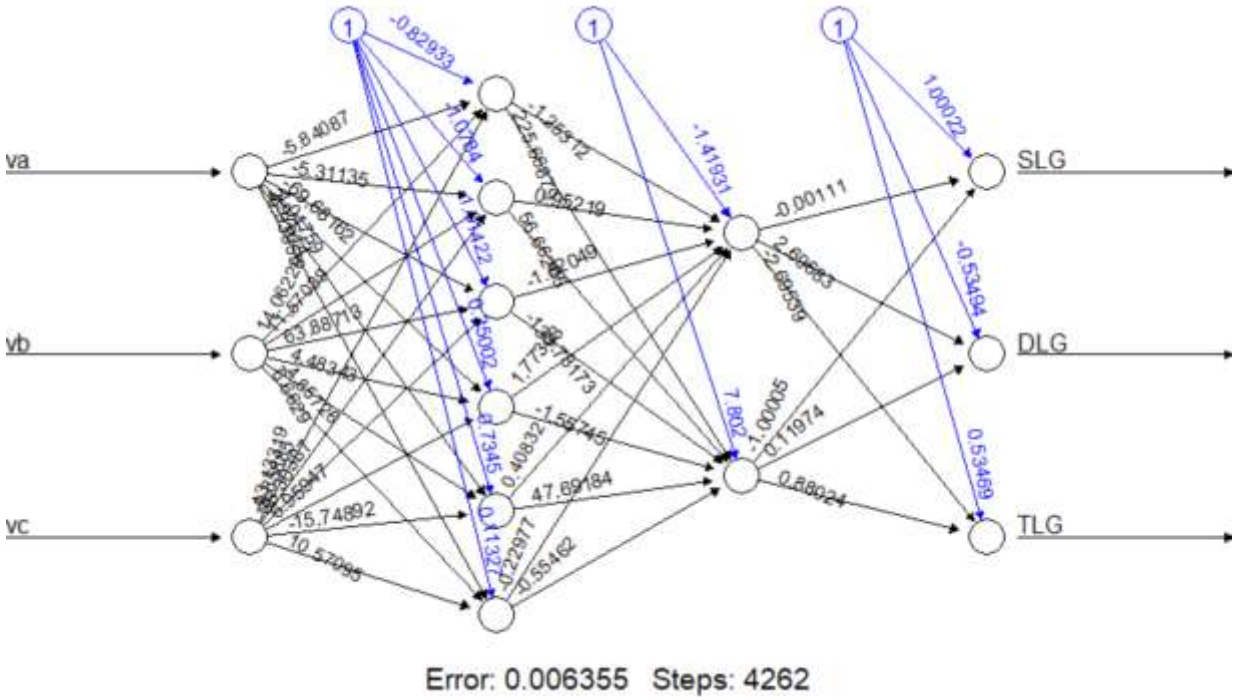


Fig 3.5 (graphical representation of neural network)

A neural network is obtained with three inputs named as va, vb, and vc which are the fault voltage for a different type of faults, extracted by simulation of line in MATLAB and the target output is the state of fault. 4262 iterations are done in obtaining the desired result. This network is more complex than the previous one but has the advantage of fast processing, as this network not uses the magnitude of the gradient but instead uses signs of a gradient in obtaining weights [14].

IV. CONCLUSION

With three different algorithms, different types of neural networks are formulated in Python, MATLAB, and R for detection and classification of faults in 220 kV overhead transmission lines.

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Type of language	Type of network	Accuracy/Error	Algorithm
Python	FEEDFORWARDPROPAGATION	91.3%	FFT
MATLAB	RADIALBASICSFUNCTION	$1.41O296e^{-31}$	WAVELET
R	RESILIENTBACKPROPAGATION	0.00635E	VOLTAGE SWELL

Each language has its own benefits, these all provide good support for training of neural networks. Libraries like Pandas, Keras, Tensor Flow, Dplyr, neural net, Graphviz, NumPy, and Matplotlib provide great assistance in data manipulation, but anyone who not having prior knowledge of coding, MATLABGUI, and toolboxes like filterDesign, nnstartcan make your work much easier and efficient.

REFERENCES-

[1]. Huibin Jia 2019. An Improved Traveling-Wave-Based Fault Location Method with Compensating the Dispersion Effect of Traveling Wave in Wavelet Domain. Mathematical Problems in Engineering 2017(8):1-11

[2]. PapiaRayaDebani, PrasadMishrab 2016.Support vector machine-based faultclassification and location of a long transmission line. Engineering Science and Technology an International Journal.

[3]. Tanbhir HoqMd 2011.Review of recent developments in distance protection of series capacitor compensated lines.Electric Power Systems Research 190(2):106831

[4]. Subhransu Samantaray 2009.Tree-based fault detection in the distance relay.International Journal of Engineering Intelligent Systems for Electrical Engineering and Communications 19(3):139

[5]. Viplav Chaitanya Reddy B 2017.Outage Management System with Fault Passage Indicator.Thesis for M.Tech: IIT Hyderabad

[6]. IIT DELHI 2021. Nptel course.Introduction to deep learning. https://swayam.gov.in › nc_details › NPTEL

[7]. Massimo Buscema2012. Introduction to artificial neural networks.European Journal of Gastroenterology & Hepatology 19(12):1046-54

[8]. FRANÇOIS CHOLLET 2022.Deep Learning with Python. MANNING publication

[9]. ANKITA NAG 2021. Artificial Neural Network for Detection and Location of Faults in Mixed Underground Cable and Overhead Transmission Line in MATLAB.The Sixth International Conference on Computational Intelligence and Information Technology.

[10]. LI Xianming XIE, Wenping XUE & Xu CHEN 2021. Hybrid teaching–learning artificial neural network for city-level electrical load prediction.Sciece China. Information Sciences journal.Published by Springer Verlag

[11]. Shengchao Jian1, Xiangang Peng ,, Haoliang Yuan 1,, Chun Sing Lai , and Loi Lei La 2021. Transmission Line Fault-Cause Identification Based on Hierarchical Multiview Feature Selection. Applied Sciences 11(17):7804

[12]. Herald Kundaeli 2021.Deep learning approaches for fault detection and classifications in the electrical secondary distribution network: Methods comparison and recurrent neural network accuracy comparison.Cogent Engineering 7(1):1857500

[13]. Rodney H.G. Tan and Vigna K. Ramachandaramurthy 2015.In book: Power Quality Issues inDistributed Generation Chapter: 3 Publisher: InTech Editors: Jaroslaw Luszcz

[14]. M. Riedmiller and H. Braun 1993. A Direct Adaptive Method for Faster Back PropagationLearning: The Rprop AlgorithmNeural Networks, IEEE International Conference.