Predicting Power System Reliability Parameters Using Combinational Cascade Neural Network

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***Abstract*— Reliability is one of the important topics in studying power systems and with its help; we can identify weaknesses of the network. This study is done in two branches: evaluation and prediction. Reliability evaluation is performed by analyzing of average pressure network incidents which cause unsuccessful performance in electricity energy transmission and with the help of this evaluation we can find network weak points. Reliability is the probability of correct and desirable performance which is based on certain criteria that an element or a system in a certain work situation and time has them. Neural networks are a proposal network which is considered with respect to calculation complexity. In this article we use an auxiliary neural network in order to network error correction in each executive period.**

Keywords*— Reliability, Artificial Neural Network, Power Systems, Distribution Network,

I. INTRODUCTION

Reliability is one of the important topics in studying power system which with its help, we can find weaknesses of the network. The main goal of power systems is maintaining cheap electricity energy with desired quality.[1] With respect to possible defects and failures in used equipment in a system we cannot expect that this energy always be available. So evaluation of power system reliability is a very important topic.

Reliability evaluation makes it possible for network users to identify proximity or remoteness of critical points in an optimal and economical manner. [2]

since calculation of reliability standard parameters calls for very exact data with great details and these kind of data is not available for many distribution companies , in recent years, many methods for estimation and perdition of these parameters are presented. But with respect to high economical costs of activities in distribution companies, they need very exact and fast methods for reliability estimation and prediction based on present information [1, 3].

With respect to the abilities and flexibility of neural networks in finding solutions similar to calculation of reliability parameters, different methods are presented in this area [4].

The whole procedure of these methods is that first, available data for many years are calculated to achieve needed information and then we will use them for neural network instruction. Neural network will be created with the matching of precise primary information and some measurable input parameters. Then we will use the network for prediction of these parameters an future years. Main factors for achievement in these plans are: suitable parameter selection for network input dada and selection of suitable neural network for gaining the best approximation. [5,6]

In this paper we proposed a new method to improve SAIFI, SAIDI prediction using Cascade neural network [3]

II. CASCADE NEURAL NETWORK

Artificial neural network is a data processing system, its idea comes from human brain system and data processing is many little processors in this network, these processors interact in serial and parallel manner in order to solve a problem. In these networks with the help of programming science, data structure is designed which can act as neuron. Then we will create a network between these neurons and apply an instructional algorithm to it. There are many neural networks and we choose Cascade neural network with respect to its capabilities for our study. [3]

In each neural network, network architecture must be specified before execution, meaning that we must identify neurons and hidden layers for each layer. Correct detection of optimal architecture is complex in many times and usually we will use trial and error method for finding the suitable one. On the other hand the instruction on the achieved network is applied on the whole network together. instructing all the neuron together has this difficulty that during the instruction process , in each stage, all the coefficients change in a direction which cause the reduction of present error and in each stage we will trace the largest error resource and in next stages, we will trace others resource(s) that has the biggest error. This cause reciprocal movement between different error resources in the network. However Cascade neural networks apply different approach. in these networks, firstly network architecture is defined by adding new neurons wherever and whenever they are needed and secondly, instead of instruction the whole network in each stage, only parts of the network will be instructed. Therefore in addition of architecture auto definition, reciprocal movements between error resources are eliminated and efficiency will be raised.

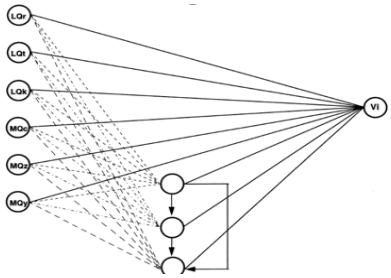

Fig. 1. A schematic view of Cascade neural networks

III. WORKING PROCESS

The most important factor for achieving a good result in prediction is having appropriate data. In practical terms, it is important, the availability and effectiveness data on output of approximation.The main goal of the proposed methodology has been applied and for that the system designed for simultaneous approximation and speed as explained in the following

IV. PROPOSED METHOD

In this method, we first identify parameters which are easily calculable and available in most of the distribution companies and then we will use them in proposed method. These parameters are:

1: Feeder length (LF)

2: common number on the Feeder (NC)

3: total number of the Feeder disconnections (NF)

4: total time of the network disconnections (TO)

After identifying parameters which are easily accessible, we will introduce relations that with the help of them, we can easily calculate neural network parameters. There relations are as below:

$$\alpha = \frac{Nc}{Lf}$$

Nc: number of subscribers

Lf: Feeder length, unit: number of subscribers per 1Km of Feeder length

$$\beta = \frac{Nf}{Lf}$$

Nf : number of total errors

Lf: Feeder length, unit: number of total errors per 1Km of Feeder length

And finally:

$$\gamma = \frac{To}{Lf}$$

Lf: Feeder length

To: the total number of Feeder blackouts

We use abovementioned relations as neural network inputs. The output is calculated by SAIDI and SAIFI in 3 recent years for sample area Feeders.

V. Using auxiliary neural network

In the proposed method we try to use a simple auxiliary neural network in order to optimize early input of the main neural network errors to improve the results. Primary network, with respect to performed calculations, generate an output error for each of the inputs, there error in addition to instruction data are used as main neural network inputs. (See fig2)

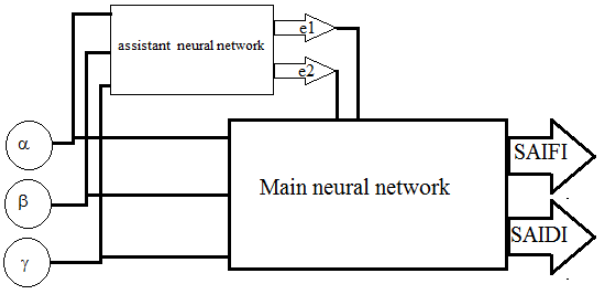

Fig. 2. A neural network with Assistant Network

With respect to fig2, the network uses the main inputs and two other inputs per each one of main inputs (these two are the errors of primary neural network).

Auxiliary neural network is a Feed Forward neural network and for the main network we will use a 5 layer network with these layer numbers: 2-2-4-4-10

VI. MMETHODOLOGIES

For raising prediction accuracy, we can use rotational design for this network. In this design, the error calculation of each cycle of network instruction is used as the input for next stage. With this method, the network will use inputs in each stage as next step error regulator.

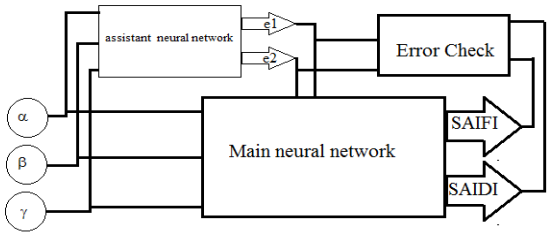

Fig. 3. A loop neural network with Assistant Network

For producing necessary data, we will calculate the information of 30 Feeders in 3 years which include: different kinds of blackout and number of subscribers without electricity and SAIFI and SAIDI parameters.

Table I: sample data which are used

Fed#	Lf	Nc	To	α	β	γ	SAIFI	SAIDI
1	8	1459	146	183.3	0.5	18.3	3.3	1.7
2	6.1	1271	225	207	0.9	36.7	1.9	1.1
3	496.8	9277	43	18.7	0.0	0.1	3.6	2.0
4	187.3	1953	138	10.4	0.1	0.7	3.9	2.4
5	60.6	1178	141	19.4	0.3	2.3	8.5	3.3
6	97.5	1634	28	16.8	0.2	0.3	6.8	3.7
7	48.1	1746	26	36.3	0.3	0.5	5.1	2.4
8	44.9	2779	227	61.9	0.4	5.1	9.3	4.1
9	38.6	1725	53	44.7	0.7	1.4	9.3	3.4

For running the environment, we will use MATLAB 2012. With respect to all data and comparing method, we will obtain below results:

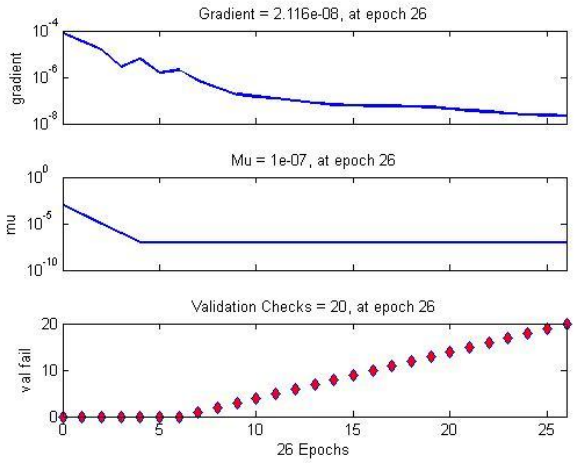

Fig. 4. Gradient, mu and Val. fail for Cascade neural network

For primary network, MSE is 1.347e-7

For the neural network with the help of an auxiliary network, obtained results are shown in fig. 5 which can be compared to fig. 4 From practical point of view, MSE for this method is 1.37e-7 which is improved.

For network running with the help of instruction iteration method, in 7th iteration, MSE is reached to 1.5184e-8 which is a great improvement. With respect to aforementioned issue for our network, fig.7 shows that with the help of minimal registered information about network error which are available in the most of distribution companies, we can calculate SAIFI and SAIDI parameters with a suitable speed. In addition, the available high precision makes the operation and programming based on these data, more effective.

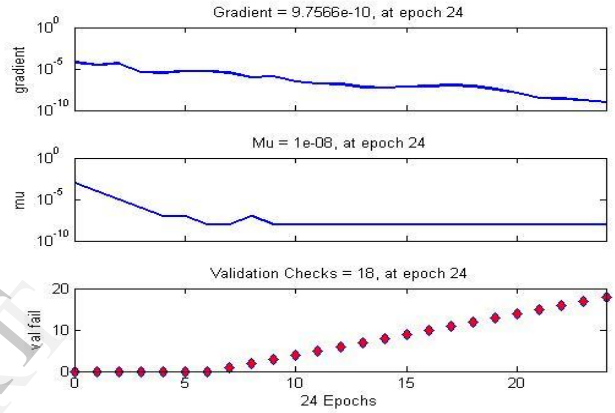

Fig.5. Gradient, mu and Val. fail for Cascade network

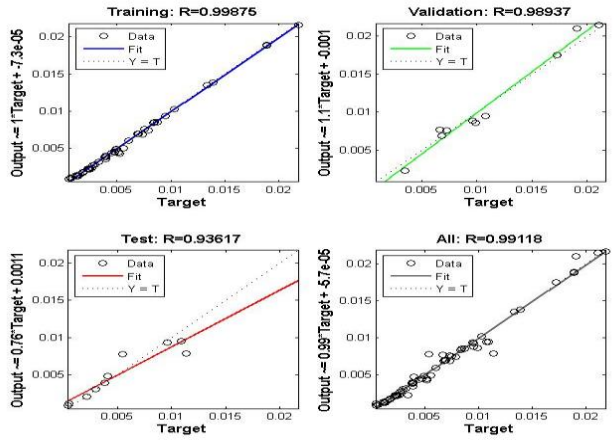

Fig. 6. The Results of Network Regression for Neural Network with Assistant Network

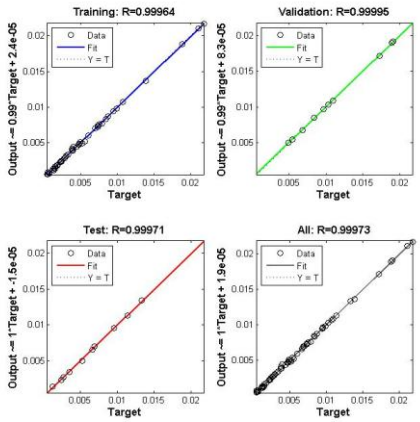

Fig.7. the results of network regression for loop Neural Network with Assistant Network

VII. CONCLUSION:

Instructed neural network, can provide a high allowance and gain high acceptability between distribution companies, with a good approximation and with the usage of minimal information which is accessible

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