Harmonic Analysis in Power Supplies Using Soft Computing

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Abstract

A methodology is shown to investigate the effect of nonlinear charges on harmonic voltage distortion in a power system and to estimate the contribution of nonlinear charges on the voltage distortion of a power system bus of interest. The use of force has been studied in this. This estimation is accomplished through the construction of a model based on soft computing using AAQEE, software dedicated to power quality (EQ) analysis. Its objective is to find the harmonic contributions of three feeders to a power system bus using soft computing techniques.

Keywords: *EQ, System, Power, Charges etc.*

Introduction

Harmonic analysis in power supplies is a technique used to analyze power quality, optimize system design, and detect faults. It can also be used for:
Identify sources of interference.
Analyze the effect of voltage sag and swell on circuit operation.
Investigate the effects of poor connections within the power grid.
Determine harmonic distortion levels and filtering requirements.
Evaluate whether the harmonic voltages and currents are at acceptable levels.
Harmonics are currents or voltages whose frequencies are integer multiples of the fundamental power frequency.
Harmonic analysis can also be used for:

- System planning
- Operating Criteria Development
- Troubleshooting
- Equipment design

A harmonics analyzer can be used to provide detailed analysis of the suspected source. The harmonic ratio function calculates a value from 0% to 100% to indicate the deviation of a non-sinusoidal and sinusoidal waveform. This value indicates the presence of harmonics. Harmonic problems can arise when non-linear loads that draw current in sudden pulses rather than in a smooth sinusoidal manner cause harmonic currents to flow back into other parts of the power system. Overheated transformers and tripped breakers may be indicative of harmonic problems.
The presence of harmonics can also cause economic losses in the long run. We can take as examples: premature aging of cables and electronic components, the need for replacement of materials earlier than intended on the project, interruptions in production areas due to overloads and untimely discharges on the network [1], and so on. According to [2], harmonics of the electric network have a negative impact on the current of the three-phase network by increasing active force loss, at resonance voltage, increasing neutral point force of alternating current equipment, causing difficulty in selectivity. Can. Output relay and capacitor bank with excessive stress.

For the prevention of disturbances in the electrical system it is necessary to periodically monitor the system, so that it is possible to identify which are the suspicious chargers that are injecting significant harmonic currents onto the electrical network, causing harmonic voltages on certain parts. Distortion is increasing. electric system. Dealerships need to use techniques or methods that can assist them in identifying which of the network connected non-linear charges are the major contributor to increased harmonic voltage distortion on specific parts of the electrical system. Have a share. This research suggests a methodology of analysis with the construction of models using the technology of Computational Intelligence Neural Networks. Through this technology the contribution of three feeders to harmonic voltage distortion in an electric system bus is analyzed, making it possible to diagnose and specific treatment for consumers served by this feeder, eliminating violations of harmonic voltage distortion indicators. Correct action is demanded to reduce it.

Literature Review

The Proceedings of Electricity Distribution on the National Electricity System (Procedimentos de Distribução de Energía Elétrica no Sistema Elétrico Nacional (PRODIST)), was created in Brazil by the Agência Nacional de Energia Elétrica (ANEEL). One of the main objectives of PRODIST is to be responsible for guaranteeing that distribution systems operate with security, efficiency and reliability. PRODIST module 8 regulates power quality on electricity distribution networks and the actual revision of PRODIST module 8 started working on 1 January 2018 [3].

The above cited criteria aim to establish acceptable levels of harmonic measurement proceedings and distortion on electrical networks, for example, in Brazil it was defined in PRODIST module 8, the indicators that make possible the quality of electricity and the acceptable levels of these indicators. Establish levels. Power distribution system, which can be highlighted by individual harmonic distortion and voltage total [4].

Nowadays, suddenly, the share of variable charge and non-linear charge has increased significantly, even more, there have been changes on charge compositions, resulting in changes on the deviation of EQ indicators, hence monitoring power quality indicators and improving them. To do is of fundamental importance. For dealerships and consumers, because the efficiency of electric and electronic equipment depends on it [5].

Harmonic distortion is caused by non-linear charges on the electrical system; A non-linear device is one in which the current is not proportional to the applied voltage, i.e., for a simple non-linear resistance there is an applied sinusoidal voltage in which the voltage and current vary while the applied voltage is perfectly sinusoidal, As a result of which the current gets distorted [6].

Research Methodology

Due to the peculiarities of the exposed set of problems, in which it is desired to repeat a certain value, i.e., to determine the harmonic voltage in function of the harmonic currents arising from non-linear charges connected to the feeders of the power system under study, to be the input of the measurement campaign. Through the data (Ih) and output (Vh) of the neural network obtained, it was adopted a neural network of multi-layers-perceptron neural network (MLP) type such that the learning is supervised, i.e. learning until the error is reduced. At each iteration the output is compared between the desired responses with the responses provided from the neural network given the unknown environment. Learning an ANN is achieved through data collected during a measurement campaign, feeding such data at the input (provided from each nonlinear charge) and output (a fixed bus of interest) to the neural network for each frequency of interest. Is put on. , It is important to highlight that the receipt of data collected must be synchronized, this means that they must be realized immediately at the same time.

In this step the estimation procedure of VH (harmonic voltage) at the bus of interest is obtained from the knowledge acquired in the learning process of the suggested ANN model, and the input data in this step is unknown to the developed neural model. Once the ANN is trained, it begins the inference process with a satisfactory error as mentioned earlier, i.e., the ANN has "learned" the characteristics of the system under study, given any chosen input. This means that any feeder is selected in the test group, to analyze the contribution of this referenced input or feeder separately, zeroing out the other inputs of the test group.

Therefore, an input or feeder that presents an output voltage time series (VNnovo) similar to the original series (VN), i.e., manifests a tendency to follow the basic harmonic voltage curve profile (VN), theoretically has a larger Presents the impact on the THDV of the bus of interest due to the ANN giving more importance to this input during the training phase.

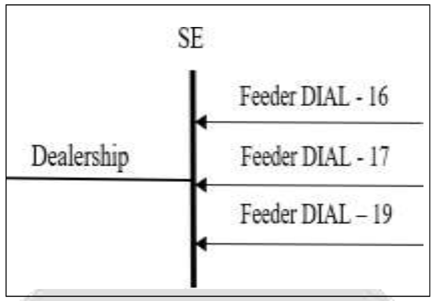


Figure 1.1. Typical electrical energy system

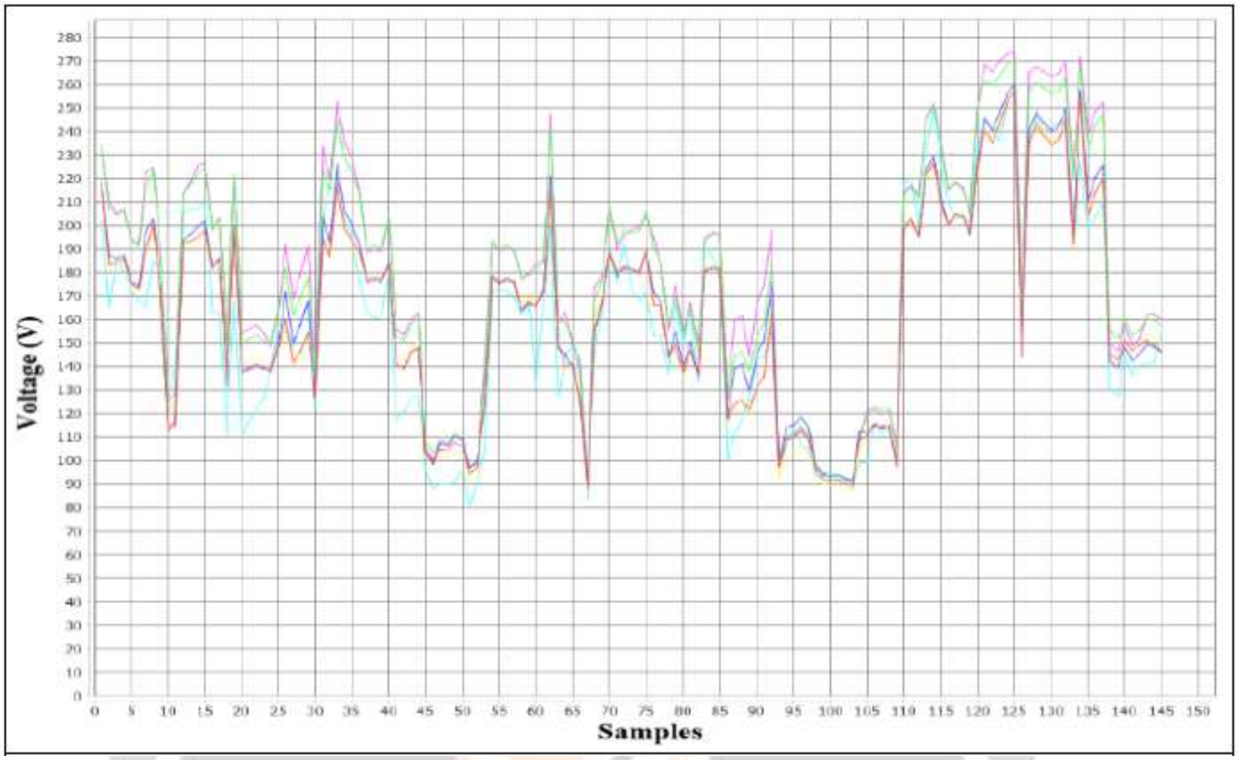
Result Analysis

The results are presented referring to the analysis of the harmonic contribution of feeders DIAL2-16, DIAL2-17, DIAL2-19 on the 3rd order harmonic voltage of the bus located on the alternating current supply DITF4-04 (13,8 kV) lower. Voltage side using artificial neural networks.
As we can see in Table 2, which contains the influence factors calculated taking into account the entire measurement period, the feeder DIAL-2-16 showed a larger influence factor in the B phase, up to a value equal to 55,803%. Has reached. However, in the A and C phases, the feeder that presented the larger impact on the voltage distortion in bus DIBR2-O3 was DIAL2-19, which presented values equal to 67,895% in the A phase and 38,229% in the C phase. Regarding the background contribution quota, the impact factor values were equal to 08,094% in the A stage, 17,147% in the Bstage, and 11,682% in the C stage, which were simply not significantly influencing the conformation of DIBR2-O3.

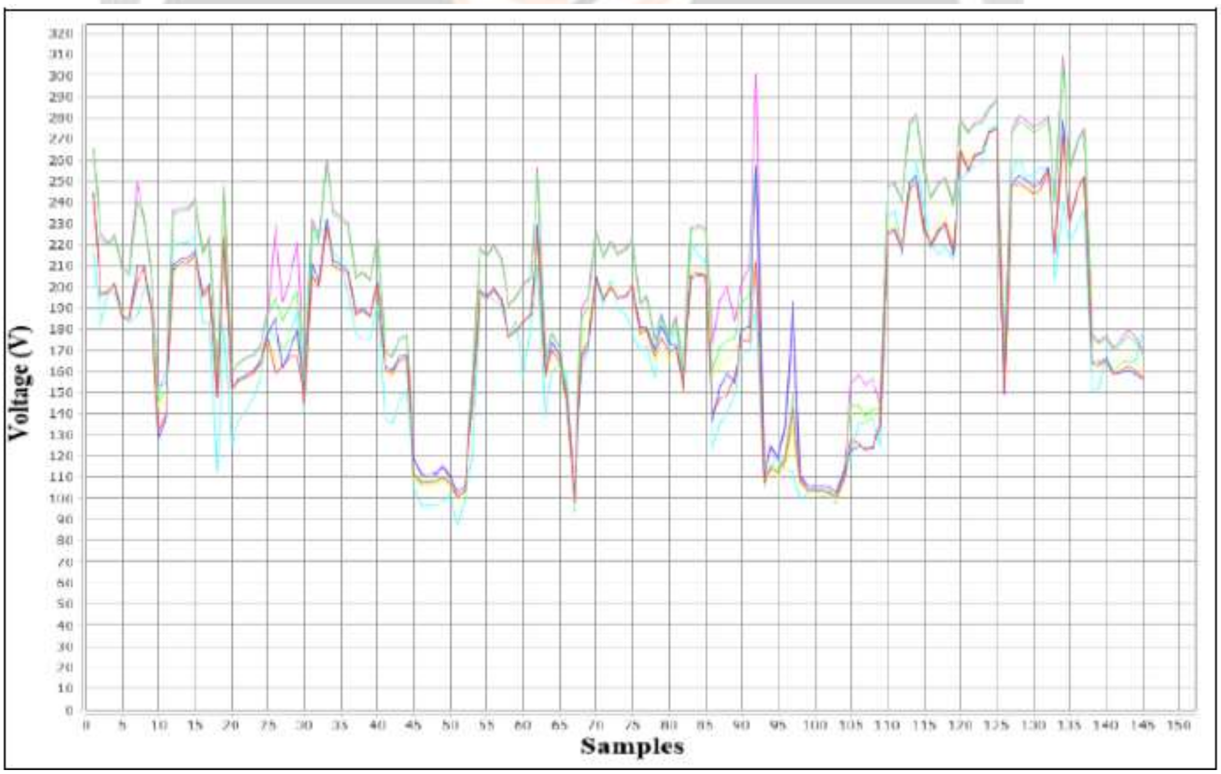
Table 1.1. Calculated effect (%) of alternating current supply ditf4- 04 (3º harmonics) on bus DIBR2-O3(13,8kv).

BASE	STAGEA	STAGEB	STAGE C
DIAL2-16	08,153	56,704	17,355
DIAL2-17	17,867	13,947	34,757
DIAL2-19	68,859	15,123	39,238
BACKGROUND	09,049	18,156	11,693

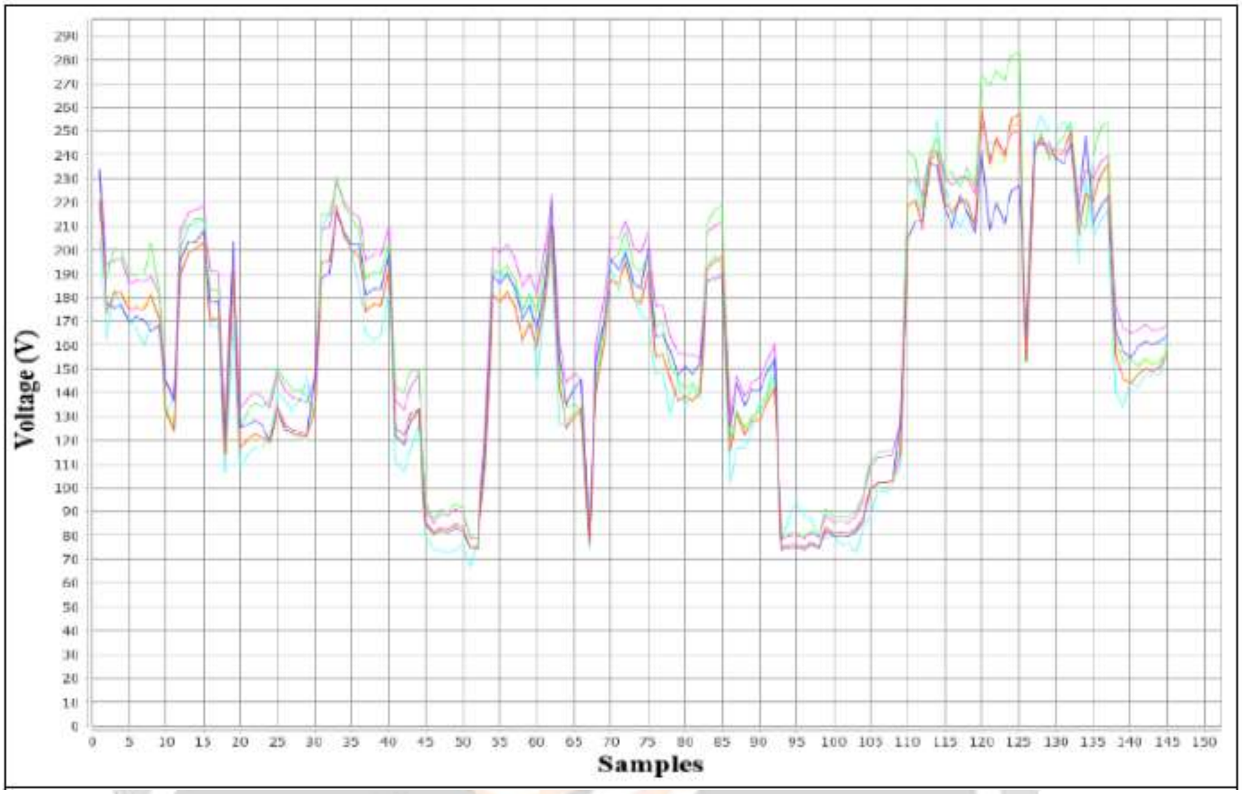
Figures 1.2, show the ANN output voltage as well as the voltage values measured on bus DIBR2-03. Analyzing these data we observed that the ANN presented a good development as there was a good approximation between the signal predicted by the ANN considering the signals measured on three feeders and the system. It can be seen in the fig. 1.2, it is difficult to identify the dominant feeder contributing to the harmonic voltage distortion in the bus DIBR 2-03 during all measurement periods, i.e., a large change on a specific feeder ANN output (large sensitivity) at certain moments. Presents, while at another moment another feeder is responsible for presenting a greater sensitivity.



Phase 1



Phase 2



Phase 3

Figure 1.2. Analysis of the ANN output voltage of the third harmonic on bus DIBR2-03 (13,8kV) of the alternating current supply DITF4-04 (phase 1,2,3).

Conclusion

It is thus presented and applied with case study activities to analyze harmonic effects on power distribution systems through the construction of mathematical models using soft computing techniques. identified feeder DIAL2-17 as most responsible for THDV in the 5th, and identified feeder DIAL2-16 as an important one. The impact factor At phase 2, ranked fifth, demonstrates the efficiency of the application of the analysis technique to harmonic effects on power systems. The ANN presented a good development, as there was a good approximation between the ANN predicted signal considering three feeders and the measured signal on the power system. The individual estimation of each feeder also presented a good development as there was a good approximation between the estimated signal of each feeder and the estimated signal taking into account the three feeders. Such a fact was awaited because these feeders are directly connected to this bus. Due to these analyses, it became possible to create a profile of feeders DIAL2-16, DIAL2-17, DIAL2-19 to reduce THDV on bus DIBR2-03 arising from the influence of harmonic currents of these feeders.

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