Research on the Fault Line Selection based on Fractal EMD

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Abstract

In this paper, the feature extraction and analysis of the transient component in the event, a small current ground fault are carried out. Through the improvement of the EMD algorithm, a line selection method is proposed on the basis of the improved EMD algorithm. The decomposition of the empirical mode decomposition method(EMD) is essentially a time-resolved decomposition of the current signal at the same time using a gentle way to decompose the IMF in a single fault at a different fault angle. Circumstances can extract some of the characteristics of different scales of data. EMD algorithm has been widely used in medical, vibration and industrial fields.

Keywords

Small Current Grounding System; Fault Line Selection; Empirical Mode Decomposition; Improved EMD Algorithm; Fractal Theory; Improved G-P Algorithm; Correlation Dimension.

1. Introduction

Among the many sources of energy, electricity is great importance to the state, the nation and the society. The safety and stability of the power system determines the state, people's economy and security. Obviously, in the failure event of the power system, it is very important to find out the fault and the eliminate fault of the power system to study the problem to prevent the fault. China's distribution network currently generally use a small current grounding system[1-2]. Small current grounding system will occur mostly single-phase ground fault, the probability is very large. In the event of failure, the current transient component of the situation is very complex, steady-state part of the current is relatively small, unstable arc. Steady-state component is not obvious. The current transformer is prone to imbalance. The load is no regular changes. These reasons lead to the distribution network of small current grounding system when the single-phase fault occurs. The single-phase fault occurs when the line has not been effectively resolved. See Fig.1.

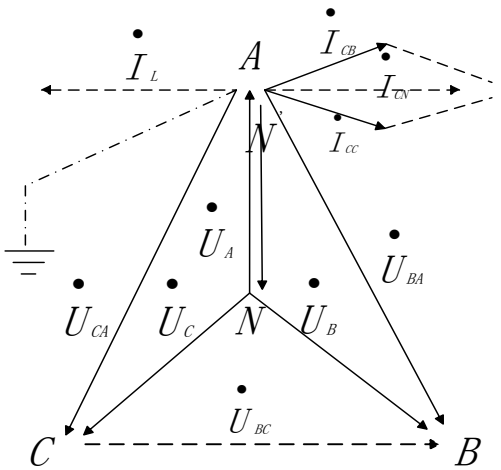


Fig.1 The safety and stability of the power system

$$\begin{cases} \dot{I}_{CCA} = -j\omega\dot{U}_0(C_{01} + C_{02} + C_{03}) \\ \dot{I}_{CCB} = j\omega\dot{U}_0C_{01} \\ \dot{I}_{CCC} = j\omega\dot{U}_0C_{01} \end{cases} \quad (1)$$

$$3\dot{I}_{0N} = -3[\dot{I}_{01} + \dot{I}_{02} + \cdots + \dot{I}_{0N-2} + \dot{I}_{0N-1}] \quad (2)$$

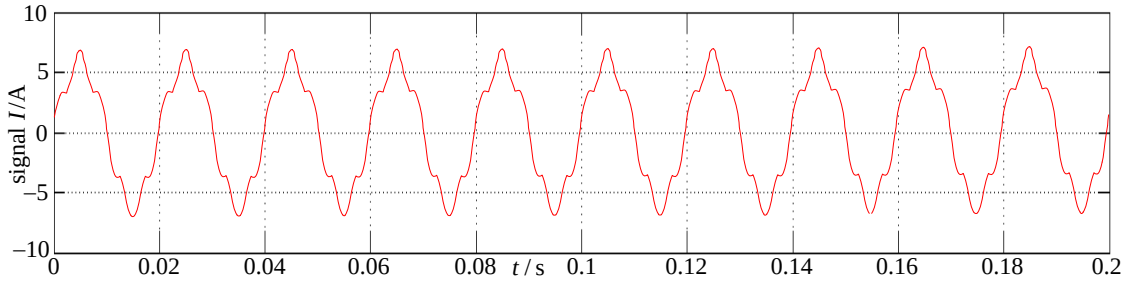
2. The EMD hierarchical decomposition

If the frequency of the acquired signal is too low or the interference signal is mutated. The end effect, modal aliasing, and false modes are represented, which makes the EMD hierarchical decomposition of several solid-state modal functions(IMF) to lose its physical meaning. It will cause the signal extraction and analysis the corresponding treatment that is a great impact. Therefore, this paper analyzes the transient current characteristics of the fault current in the small current grounding fault. And it proposes a method of small current grounding line based on improved EMD algorithm[3-5]. The improved EMD algorithm is based on the shortcomings of the EMD algorithm, so that the signal on the basis of this solution to the endpoint effect, modal aliasing and modal false problem. And the improved EMD algorithm retains its original advantages. It can be a good time-frequency characteristics and adaptive characteristics and can effectively avoid many the previous selection of the use of the basis of the function, which remains its effective decomposition and extraction of non-linear, non-stationary fault signal.

$$\begin{cases} X_i^{(m)} = \{x(i), x(i+\tau), \cdots, x(i+(m-1)\tau)\} \\ X_j^{(m)} = \{x(j), x(j+\tau), \cdots, x(j+(m-1)\tau)\} \end{cases} \quad (3)$$

$$\begin{cases} X_i^{(m+1)} = \{x(i), x(i+\tau), \cdots, x(i+(m-1)\tau), x(i+m\tau)\} \\ X_j^{(m+1)} = \{x(j), x(j+\tau), \cdots, x(j+(m-1)\tau), x(j+m\tau)\} \end{cases} \quad (4)$$

The low-frequency, non-linear, non-stationary signal is processed by the improved EMD algorithm. The solid-state modal functions of the information with the faulty feature is obtained by removing the interference from the noise. Based on the single-phase ground fault the IMF, which is decomposed by the improved EMD algorithm. It shows different characteristic energy of the fault line and the monotonous of the low frequency waveform at the time of failure, and then the corresponding correlation dimension is calculated by selecting the component of the feature(IMF).Through the improved G-P algorithm to determine the size of the associated dimension can be very good when the failure of the line and the failure of the perfect line between the two differences between the degree of correlation can be identified. It achieves an accurate fault line selection. The effectiveness of the method is verified by the simulation of single-phase ground fault. See Fig. 2.



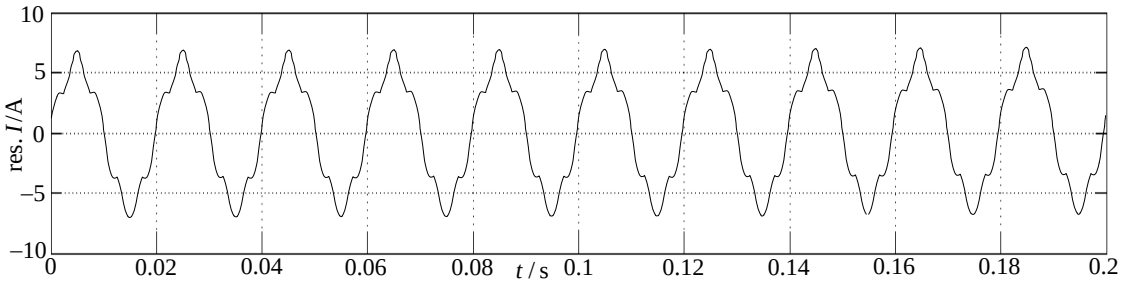


Fig.2.The EMD hierarchical decomposition

3. Experimental Results and Analysis

This paper first introduces the current research situation of single-phase grounding fault in the fault of small current system in distribution network, and summarizes the current line selection method and principle. At the same time, the grounding system of small current characteristics of the transient signal and the steady-state signal appearing in the phase fault are analyzed and summarized. Then the method of the fault line selection is combined with the empirical mode decomposition and the fractal theory. The advantages and disadvantages of the empirical mode decomposition are analyzed in detail. Algorithm and its problems are based on the empirical mode decomposition and the analysis of the fractal theory and the improvement in the EMD algorithm, the fractal theory algorithm and the correlation dimension, which are studied and analyzed. The empirical mode decomposition can be made effective in this paper. The advantages and disadvantages of the fractal theory are improved, and finally the method of selecting the single line fault in the system with small current grounding fault is put forward. The method is based on empirical mode decomposition and fractal theory improvement[6-7]. See Fig.3.

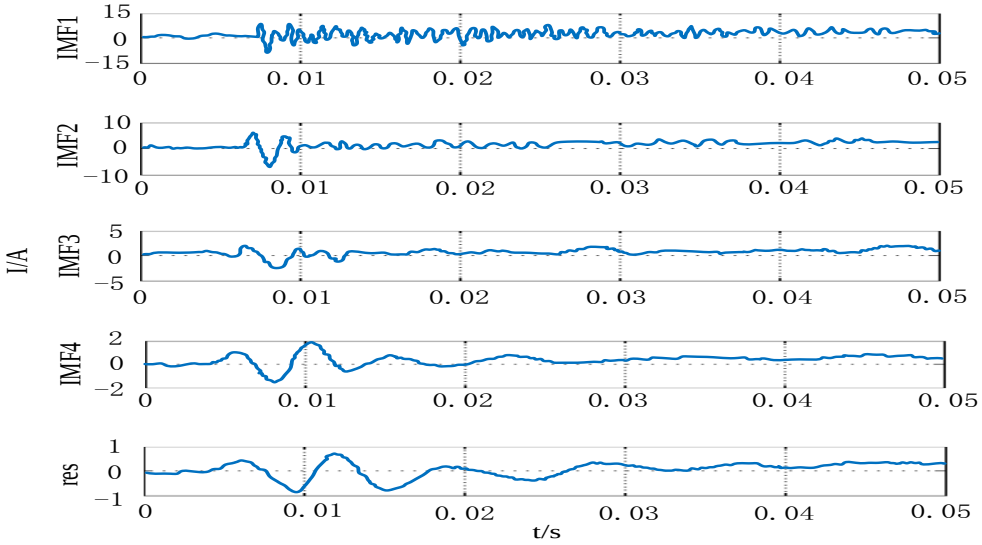


Fig.3 The EMD algorithm

4. Conclusion

In this paper, the simulation model of the small current grounding system of distribution network is established by MATLAB software. In order to test and verify the effectiveness of the method, a large number of numerical simulation and calculation of the fault are carried out. In the course of the experiment, the reliability of the fault line is based on the improved empirical mode decomposition and the fractal theory is improved by changing the position of the grounding point, the length of the line, the grounding resistance, the closing angle of the fault and so on. The results show that the improvement of the EMD algorithm and the improvement of the G-P algorithm can be effectively solved the problem of modal aliasing, end effect and reasonable selection of neighborhood radius interval, step size and linear part, which can be obtained accurately and objectively embedded

dimension, also effectively reduce the amount of the computation and shorten the corresponding program running time. The simulation results verify the accuracy and the effectively.

Acknowledgments

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