A Study on the Arc Detection Algorithm via Analysis of the Arc’s Electric Characteristics

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ABSTRACT

In this paper, we propose an arc detection algorithm that is carried out via the analysis of the arc’s electric characteristics. Additionally, in order to reduce the error rate and increase the detection reliability for the real-time arc detection algorithm executed in the time and frequency domains, the wavelet-based adaptive algorithm, which was executed in the transform domain, was also applied in order to propose a new real-time arc detection algorithm. This simulation is divided into three steps: the time, frequency, and transform domains. Simulation was conducted for arc detection for each step in order to verify the algorithm performance.


1. INTRODUCTION

1.1. Background

The most prominent cause of electric fires are short-circuits, electric leakage, overcurrent, and sparks. Thus, persistent monitoring of the load current that is utilized and monitoring of the contact failure or dielectric breakdown in the electric circuit should enable detection in advance, which would prevent many electric fires. Therefore, the principle of electric fire prediction lies in the prior detection of contact failures or related arc phenomenon and in monitoring overload use.¹ It cannot be said that all fires involve such arc or spark phenomena, but, because these do exist in most fires, monitoring arcs during malfunction should prevent many fires, and their presence can be utilized to detect the signs of electric fires.

To date, arc detection methods have included optic detection methods that detect the light from arc occurrence, electromagnetic wave detection, high-frequency voltage/current detection methods based on rapid changes in the impedance, and voltage detection methods. Also, in terms of the domains of analysis, there are time domain, frequency domain, and discrete wavelet analyses. Methods using the time domain can detect arcs through changes in the maximum and rms values, but have limitations in that the changes in the resistivity load are small. Methods using the frequency domain can detect arcs through harmonic waves, internal harmonic wave rms values, and energies; however, these also have weaknesses such as lacking time information and having difficulties obtaining precise frequency analysis. Methods using the discrete wavelet can detect arcs through changes in the maximum and rms values by breaking down the arc waveform into approximate coefficients and detailed coefficients. However, the appropriate breakdown level and frequency range must be selected depending on the waveform characteristics; thus, it is difficult to precisely detect for a variety of loads.²,³

1.2. Study Proposal

When an arc is generated, the voltage waveform at both ends of the arc generation shows a mixed waveform of a circular wave and an impulse. The impulse waveform portion of the voltage showed the 0 point delay phenomenon of the current. When an arc is generated, the odd harmonic wave component increased. Additionally, in the low-frequency domain (below 1 kHz), the arc power size was 50% smaller than the normal state power. Conversely, in the high-frequency domain (over 1 kHz) the arc power size was about 200% larger than the normal state power. We are able to predict the occurrence of electrical fires through analysis of the electric signal characteristics of the arc. Therefore, we should be able to prevent fires from occurring.

Here, in order to reduce the error rate and increase the detection reliability for a real-time arc detection algorithm executed in the time and frequency domains, the wavelet-based adaptive algorithm, executed in the transform domain, is also applied in order to propose a new real-time arc detection algorithm.

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