DIAGNOSTYKA, 2019, Vol. 20, No. 1

ISSN 1641-6414
e-ISSN 2449-5220
DOI: 10.29354/diag/99854

PREDICTION OF CRITICAL FLASHOVER VOLTAGE OF POLLUTED INSULATORS UNDER SEC AND RAIN CONDITIONS USING LEAST SQUARES SUPPORT VECTOR MACHINES (LS-SVM)

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Abstract

This paper describes a methodology that was developed for the prediction of the critical flashover voltage of polluted insulators under sec and rain conditions least squares support vector machines (LS-SVM) optimization. The methodology uses as input variable characteristics of the insulator such as diameter, height, creepage distance, and the number of elements on a chain of insulators. The estimation of the flashover performance of polluted insulators is based on field experience and laboratory tests are invaluable as they significantly reduce the time and labour involved in insulator design and selection. The majority of the variables to be predicted are dependent upon several independent variables. The results from this work are useful to predict the contamination severity, critical flashover voltage as a function of contamination severity, arc length, and especially to predict the flashover voltage. The validity of the approach was examined by testing several insulators with different geometries. A comparison with the Grouping Multi-Duolateration Localization (GMDL) method proves the accuracy and goodness of LS-SVM. Moreover LS-SVMs give a good estimation of results which are validated by experimental tests.

Keywords: LS-SVM, flashover, modelling, polluted insulator, GMDL.

1. INTRODUCTION

Outdoor insulators can become heavily coated with dirt and chemicals by environmental pollution. In severe atmospheric conditions such as fog, dew or drizzle, the contaminant will were partially dissolved, forming a conductive layer. Leakage current flows along the surface will increase and may eventually cause flashover Insulators often undergo different kinds of pollution; among them, salt deposit near coasts, insect deposit or dust deposit. All this pollution can create weak areas on the surface of insulators which can cause a local discharge. Successively, those discharges can establish a flashover.

The critical flashover voltage of a polluted insulator is a significant parameter for the reliability of power systems. Several approaches have been developed for the estimation of the flashover voltage. Experimental tests are time-consuming and increase the cost of the system. To overcome such a problem researcher groups in high voltage engineering proposed some mathematical models based either on physical modeling, using electrical equivalent models or on mathematical regressions using artificial intelligent approximates [1-4]. The level and type of contamination of a region are associated with the pollution sources that produce it, as well as meteorological factors of the place. When the weather influence is greater than pollution source influence, seasonal variations affect the tendency of contaminant accumulation over the insulator's surface. In these cases, the behavior of pollution level is very dynamic, coming to have in a same year highest and lowest pollution levels. Typical cases are the coasts [5]. A variety of prediction models have been proposed in the literature that include time-series models, regression models, artificial neural network (ANN) models, adaptive Neuro-fuzzy inference system (ANFIS) and support vector machine (SVM) models. The application of genetic algorithms enables the definition of the arc constants, resulting also in the calculation of the critical conditions at the beginning of the pollution flashover mechanism. A mathematical model has been established, which simulates accurately the experimental results [1, 5-7]. A new method like SVMs has been introduced for pattern recognition and regression [2]. SVMs have often been found to provide better prediction results [3]. As a simplification of traditional of SVM, Suykens et al. have proposed the use of the least squares support vector machines (LS-SVM) [4]. LS-SVM has been used for classification in various areas of pattern recognition [1], lately has been handled regression problems successfully [2]. In addition, experimental procedures introduced to treat flashover voltage of