Transient signal analysis in the context of wide band propagation environments

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Wide band channels become an interesting field of study since the technological advances, both in terms of electronic equipment and data processing. In this thesis, the main objective of is to contribute to the analysis of transient signals in wide band propagation channels. The aim of this analysis to better understand them as well as to estimate their describing parameters from the machine learning perspective.

Different applicative contexts have been investigated with emphasis on power grid systems and wide band communication environment. Despite the differences between the physical considerations, I propose a unique mathematical model of the signals used to analyze the considered phenomena. This model is based on a new form of quantification of information from the phase diagram, namely the phase diagram-based entropy method. This method quantifies the spatial distribution of the representation vectors by analyzing two representation dimensions in order to highlight the information of interest. This approach was compared with classical analysis methods currently used in these systems (spectrogram analysis, wavelet transform, statistical analysis) and proved to be superior.

In the power grid systems, this approach brings very good results regarding the detection of transient signals on the power cables and the localization of partial discharge sources. Moreover, I propose new tools for the investigation of the signal's characteristics, namely the phase diagram spatial features. Through them, the classification of transient phenomena is successfully carried out, the usefulness of these features being validated by the use of Machine Learning algorithms. Following this classification, the specific signals of cable defects (partial discharge activities) are separated, and by using the information given by the quantification of propagation effects using a metric based on the phase diagram entropy, the operation of locating the source of the defect is carried out.

In the communication system, the phase diagram-based entropy managed to characterize and highlight the defining aspects hidden from the classical techniques for identifying and recognizing the type of modulation used. The results in this process have an extremely high accuracy, exceeding the normal values obtained with classical methods. My work presents the experimental results using the proposed theoretical methods introduced by this thesis. The results are compared with classical techniques using Machine Learning algorithms in order to be able to show the innovative and useful character of this proposed approach.

The conclusions resulting both from the theoretical perspective and from the experiments carried out within these two different environments, as well as the perspectives of this thesis are presented at the end of the thesis.