National Institute of Technology Rourkela

Registration Seminar

Seminar Title	: Diagnostic Monitoring and Identification of Failure Root Causes of Aged High Voltage Power Cable
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Venue	: EE-401 Seminar Room, Department of Electrical Engineering, NIT Rourkela
Date and Time	: 16 May 2025 (10:00 AM)

Abstract

: Underground cables are critical components of power system networks however, aging, electrical treeing, and partial discharge (PD) are among the main factors contributing to their degradation and reduced performance. Monitoring these phenomena is essential to ensure system reliability and minimize failures. This research presents a comprehensive study of the degradation mechanisms in XLPE-insulated cables using experimental techniques, along with machine learning (ML) and deep learning (DL) approaches for condition assessment. Firstly, XLPE samples were electrically aged for 80 hours at 28 kV, with PD signals recorded at 40 and 80 hours. Nine statistical features were extracted and used to train ML classifiers, including Logistic Regression, K-Nearest Neighbors, Decision Tree, and XGBoost, to distinguish between insulation aging stages. XGBoost achieved the highest classification accuracy of 93.33%. FTIR analysis further confirmed increased oxidative degradation with aging. Next, the classification of electrical tree growth stagesinto Inception, Propagation, and Breakdown, was performed using CNN and pretrained models such as InceptionNet, ResNet, and EfficientNet, combined with various optimizers. EfficientNet with RMSprop achieved the best performance, with an accuracy of 98.78%. To address PD diagnostics more comprehensively, a multi-modal, multi-task DL framework was developed to classify PD types into corona, internal, surface and severity levels into low, moderate, high. The framework integrated image-based and feature-based data through three subnetworks: an information extraction module, a shared feature learning module, and task-specific classifiers. For image modality pretrained models were used and for rest subnetworks ANNs with varying depths were used. The optimal architecture was found out to be EfficientNetB7 for image data and a five-layer ANN for feature data in the information extraction module, with four three-layer ANNs in the shared and task-specific subnetworks. It achieved an overall accuracy of 97.72%. Finally, a regression-based approach was adopted to estimate the Health Index of underground cable joints, using features such as Age, PD, TD Stability, Mean TD, Delta TD, Neutral Corrosion, and Visual Condition. Multiple algorithms including XGBoost, CatBoost, Partial Least Squares, and ElasticNet were evaluated, with XGBoost outperforming others, achieving an MAE of 0.084 and R2 of 0.9998. To simulate real-time scenarios, synthetic samples were generated using CTGAN, and the trained XGBoost model was successfully deployed via LabVIEW, demonstrating strong generalization to unseen data