ABSTRACT

In the current era of big data, optical network serve as the backbone for high-capacity and long range data transmission, with Indonesia's national optical fiber network deployment reaching 97,86% across 514 regencies/cities in 2022. This extensive scale of network brings its own challenges, particurlaly vurnerability to optical network failures which could cause serious consequences such as massive data loss, communication disruptions, and significant financial losses. Maintenance in the optical network industry is very crucial and difficult, as there are still many operators implementing a reactive maintenance approach which only performed once a failure occured.

This research develops a multi-failure classification system in optical fiber network cable using a machine learning approach based on Ensemble Learning with the CatBoost algorithm. The system is designed to identify 8 types optical cable condition which consist of a normal condition and 7 reflective and non-reflective failures such as fiber tapping, bad splice, bending, dirty connector, fiber cut, PC connector, and reflector. To address data imbalances, BorderlineSMOTE technique and *hyperparameter tuning* using the Optuna framework is applied, then the system is implemented in the form of a *website* platform that allows users to make a prediction using either manual input or Excel file upload input methods.

Test results show that the CatBoost model successfully achieved excellent performance with 90.58% of accuracy, 90.74% precision, 90.58% recall, 90.56% F1-Score, and an average score AUC of 0.9943, all of which exceed the minimum specification target score of 85%. This system has proven to be effective as a diagnostic tool for optical network failures, supporting predictive maintenance strategy to enhance the reliability and operational efficiency of the network.

Keywords: ensemble learning, machine learning, multi-failure classifications, optical network