ABSTRACT

*Free Space Optic (*FSO*) is a wireless communication technology based on light that is capable of transmitting data at high speeds and cost efficiency. However, this system is highly vulnerable to atmospheric disturbances such as fog, rain, and air turbulence, which can lead to an increase in Bit Error Rate (*BER*) and degrade transmission quality. Therefore, a system capable of accurately predicting* BER *values is needed to maintain communication reliability under dynamic weather conditions.*

This research produces a prediction system called FSOPredict*, designed to estimate* BER *values on* FSO *communication networks in real-time. This system combines a machine learning approach using the Random Forest algorithm, optical simulation from OptiSystem, and an interactive web interface based on Next.js and Flask. The model is optimized using the Optuna hyperparameter tuning method, and the system is equipped with authentication features using JSON Web Token (*JWT*). This website not only provides BER prediction but also weather classification, technical recommendations for* FSO *systems, and prediction history storage.*

Testing results show excellent model performance with an R^2 *value of 1.0000,* MAE *of 0.0052,* MSE *of 0.0786, and* RMSE *of 0.2803. Meanwhile, for weather condition classification, the model optimized with Optuna also shows performance that meets specifications for weighted metrics, achieving an accuracy of 0.84, precision of 0.86, recall of 0.84, and F1-score of 0.84. The low inference time (< 0.5 seconds) proves that this system is suitable for adaptive decision-making in the field. From the interface side, the Google Lighthouse score reaches 97 (desktop) and 82 (mobile) for performance, 100 for Best Practices and* SEO*, and 91 for Accessibility. A user survey also shows a high level of satisfaction with an average score between 4.68 and 4.72. With a combination of prediction accuracy, system efficiency, and ease of use,* FSOPredict *becomes an effective and applicable solution to support the reliability of weather-based optical communication systems.*

Keywords: Bit Error Rate, Free Space Optic, Machine Learning, Random Forest, Optuna, Interactive Web, JWT.