

ABSTRAK

Isolator merupakan komponen penting pada saluran transmisi yang berfungsi memisahkan penghantar dengan menara transmisi. Kerusakan akibat korosi maupun kontaminasi polutan dapat menurunkan keandalan sistem tenaga listrik dan meningkatkan risiko gangguan pada jaringan transmisi. Oleh karena itu, diperlukan metode inspeksi yang mampu mengidentifikasi kondisi isolator secara cepat dan akurat. Penelitian ini bertujuan merancang dan mengimplementasikan model klasifikasi kondisi isolator berbasis citra menggunakan *Convolutional Neural Network* (CNN) serta mengevaluasi kinerja model yang dikembangkan. Dataset yang digunakan terdiri atas enam kelas isolator, yaitu kaca bersih, kaca polutan, keramik bersih, keramik korosi, keramik korosi+polutan, dan keramik polutan. Citra isolator diperoleh melalui proses deteksi dan *cropping* setiap *disc* isolator menggunakan YOLOv11. Selanjutnya, citra diberikan augmentasi berupa *horizontal flip* dan rotasi untuk meningkatkan variasi data pelatihan. Model klasifikasi dikembangkan menggunakan pendekatan *transfer learning* dengan MobileNetV2 sebagai model dasar. Hasil pengujian menunjukkan bahwa model memperoleh nilai *accuracy* sebesar 94%, *macro average precision* sebesar 0,93, *recall* sebesar 0,94, dan *F1-score* sebesar 0,93. Selain itu, validasi ahli terhadap 27 sampel citra *disc* isolator menunjukkan tingkat kesesuaian sebesar 100% antara hasil prediksi model dan hasil identifikasi ahli. Model yang dikembangkan juga berhasil diimplementasikan ke dalam website menggunakan *framework* Gradio pada platform Hugging Face Spaces, sehingga dapat digunakan untuk melakukan klasifikasi kondisi isolator secara mudah. Hasil penelitian menunjukkan bahwa model CNN yang dikembangkan mampu mengklasifikasikan kondisi isolator dengan baik dan berpotensi mendukung proses inspeksi serta pemeliharaan saluran transmisi 150 kV.

Kata kunci: *Convolutional Neural Network*, *disc* isolator, klasifikasi citra, kondisi isolator, saluran transmisi 150 kV.

ABSTRACT

Insulators are essential components in transmission lines that function to electrically isolate conductors from transmission towers. Damage caused by corrosion and surface contamination can reduce the reliability of power systems and increase the risk of transmission network failures. Therefore, an inspection method capable of identifying insulator conditions accurately and efficiently is required. This study aims to design and implement an image-based insulator condition classification model using a Convolutional Neural Network (CNN) and evaluate its performance. The dataset consists of six insulator classes: clean glass, polluted glass, clean ceramic, corroded ceramic, corroded and polluted ceramic, and polluted ceramic. The insulator images were obtained through the detection and cropping of individual insulator discs using YOLOv11. Subsequently, the images were augmented using horizontal flipping and rotation to increase the diversity of the training data. The classification model was developed using a transfer learning approach with MobileNetV2 as the base model. The experimental results show that the proposed model achieved an accuracy of 94%, a macro-average precision of 0.93, a recall of 0.94, and an F1-score of 0.93. Furthermore, expert validation conducted on 27 insulator disc image samples demonstrated a 100% agreement between the model predictions and the expert assessments. The developed model was also successfully implemented into a web-based application using the Gradio framework on the Hugging Face Spaces platform, enabling users to classify insulator conditions conveniently. The results indicate that the proposed CNN model is capable of accurately classifying insulator conditions and has the potential to support the inspection and maintenance of 150 kV transmission lines.

Keywords: Convolutional Neural Network, disc insulator, image classification, insulator condition, 150 kV transmission line.

