

ABSTRAK

SISTEM DIAGNOSIS CERDAS DEGRADASI ISOLATOR PORSELEN AKIBAT POLUSI ABU BATUBARA BERBASIS AI MULTIMODAL

(2026 : xiv + 61 Halaman + Daftar Gambar + Daftar Tabel + Lampiran)

Muhammad Fahdelin Hafiz
062330310521
Jurusan Teknik Elektro
Program Studi Teknik Listrik
Politeknik Negeri Sriwijaya

Isolator outdoor merupakan komponen penting dalam sistem tenaga listrik yang berfungsi sebagai pemisah antara konduktor bertegangan dengan struktur penyangga. Pada lingkungan industri dan pembangkit listrik berbahan bakar batubara, isolator rentan mengalami degradasi akibat paparan polusi abu batubara yang dapat menurunkan kemampuan isolasi dan meningkatkan risiko gangguan sistem. Proses degradasi yang terjadi secara bertahap sering kali sulit dideteksi melalui inspeksi visual konvensional. Oleh karena itu, penelitian ini bertujuan untuk merancang sistem diagnosis cerdas berbasis *Artificial Intelligence* (AI) multimodal menggunakan metode *Convolutional Neural Network* (CNN) untuk mengidentifikasi kondisi degradasi isolator outdoor. Penelitian dilakukan dengan memanfaatkan citra isolator yang dikelompokkan ke dalam tiga kategori, yaitu kondisi berdebu banyak, kondisi berdebu sedikit, dan kondisi bersih. Data citra diproses melalui tahapan preprocessing, pelatihan model CNN, serta evaluasi menggunakan grafik accuracy, loss, dan confusion matrix. Hasil pelatihan menunjukkan bahwa nilai training accuracy meningkat hingga mencapai 100% pada epoch ke-30, sedangkan nilai loss mengalami penurunan hingga mendekati nol. Hasil pengujian confusion matrix menunjukkan bahwa sebagian besar data berhasil diklasifikasikan dengan benar, dimana setiap kelas mampu dikenali dengan tingkat ketepatan yang baik. Berdasarkan hasil penelitian, metode CNN mampu mengenali pola visual degradasi isolator akibat polusi abu batubara dengan baik dan berpotensi digunakan sebagai sistem diagnosis cerdas untuk mendukung pemantauan kondisi isolator secara lebih efektif, cepat, dan akurat sehingga dapat membantu meningkatkan keandalan sistem tenaga listrik.

Kata Kunci : Isolator Outdoor, Degradasi Isolator, Abu Batubara, *Artificial Intelligence*, CNN, AI Multimodal.

ABSTRACT

INTELLIGENT DIAGNOSTIC SYSTEM FOR PORSELEN INSULATOR DEGRADATION CAUSED BY COAL ASH POLLUTION BASED ON MULTIMODAL ARTIFICIAL INTELLIGENCE

(2026 : xiv + 61 Pages + List of pictures + List of Tables + attachments)

Muhammad Fahdelin Hafiz
062330310521
Jurusan Teknik Elektro
Program Studi Teknik Listrik
Politeknik Negeri Sriwijaya

Outdoor insulators are important components in electric power systems that function as electrical separators between energized conductors and supporting structures. In industrial environments and coal-fired power plants, insulators are vulnerable to degradation caused by coal ash pollution, which can reduce insulation performance and increase the risk of system disturbances. Since the degradation process occurs gradually, it is often difficult to detect through conventional visual inspections. Therefore, this study aims to develop an intelligent diagnostic system based on Multimodal Artificial Intelligence (AI) using the Convolutional Neural Network (CNN) method to identify the degradation condition of outdoor insulators. The study was conducted using insulator images classified into three categories: heavily polluted condition, lightly polluted condition, and clean condition. The image data were processed through preprocessing, CNN model training, and evaluation using accuracy graphs, loss graphs, and confusion matrix analysis. The training results showed that the training accuracy increased to 100% at the 30th epoch, while the loss value decreased close to zero. The confusion matrix results indicated that most of the testing data were successfully classified into the correct categories, demonstrating good classification performance for each class. Based on the obtained results, the CNN method is capable of recognizing visual degradation patterns of outdoor insulators caused by coal ash pollution and has the potential to be implemented as an intelligent diagnostic system for more effective, faster, and accurate condition monitoring, thereby improving the reliability of electric power systems.

Keywords : Outdoor Insulator, Insulator Degradation, Coal Ash Pollution, Artificial Intelligence, CNN, Multimodal AI.