

## INTISARI

### KLASIFIKASI GLAUKOMA DARI CITRA FUNDUS RETINA MENGUNAKAN KOMBINASI CNN DAN SVM DENGAN SELEKSI FITUR RFE-SHAP

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Glaukoma merupakan penyakit mata yang menjadi penyebab utama kebutaan permanen. Secara global, terdapat 3,61 juta kasus kebutaan akibat glaukoma pada tahun 2020. Tingginya prevalensi glaukoma disebabkan oleh tidak muncul gejala pada tahap awal, sehingga diagnosis dan penanganan sering kali terlambat. Diagnosis glaukoma secara konvensional dengan funduskopi melalui analisis citra fundus retina masih dilakukan secara manual, sehingga bersifat subjektif antar pakar medis. Pendekatan *machine learning* dan *deep learning* telah dikembangkan untuk otomatisasi glaukoma, namun masih memiliki keterbatasan dalam akurasi dan interpretabilitas. Penelitian ini mengusulkan kerangka klasifikasi glaukoma otomatis berbasis citra fundus retina dengan mengkombinasikan *Convolutional Neural Network* (CNN) dan *Support Vector Machine* (SVM), serta seleksi fitur *Recursive Feature Elimination* berbasis SHAP (RFE-SHAP) yang diuji dengan dataset ACRIMA dan ORIGA. Metode yang diusulkan tidak hanya fokus pada peningkatan performa klasifikasi, tetapi juga menekankan aspek interpretabilitas model melalui pendekatan SHAP. Eksperimen berhasil mencapai performa tertinggi khususnya pada dataset ACRIMA dengan model SVM berbasis subset fitur DenseNet-201 mencapai akurasi sebesar 0,9787, *precision* 0,9634, dan *recall* 1,0000. Sementara itu, pada dataset ORIGA performa model belum optimal dengan akurasi sebesar 0,8462 dan *recall* 0,6176 yang menandakan terdapat perbedaan karakteristik dan kompleksitas citra antar dataset, sehingga mempengaruhi kemampuan generalisasi model. Selain itu, analisis interpretabilitas pada level fitur berbasis SHAP berhasil menjelaskan kontribusi dan pengaruh setiap fitur dalam mengklasifikasi kelas glaukoma dan normal, sehingga mendukung pengembangan sistem berbasis kecerdasan buatan yang lebih transparan dan dapat dijelaskan.

**Kata Kunci:** Glaukoma, Citra Fundus Retina, CNN, RFE-SHAP, SVM.

## ABSTRACT

### ***GLAUCOMA CLASSIFICATION FROM RETINAL FUNDUS IMAGES USING CNN-SVM HYBRID MODEL WITH RFE-SHAP FEATURE SELECTION***

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Glaucoma is an eye disease that represents one of the leading causes of irreversible blindness. Globally, there were approximately 3,61 million cases of blindness caused by glaucoma in 2020. The high prevalence of glaucoma is largely attributed to the absence of early-stage symptoms, which often leads to delayed diagnosis and treatment. Conventional diagnosis using funduscopy through manual analysis of retinal fundus images remains highly subjective and dependent on clinician expertise. Machine learning and deep learning approaches have been developed to automate glaucoma detection; however, these methods often suffer from limited accuracy and interpretability. This research proposed an automated glaucoma classification framework based on retinal fundus images by combining a Convolutional Neural Network (CNN) and Support Vector Machine (SVM), enhanced through SHAP-based Recursive Feature Elimination (RFE-SHAP) for feature selection. The proposed framework was evaluated using the ACRIMA and ORIGA dataset. It not only focuses on improving classification performance but also emphasizes model interpretability through the SHAP approach. Experimental results demonstrate that proposed method achieved the highest performance on ACRIMA dataset, where the SVM model with DenseNet-201 feature subsets obtained an accuracy of 0,9787, precision of 0,9634, and recall of 1,0000. In contrast, the model performance on ORIGA dataset was less optimal, with an accuracy of 0,8462 and recall of 0,6176, indicating differences in image characteristics and complexity across datasets that affect model generalization. Furthermore, interpretability analysis at the SHAP-based feature level successfully explains the contribution and influence of each feature in classifying glaucoma and normal classes, thereby supporting the development of more transparent and explainable artificial intelligence-based diagnostic systems.

**Keyword: Glaucoma, Retinal Fundus Image, CNN, RFE-SHAP, SVM.**