

**DETEKSI *DIABETIC RETINOPATHY* MENGGUNAKAN METODE  
*HYBRID INCEPTIONRESNETV2-KELM***

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## ABSTRACT

### DIABETIC RETINOPATHY DETECTION USING THE HYBRID INCEPTIONRESNETV2-KELM METHOD

Diabetic Retinopathy (DR) is a complication of Diabetes Mellitus (DM) that occurs in the eyes. Type 1 DM and type 2 DM both experience DR. Based on the severity, DR is divided into stages of Mild DR, Moderate DR, Severe DR and Proliferative DR. Manual detection is difficult because there are quite small differences between normal and DR, so a Computer-Aided Diagnosis (CAD) system is the solution. The aim of this research is to detect the severity of DR quickly and accurately, so that DR sufferers do not get more severe, which can cause blindness. Fundus images are used to take fundus images of the retina to detect DR. The fundus image data collection in this study uses data sourced from Mesindor. This data consists of four classes, namely normal, mild DR, moderate DR, and severe DR. A hybrid method of the InceptionResnetV2 Convolutional Neural Network (CNN) architecture with the KELM method. InceptionResNetV2 is used for feature extraction and the Kernel Extreme Learning Machine (KELM) as a classifier is able to detect very well and quite effectively in time. This research uses KELM parameter tests including using several kernels such as RBF, linear, polynomial, and wavelet. Apart from that, we also conducted regulation coefficient ( $C$ ) experiments using 0.1, 1, 10, 100, and 1000. The results that showed the highest sensitivity values were in the polynomial kernel experiment and  $C = 10$ . The evaluation results produced sensitivity of 99.88%, accuracy of 99.88%, specificity of 99.96%, precision of 99.88%, and f1-score of 99.88%.

**Keywords:** Diabetes Mellitus, Diabetic Retinopathy, Convolutional Neural Network (CNN), InceptionResNetV2, Kernel Extreme Learning Machine (KELM)

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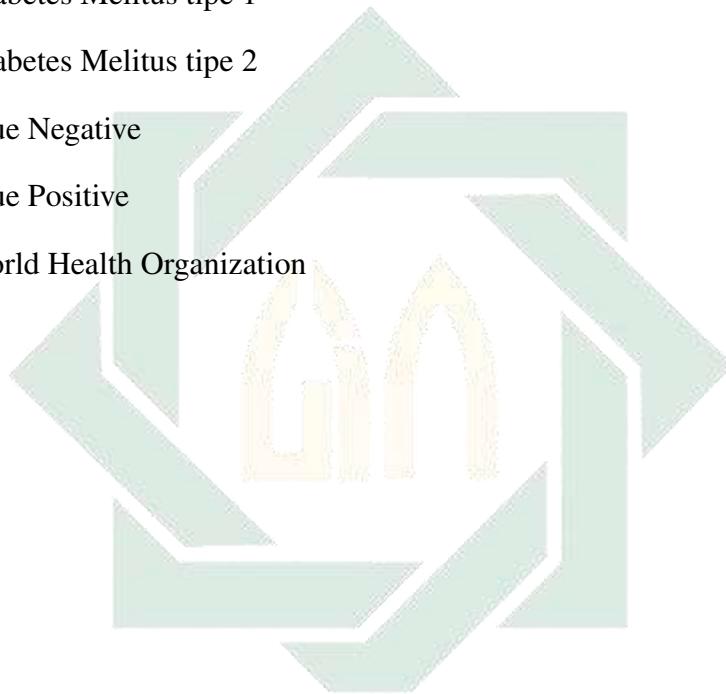


## DAFTAR SINGKATAN

Acc	: Akurasi
AdaGrad	: Adaptive Gradient
AHE	: Adaptive Histogram Equalization
ANN	: Artificial Neural Networks
BBHE	: Brightness Preserving by Histogram Equalization
BPDHE	: Brightness Preserving Dynamic Fuzzy Histogram Equalization
BV	: Blood Vessels
CAD	: Computer-Aided Diagnosis
CLAHE	: Contrast Limited Adaptive Histogram Equalization
CM	: Confusion Matrix
CNN	: Convolutional Neural Network
Conv	: Convolution layer
CV	: Cross Validation
DELM	: Deep Extreme Learning Machine
DM	: Diabetes Mellitus
DR	: Diabetic Retinopathy
EKG	: Elektrokardiogram
ELM	: Extreme Learning Machine
EX	: Exudates
FC	: Fully-Connected
FN	: False Negative
FP	: False Positif

GAP	: Global Average Pooling
GLAC	: Gradient Local Auto-Correlations
GLCM	: Gray-Level Co-occurrence Matrix
HE	: Histogram Equalization
HEBPDS	: dynamic stretching technique
HM	: Haemorrhage
HOG	: Histogram of Oriented Gradients
HRV	: Heart Rate Variability
IRV2	: InceptionResNetV2
KELM	: Kernel Extreme Learning Machine
KNN	: K-Nearest Neighbors
LBP	: Local Binary Pattern
LSTM	: Long Short-Term Memory
MA	: MikroAneurisma
MLELM	: Multi-Layer Extreme Learning Machine
MLP	: Multi-Layer Perceptron
MLSVM	: Multi-Label Support Vector Machine
NAG	: Nesterov Accelerated Gradient
NPDR	: Non-Proliferative Diabetic Retinopathy
PCA	: Principal Component Analysis
PDR	: Proliferative Diabetic Retinopathy
RBF	: Radial Basis Function
RGB	: Red Green Blue
Sen	: Sensitivitas
SGD	: Stochastic Gradient Descent
SLFN	: Single-layer feedforward networks

Spec : Spesifisitas  
SVD : Singular Value Decomposition  
SVM : Support Vector Machine  
T1DM : Diabetes Melitus tipe 1  
T2DM : Diabetes Melitus tipe 2  
TN : True Negative  
TP : True Positive  
WHO : World Health Organization



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