**Smart Detection of Diabetic Retinopathy Using Machine Learning and Fast R-CNN**

**Abstract**
Diabetic Retinopathy (DR) is one of the major causes of vision loss in people with diabetes. This project presents an automatic method to detect DR using machine learning, especially Fast Regional Convolutional Neural Networks (Fast R-CNN). The system processes retinal images using several image enhancement techniques such as noise removal, contrast improvement, and segmentation of abnormal regions like microaneurysms and hemorrhages. Important features such as texture, statistical values, and lesion count are extracted and given to a Random Forest classifier. The system accurately classifies the disease into four stages: Normal, Mild, Moderate, and Severe DR. The proposed method achieved an accuracy of 89.9%.

**Introduction**
Diabetic Retinopathy is a serious eye disease caused by diabetes that damages the blood vessels of the retina. If not detected early, it can lead to permanent vision loss. The number of DR cases is increasing worldwide, especially in India. Manual diagnosis by specialists is time-consuming, expensive, and limited in rural areas. Therefore, an automated system is necessary for large-scale and early detection.

**Problem Statement**
Traditional DR detection suffers from specialist shortages, lack of rural access, poor patient follow-up, and high diagnosis cost. These issues create delays in treatment and increase the risk of blindness. An automated solution is required for faster and reliable diagnosis.

**Proposed Methodology**
The system follows this flow: Retinal Image → Preprocessing → Segmentation → Feature Extraction → Classification → Output.

**Preprocessing**
Green channel extraction improves contrast. Median filtering removes noise. CLAHE enhances contrast for better visibility. All images are resized for consistency.

**Segmentation**
The retinal region is separated from the background. Blood vessels are removed. Microaneurysms and hemorrhages are extracted using edge detection and morphological operations.

**Feature Extraction**
Texture, statistical, and morphological features are extracted to determine disease severity.

**Classification**
A Random Forest algorithm classifies images into Normal, Mild, Moderate, and Severe DR stages.

**Experimental Results**
Accuracy: 89.9%, Sensitivity: 87.2%, Specificity: 92.1%, Precision: 88.5%, F1-Score: 87.8%. These results show strong performance.

**Applications**
The system can be used in hospitals, eye clinics, rural screening camps, and telemedicine platforms.

**Conclusion**
This automated system provides accurate and early detection of Diabetic Retinopathy. It reduces doctor workload and supports large-scale screening. Future improvements include real-time implementation and hospital system integration.