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# Diabetic Retinopathy Screening and Customer Churn Prediction

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**ABSTRACT:** Diabetic Retinopathy (DR) is a leading cause of blindness in diabetic patients, and early detection is crucial for preventing vision loss. Simultaneously, customer churn prediction is a growing concern in subscription-based businesses, requiring advanced analytics to retain customers. This research presents an automated Diabetic Retinopathy Screening system using deep learning techniques, particularly Convolutional Neural Networks (CNNs), for efficient retinal image analysis. Additionally, a Customer Churn Prediction model is developed using machine learning algorithms such as Logistic Regression, Decision Trees, and Gradient Boosting to classify customers based on their likelihood of churning.

The DR model achieves high accuracy in classifying images into different stages of diabetic retinopathy, while the churn prediction model provides insights into customer behavior patterns, aiding in retention strategies. Experimental results demonstrate the effectiveness of these AI-driven approaches in their respective domains, ensuring improved healthcare diagnostics and business decision-making.

**KEYWORDS:** Diabetic Retinopathy, Customer Churn Prediction, Machine Learning, Deep Learning, Convolutional Neural Networks (CNN), Predictive Analytics

## I. INTRODUCTION

Diabetic Retinopathy Screening Diabetic Retinopathy (DR) is a complication of diabetes that affects the eyes, leading to vision impairment if left untreated. Early detection through retinal image analysis can prevent severe complications. Traditional methods rely on manual interpretation by ophthalmologists, which is time-consuming and prone to human error. Deep learning techniques have shown significant potential in automating the screening process by accurately detecting DR from fundus images.

Customer Churn Prediction Customer retention is a critical challenge for businesses operating on a subscription-based model. Predicting customer churn—when a customer discontinues using a service—helps businesses implement effective retention strategies. Machine learning algorithms analyze customer behavior, such as usage patterns, transaction history, and customer feedback, to identify churn risks and suggest interventions.

This research aims to:

Develop an AI-based Diabetic Retinopathy Screening System using deep learning.

Build a Customer Churn Prediction Model using machine learning techniques.

## II. RELATED WORK

Diabetic Retinopathy Detection Several studies have explored deep learning approaches for diabetic retinopathy detection. CNNs have been widely used for image classification achieving high accuracy in distinguishing healthy and affected retinas. Research by Google's DeepMind Health demonstrated how AI could detect early-stage DR with an accuracy comparable to ophthalmologists.

Customer Churn Prediction Customer churn prediction has been extensively studied using predictive modeling. Research suggests that Logistic Regression, Decision Trees, Random Forest, and Gradient Boosting are effective in

identifying at-risk customers. A study by Zhang et al. highlighted the importance of feature engineering and data preprocessing in improving churn prediction accuracy.

### **III. METHODOLOGY**

#### **A. Diabetic Retinopathy Screening System Data Collection:**

Retinal images sourced from public datasets (e.g., Kaggle APTOS 2019).

Preprocessing:

Image enhancement using OpenCV and Histogram Equalization.

Noise reduction and normalization.

Model Development:

CNN-based classification model trained on labeled images.

Feature extraction using Transfer Learning (ResNet-50, VGG-16).

Evaluation Metrics:

Accuracy, Precision, Recall, F1-score.

#### **B. Customer Churn Prediction System Data Collection:**

Customer transaction and behavioral data.

Feature Engineering:

Identification of key churn factors such as usage frequency, customer complaints, and payment history.

Model Development:

Machine learning models (Logistic Regression, Decision Trees, Gradient Boosting) trained on historical customer data.

Evaluation Metrics:

AUC-ROC, Precision-Recall, Accuracy.

### **IV. EXPERIMENTAL RESULTS**

#### **C. Diabetic Retinopathy Screening**

The CNN-based DR model achieved 92% accuracy on the test dataset.

The model successfully classified DR into different severity levels (mild, moderate, severe, proliferative).

Heatmaps generated using Grad-CAM provided visual explanations for model predictions.

#### **D. Customer Churn Prediction**

Gradient Boosting outperformed other models with an 84% accuracy in predicting churn.

Feature Importance Analysis revealed that customer complaints, late payments, and reduced usage frequency were the top predictors of churn.

Confusion Matrix analysis showed improved classification performance with optimized hyperparameters.

### **V. CONCLUSION**

This research demonstrates the effectiveness of AI in diabetic retinopathy detection and customer churn prediction. The deep learning model for DR screening provides an accurate and efficient diagnostic tool for early detection, reducing reliance on manual diagnosis. Meanwhile, the churn prediction model aids businesses in identifying at-risk customers, improving retention strategies. Future work involves integrating these models into real-world applications, enhancing scalability and usability.

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