SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
SCHOOL OF COMPUTING
DEPARTMENT OF COMPUTING TECHNOLOGIES

Early Detection of Diabetic Retinopathy from Retinal Fundus Images using Transfer Learning

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21CSP302L - MINOR PROJECT

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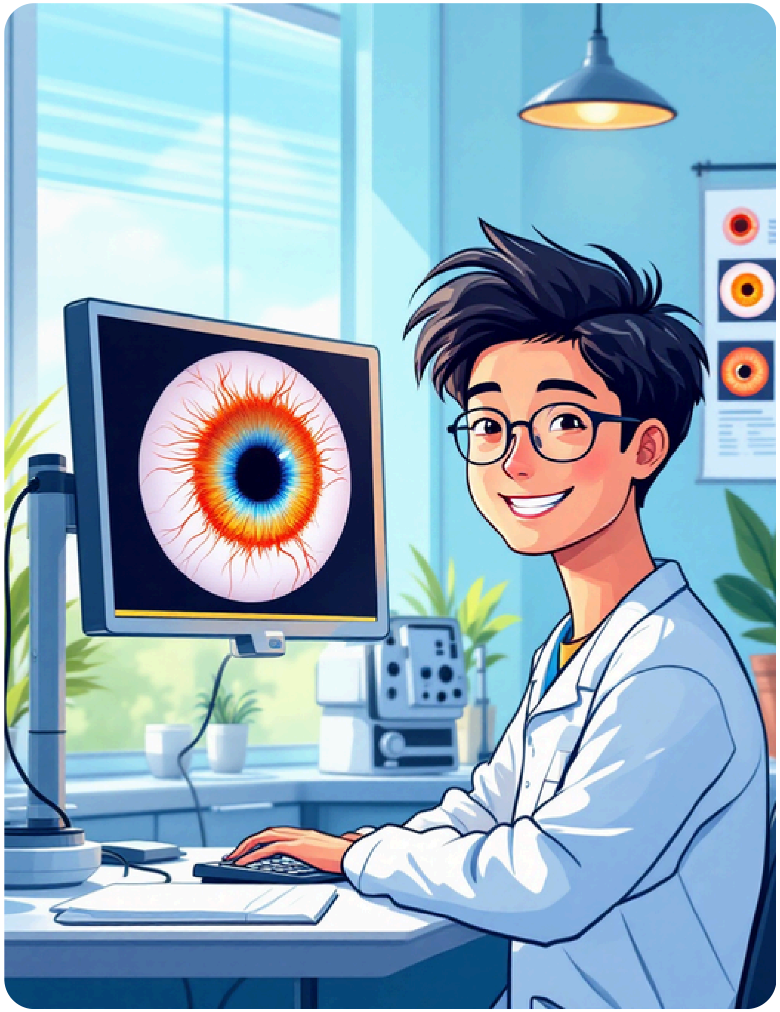
Abstract

Diabetic Retinopathy (DR) is a leading cause of vision loss among diabetic patients. Early detection is vital to prevent blindness, yet **manual screening is time-consuming and inconsistent**.

This study proposes an automated DR detection framework using transfer learning with models like VGG16, ResNet-18, and GoogleNet.

Using datasets such as EyePACS and Messidor, the model could achieve over 90% accuracy and high sensitivity for early-stage detection.

The proposed approach shows strong potential for integration into clinical workflows as a digital assistant or fully automated diagnostic tool.



Literature Survey

Summary:

- Gulshan et al. (2016): Achieved expert-level DR detection accuracy in Deep CNN.
- Jabbar et al. (2022): Used transfer learning (VGG models) for DR; reduced training time but faced data imbalance.
- Ishtiaq et al. (2023): Hybrid CNN + SVM approach improved accuracy and robustness.
- Arora et al. (2024): Ensemble EfficientNet models enhanced severity grading performance..

Gaps Identified:

- Limited and imbalanced datasets.
- Poor early-stage DR sensitivity.
- Weak generalization across populations.
- Lack of clinical integration and real-world testing.

Problem Definition and Objectives

Problem Definition:

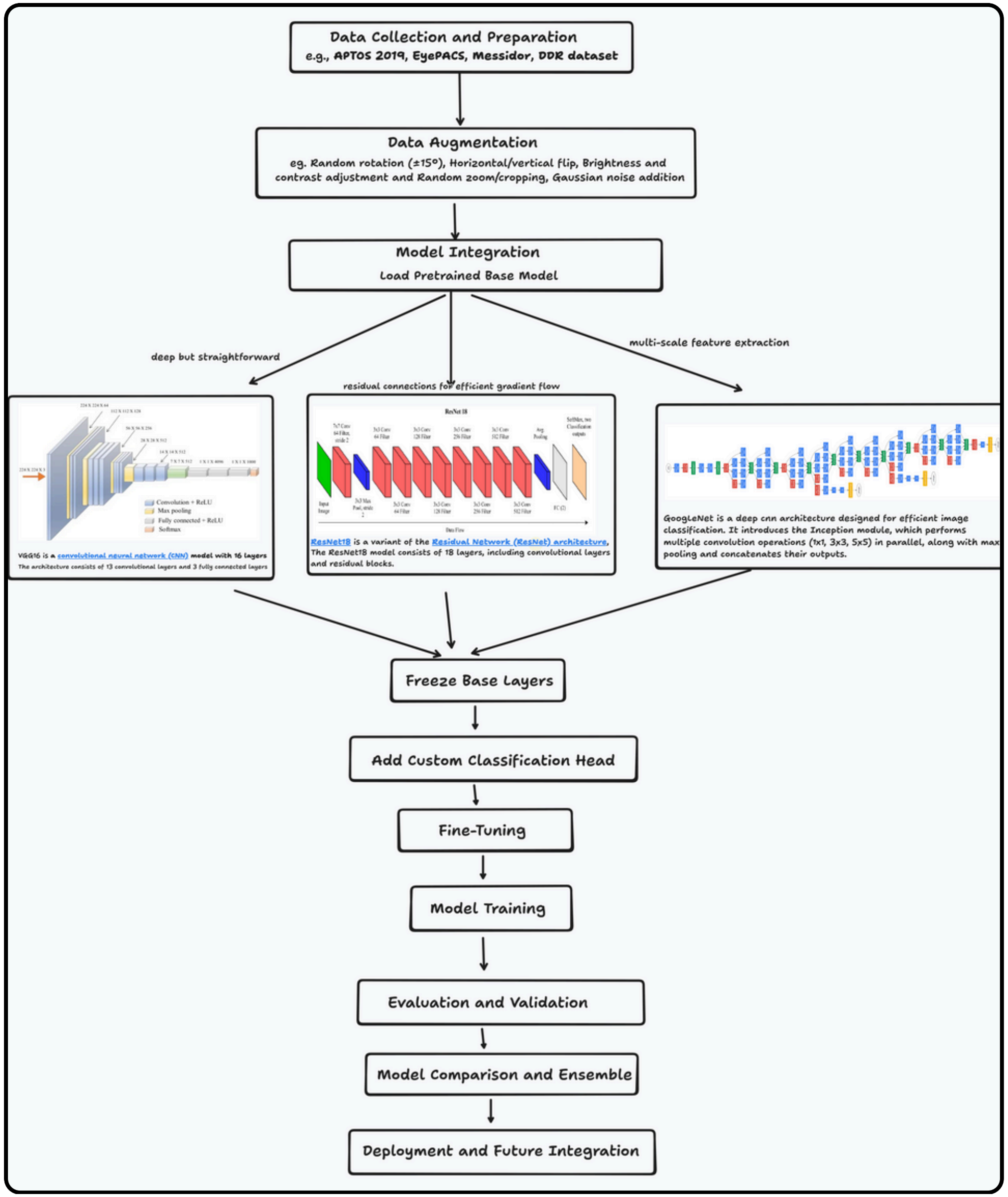
- Diabetic Retinopathy (DR) is a major cause of vision loss among diabetic patients.
- Manual diagnosis from retinal fundus images is **time-consuming, subjective, and error-prone, especially in large-scale screenings.**
- Early detection is difficult due to subtle visual symptoms in initial stages, leading to delayed treatment and potential blindness.

Objectives:

- Develop an automated DR detection system using transfer learning on retinal fundus images.
- Fine-tune CNN models (VGG16, ResNet-18, GoogleNet) for accurate early-stage detection.
- Improve accuracy, sensitivity, and specificity through data preprocessing, augmentation, and regularization.
- Enable scalable, low-cost deployment in real-world clinical and remote healthcare environments.

Proposed Methodology

- **Data Collection**: Retinal fundus images from public datasets (EyePACS, Messidor) covering both healthy and DR-affected cases.
- **Preprocessing**: Images are resized, normalized, and enhanced for clarity and consistency.
- **Data Augmentation**: Rotation, flipping, add noise etc expands the dataset and address class imbalance.
- **Transfer Learning**: Pre-trained CNNs (VGG16, ResNet-18, GoogleNet) are fine-tuned to extract retinal features.
- **Regularization**: Dropout, batch normalization, and early stopping prevent overfitting.
- **Hybrid Ensemble**: Deep features from multiple models are fused and classified.
- **Evaluation**: Performance is assessed via Accuracy, Sensitivity, Specificity, Precision, and AUC for reliable early DR detection.



Work Plan

PHASE	TASK	DURATION
Phase 1	**1. Data Collection:** Collect retinal fundus images from Kaggle's APTOS/EyePACS dataset. Include multiple classes representing all stages of Diabetic Retinopathy (No DR → Proliferative DR).	Week 1-2
Phase 2	**2. Data Preprocessing:** • Perform image resizing, normalization, and noise removal for uniformity. • Apply augmentation techniques (rotation, flipping) to balance the dataset and prevent overfitting.	Week 3-4
Phase 3	**3. Model Development:** • Utilize transfer learning with pre-trained models — VGG16, ResNet-18, and GoogleNet. • Fine-tune layers to adapt to DR features and add fully connected classification layers.	Week 5-6
Phase 4	**4. Training & Validation:** • Split dataset into training (80%) and testing (20%) sets. • Apply early stopping and dropout to improve generalization	Week 7-8
Phase 5	**5. Evaluation:** • Evaluate model using Accuracy, Precision, Recall, F1-score, and Confusion Matrix. • Compare results among the three CNN models to identify the best-performing one.	Week 9-10

System Requirements

Hardware Requirements:

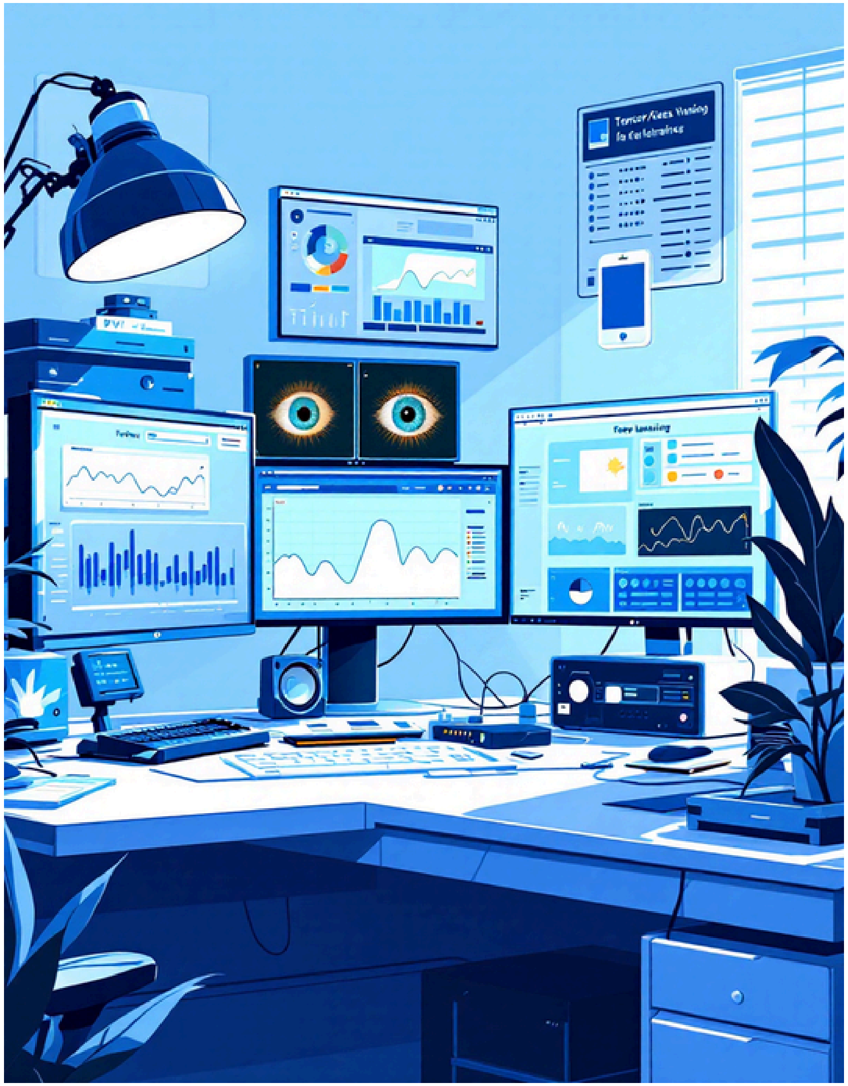
- CPU: Intel Core i5 / AMD Ryzen 5
- RAM: 8–16 GB
- Storage: 256 GB SSD (faster data loading)
- GPU (optional):
  - NVIDIA GTX 1050 Ti / GTX 1650
  - CUDA + cuDNN support required for TensorFlow/Keras GPU acceleration
- Display: 1080p monitor for visualization

Software Requirements:

- Operating System: Windows / Linux / macOS
- Programming Language: Python 3.8+
- Libraries: TensorFlow / Keras, NumPy, OpenCV, Pandas, Matplotlib, Scikit-learn
- IDE/Tools: Jupyter Notebook / VS Code
- Dataset Source: Kaggle (APTOS / EyePACS)

Optional Tools:

- Google Colab for GPU-based training
- Flask / Streamlit for model deployment



SDG Mapping

SDG 3: Good Health and wellbeing (Category: HealthCare)

- Supports target 3.4: Reduce premature mortality from non-communicable diseases through prevention and treatment.
- Promotes early diagnosis of diabetic retinopathy to prevent blindness and improve quality of life.
- Encourages affordable AI-based healthcare solutions for underserved and remote areas.

Contribution:

- Enhances accessibility of eye disease screening.
- Reduces burden on ophthalmologists through automation.
- Helps achieve universal health coverage with smart diagnostic tools.

References

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- Pratt, H., et al. (2016). Convolutional Neural Networks for Diabetic Retinopathy Detection. Procedia Computer Science.
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- Simonyan, K. & Zisserman, A. (2014). Very Deep Convolutional Networks for Large-Scale Image Recognition (VGGNet).
- He, K., et al. (2016). Deep Residual Learning for Image Recognition (ResNet).
- Szegedy, C., et al. (2015). Going Deeper with Convolutions (GoogleNet).

THANK YOU

Extra’s

Detecting diabetic retinopathy (DR) from fundus images.

deep neural network from scratch

why we didnt train a deep neural network from scratch?

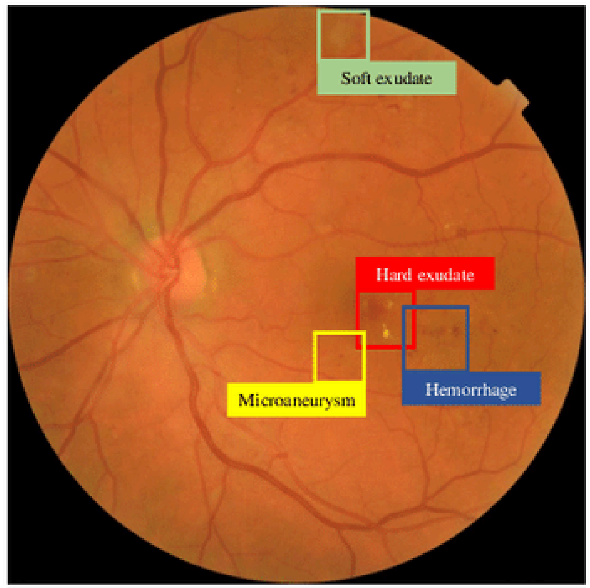
It requires millions of images and a lot of computation

pretrained CNN

already knows how to detect general image features (edges, textures, colors, shapes).

You then **adapt (fine-tune)** those learned features to your specific medical domain.

Normal



Diabetic retinopathy

- **Microaneurysms (tiny red dots)**
- **Hemorrhages (bleeding spots)**
- **Hard or soft exudates (yellowish fatty deposits)**
- **Neovascularization (growth of abnormal new blood vessels)**
- **Macular edema (swelling around the macula)**