**Diabeto-Vision**



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**Final Approval**

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**Declaration**

We hereby declare that this document “**Diabteo-Vision**” neither as a whole nor as a part has been copied out from any source. It is further declared that we have done this project with the accompanied report entirely on the basis of our personal efforts, under the proficient guidance of our teachers, especially our supervisor **Prof. Tajamul Shahzad**. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from anywhere else, we shall stand by the consequences.

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**Dedication**

Our project is dedicated to our parents, seniors, friends, and our supervisor "Prof Tajamul Shahzad" who has been our continual source of inspiration and whose support has helped this project succeed. This project would not have been possible without their trust and support.

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# Abstract

Diabetic Retinopathy is a serious complication of diabetes that affects the eyes, potentially leading to vision loss if left untreated. Early detection and accurate grading are crucial for timely treatment and better outcomes.

**Diabeto Vision** is a web application developed to offer assistance in scanning and determining the degree of severity of diabetic retinopathy using the latest machine learning algorithms. The system retrieves the fundus images of the eye and analyses them to see if the patient suffers from the problem and if yes, the level of severity is established. This easy to use platform seeks to give both patients and health care providers a fast and accurate method of detecting and coordinating the treatment of Diabetic retinopathy

**Chapter 1:**

**INTRODUCTION**

According to the WHO, the number of visually impaired people worldwide is estimated to be 2.2 billion, of whom at least 1 billion have vision impairment could have been prevented or are yet to be addressed. The world faces considerable challenges in terms of eye care, including inequalities in the coverage and quality of prevention, treatment, and forestall of rehabilitation services. Early detection and diagnosis of ocular pathologies would enable forestall visual impairment. The traditional diagnosis systems are slow, time-consuming, expensive and require a certain level of expertise to use, whereas the proposed system will provide an easy-to-use, reliable, fast, and cheap alternative for the users. It will be a web-based project which will integrate image-processing techniques. Medical professionals can also benefit from the system, as it will enable them to verify the results from conventional systems. The users are required to input fundus and retinal photographs of their eyes, and the system will preprocess them, extract features, and make a diagnosis based on the available datasets.

* 1. Goals and Objectives:

The primary goal of **Diabeto-Vision** is to screening and also grading the diabetes. Some goals and objectives are given below.

* + 1. **Goals:**
* Design a user-friendly React.js-based frontend.
* Implement secure login and registration systems.
* Allow users to upload fundus images for analysis.
* Integrate trained ML models for detection and severity grading.
  + 1. **Objectives:**
* Develop a web-based platform, Diabeto Vision, for detecting and grading diabetic retinopathy.
* Utilize machine learning models to analyze fundus images for accurate diagnosis.
  1. **Scope of the Object:**

**Healthcare Support:**

* Helps doctors and patients detect diabetic retinopathy early and understand its severity.

**Web-Based Access:**

* Users can access the platform from anywhere to upload fundus images and get results.

**Machine Learning Powered:**

* Uses trained ML models to provide accurate and reliable diagnoses.

**User-Friendly Design:**

* Simple and intuitive interface, making it easy for anyone to use.

**Data Security:**

* Ensures that all user data and images are kept private and secure.

**Scalable and Future-Ready:**

* Designed to handle more users and datasets as it grows.

**Educational Purpose:**

* Useful for medical research, training, and learning about diabetic retinopathy.

**Chapter 2:**

# LITERATURE REVIEW

**2.1 Introduction**

Diabetic Retinopathy (DR) is one of the leading causes of vision impairment globally, with an increasing prevalence due to the rise in diabetes cases. The detection of DR in its early stages is crucial to prevent vision loss. This report explores various CNN architectures and methodologies to automate DR detection using retinal images, enhancing accuracy, efficiency, and scalability.

**2.2 Background**

Traditional DR diagnosis involves manual examination of retinal fundus images by ophthalmologists. However, this process is time-consuming, prone to human error, and dependent on specialized skills. The advent of Convolutional Neural Networks (CNNs) has revolutionized image recognition tasks, offering a promising solution for automating DR detection. CNNs can identify complex patterns in retinal images, enabling early detection and classification of DR stages with higher precision and speed.

**2.3 Detailed Literature review**

**2.3.1 Introduction**

Contributions of various studies aimed at improving DR detection through advanced deep learning methods. It focuses on different CNN architectures, preprocessing techniques, datasets, and their performance metrics.

1. **Study 1:** Refined ResNet18 Architecture

* **Objective:** To improve DR detection accuracy using a refined ResNet18 with Swish activation.
* **Key Features:**

Swish activation improves gradient flow.

Data augmentation addresses dataset imbalances.

* **Results:** Achieved 93.51% accuracy on APTOS Kaggle Database, surpassing other models.

1. **Study 2:** Supervised Contrastive Learning (SCL)

* **Objective:** To overcome limitations of cross-entropy loss in traditional models.
* **Key Features:**

Preprocessing with CLAHE enhances image quality.

Xception CNN used as the encoder.

* **Results:** 98.36% accuracy and 98.50% AUC for binary classification.

1. **Study 3:** Very Deep ConvNet Architectures

* **Objective:** To investigate the impact of network depth on large-scale image recognition tasks.
* **Key Features:**

Utilized 16–19 layers with small 3×3 filters.

Efficient parameter usage improved accuracy.

* **Results:** State-of-the-art performance in ImageNet and other datasets.

1. **Study 4:** Parallel CNN and Extreme Learning Machine (ELM)

* **Objective:** To provide a robust and computationally efficient framework for DR detection.
* **Key Features:**

CLAHE preprocessing.

Parallel CNN for feature extraction.

ELM for classification.

* **Results:** 91.78% accuracy on Kaggle DR dataset, 97.27% on APTOS dataset.

1. **Study 5:** Multifractal Geometry and SVM

* **Objective:** Early detection of DR using OCTA images.
* **Key Features:**

Multiracial geometry for analyzing retinal blood vessels.

SVM achieved 98.5% detection accuracy.

1. **Study 6:** VGG-NIN Architecture

* **Objective:** To create an efficient model with fewer parameters for DR classification.
* **Key Features:**

Combines VGG16, SPP, and NiN for flexibility and accuracy.

* **Results:** High performance with fewer computational resources on Kaggle EyePACS dataset.

**2.3.2 Conclusion**

The reviewed studies demonstrate significant advancements in DR detection using CNN-based approaches. Each method highlights unique strengths, such as improved accuracy, computational efficiency, and scalability. However, challenges like imbalanced datasets, overfitting, and the need for real-time application remain.

**2.4 Literature Review Summary Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Study** | **Techniques used** | **Key Features** | **Datasets** | **Accuracy** |
| Refined ResNet18 | Swish activation, data augmentation | Gradient flow improvement | APTOS, Messidor, EyePACS, IDRID | 93.51% |
| SCL with Xception | CLAHE preprocessing, SCL training | Enhanced image quality, high AUC | APTOS, Messidor-2 | 98.36% |
| Parallel CNN + ELM | CLAHE preprocessing, Parallel CNN, ELM | Faster predictions | Kaggle DR 2015, APTOS | 91.78%-97.27% |
| Multifractal + SVM | Multifractal geometry, lacunarity, SVM | Early DR detection | OCTA Dataset | 98.50% |

**2.5 Research Gap**

Despite the advancements, several gaps persist in DR detection research:

* Difficulty in handling highly imbalanced datasets.
* Limited real-time applications due to high computational costs.
* Challenges in generalizing models across diverse datasets.
* Lack of robust systems for early detection in resource-constrained settings.

**2.6 Problem Statement**

Manual diagnosis of diabetic retinopathy is inefficient, error-prone, and lacks scalability. Automated CNN-based systems address these challenges but face issues such as imbalanced datasets, computational limitations, and generalizability. This project aims to develop an efficient, accurate, and scalable CNN-based solution for DR detection, bridging these gaps and improving accessibility in diverse healthcare environments.

# Chapter 3:

# REQUIREMENTS AND DESIGN

**3.1 REQUIREMENTS**

**3.1.1 Functional Requirements**

|  |  |
| --- | --- |
| ID | Requirements |
| FR - 1.1 | Admin shall be able to log in to the system. |
| FR - 1.2 | The system shall perform real-time diabetic retinopathy detection on uploaded images. |
| FR – 1.3 | Admin shall be able to check real time detection of students in the portal. |
| FR – 1.4 | Admin shall be able to view detailed detection results, including DR stage classification. |
| FR – 1.5 | The system shall store patient information and diagnostic results securely in the database. |
| FR - 1.6 | The system shall generate visual overlays (bounding boxes) to highlight areas of concern on images. |
| FR – 1.7 | Admin shall be able to download detection reports in a structured format (e.g., PDF). |

**3.1.1 Non Functional Requirements:**

* The deep learning model shall utilize datasets like Aptos and IDRiD to achieve high accuracy in DR detection.
* The system shall maintain a response time under 2 seconds for image analysis.
* MongoDB shall be used to ensure efficient and secure storage of patient and image data.
* The web interface shall be intuitive and user-friendly, enabling easy upload and result retrieval.
* Only authorized users (admins) shall have access to the system.

**3.1.3 Hardware and Software Requiremnets:**

Training our model required high end systems for smooth processing.

* + - 1. **Hardware Requirements:**
* **GPU:** The group will be leveraging the **Nvidia GeForce RTX 3050** GPU for fast training of deep learning model for detection of student’s behavior’s
  + - * **Web Cam:** Web cam will be used in this project for real time detection of student's behaviors in the physical setting.
      * **Camera:** Camera technology will be used especially **DSLR** for creating and generating the custom dataset of images which contain student’s performing cheating and not cheating behaviors.
      1. **Software requirements:**

The complete system will be built by using the following tech stack:

* + - * **Programming Language**: Python (for model development and backend APIs).
      * **Frameworks**: TensorFlow/Keras for deep learning model development.
      * **Libraries**: OpenCV for image processing; Scikit-learn for evaluation metrics.
* **Web Technologies**:HTML, CSS, and JavaScript for frontend development,Flask/Django for backend integration.
* **Database**: MongoDB for storing patient data and results.
* **Development Environment**: Google Colab and Jupyter Notebooks for model training and experimentation.

**3.2 PROPOSED METHODOLOGY:**

The Diabetic Retinopathy Detection System is a machine learning-based solution that uses a trained deep learning model to identify the presence and stage of diabetic retinopathy from retinal images. The system is accessible via a web application, making it user-friendly and scalable.

**3.2.1 Dataset:**

* **Datasets Used**: Aptos and IDRiD datasets containing labeled retinal images with DR stages.
* **Dataset Preprocessing**: Images are resized, normalized, and augmented to enhance model robustness.

**3.2.2 Model Development:**

* A CNN-based architecture (e.g., EfficientNet or ResNet) is employed for classification and segmentation tasks.
* Transfer learning techniques are applied to fine-tune a pretrained model.
* Hyperparameters like learning rate, batch size, and optimizer are optimized for better performance.

**3.2.3 Web Integration:**

* The trained model is integrated into a Flask/Django backend.
* The web app provides an interface for image upload and displays detection results visually with bounding boxes and confidence scores.

**3.2.4 Database Management:**

* MongoDB stores patient data, uploaded images, and results securely.
* Each record includes metadata like user ID, and diagnosis results.
  1. **System Architecture:**
  2. **Use Cases:**
     1. **Login**

|  |  |
| --- | --- |
| **Name** | **Login** |
| **Actors** | Admin |
| **Summary** | Admin logs into the system using valid credentials to access the dashboard |
| **Pre-Conditions** | The admin credentials must be saved in the database |
| **Post-Conditions** | The admin is redirected to the dashboard after successful login. |
| **Basic flow** |  |
| 1. Admin opens the login page | 1. The system displays a form for email and password |
| 1. Admin enters valid credentials | 1. The system verifies and redirects to the the dashboard. |
| **Alternative flow** |  |
| 3A. Admin enters invalid credentials. | 4A. The system displays an error message: "Invalid email or password." |

* + 1. **Upload retinal image for detection:**

|  |  |
| --- | --- |
| **Name** | **Upload Retinal Image** |
| **Actors** | Admin |
| **Summary** | Admin uploads a retinal image to perform DR detection. |
| **Pre-Conditions** | Admin must be logged in. |
| **Post-Conditions** | The uploaded image is analyzed, and results are displayed. |
| **Basic Flow** |  |
| 1. Admin navigates to the upload page. | 2. The system displays an upload form. |
| 3. Admin selects and uploads an image. | 4. The system processes the image and displays results on the dashboard. |
| **Alternative Flow** |  |
| 3A. Admin uploads an unsupported file. | 4A. The system displays an error message: "Invalid file format." |

* 1. **Database design**
  2. **Class diagram**