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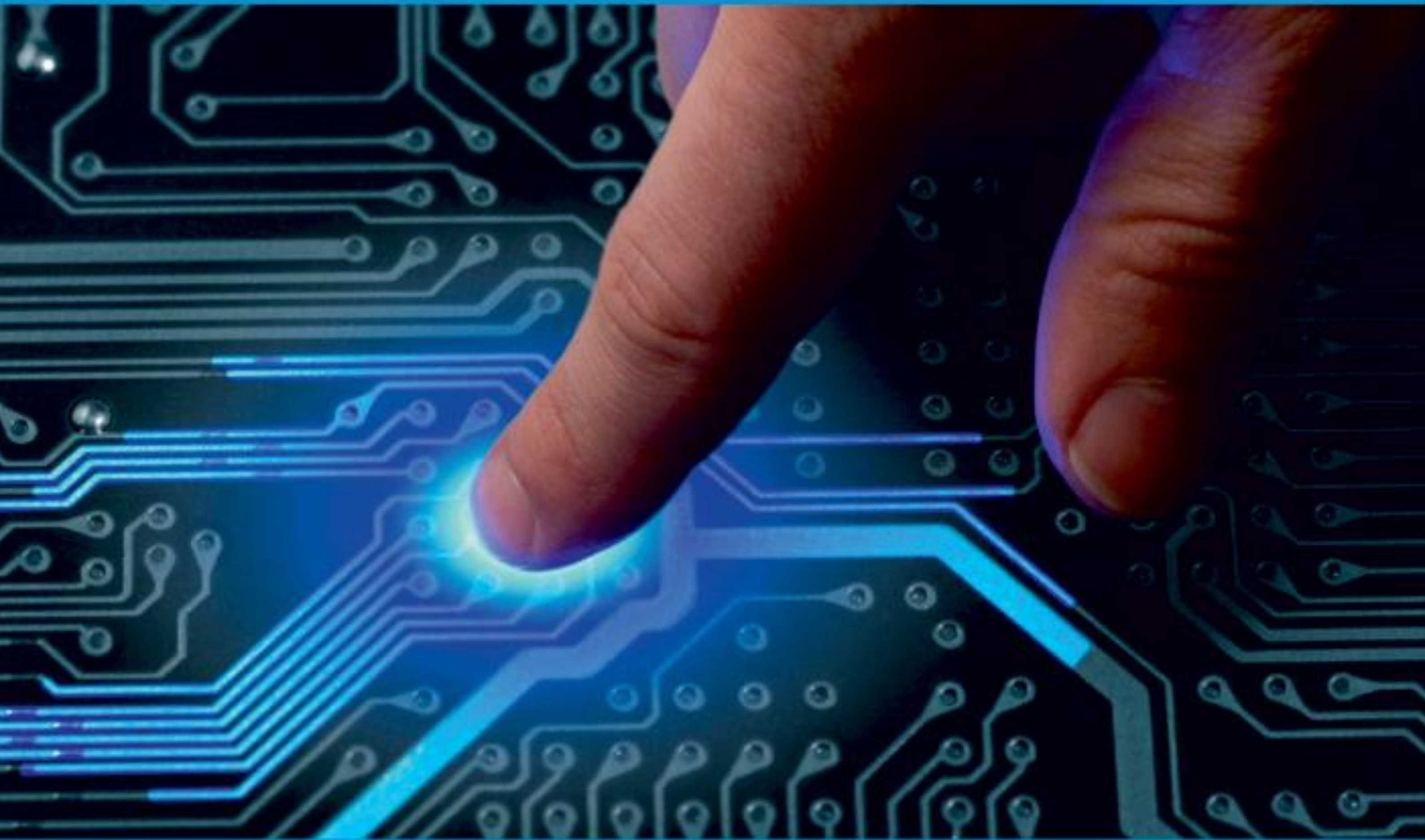

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Diabetic Retinopathy Detection using Inception V3 and OpenCV

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ABSTRACT: Diabetic retinopathy (DR) is a severe complication of diabetes that affects the eyes, leading to vision impairment and blindness if left untreated. Early detection and timely intervention are crucial in managing this condition effectively. This research paper focuses on the development of an automated system for diabetic retinopathy detection using machine learning techniques.

The proposed system utilizes retinal images obtained through fundus photography as input data. Preprocessing techniques such as image enhancement and noise reduction are applied to improve the quality of the images.Machine learning algorithms, such as support vector machines (SVM), random forests, and convolutional neural networks (CNN), are then trained on a large dataset of labeled retinal images. These algorithms learn to classify the retinal images into different stages of diabetic retinopathy, ranging from mild to severe. The findings of this research contribute to the field of diabetic retinopathy detection by providing an automated and accurate system that can assist healthcare providers in early diagnosis and intervention. Ultimately, the proposed system has the potential to enhance the management and treatment outcomes of diabetic retinopathy, reducing the risk of vision loss among individuals with diabetes.

KEYWORDS: Convolutional Neural Networks (CNN), Inception V3, Support vector machine(SVM). These algorithms learn to classify the retinal images into different stages of diabetic retinopathy, ranging from mild to severe.

I. INTRODUCTION

Diabetic retinopathy (DR) is a common and severe ocular complication of diabetes mellitus, affecting a significant proportion of individuals worldwide. It is characterized by damage to the blood vessels of the retina, leading to vision impairment and, if left untreated, blindness. According to the International Diabetes Federation, approximately one-third of people with diabetes have some form of diabetic retinopathy, making it a major public health concern. Early detection and timely intervention are critical in managing diabetic retinopathy effectively. Regular screening and diagnosis of this condition can facilitate early treatment, reducing the risk of vision loss and improving long-term outcomes. However, manual screening and interpretation of retinal images by ophthalmologists are time-consuming, expensive, and often subject to human error and inter-observer variability. In recent years, the advancement of machine learning techniques, particularly in the field of computer vision, has shown great promise in automating the detection and diagnosis of various medical conditions. Machine learning algorithms can effectively analyze large amounts of data, extract meaningful features, and make accurate predictions based on patterns and trends. Therefore, the application of machine learning in diabetic retinopathy detection holds immense potential to improve screening efficiency, accuracy, and accessibility.

The primary objective of this research project is to develop an automated system for diabetic retinopathy detection using machine learning algorithms. The proposed system aims to analyze retinal images obtained through fundus photography and accurately classify them into different stages of diabetic retinopathy, ranging from mild non-proliferative retinopathy to severe proliferative retinopathy. By automating the detection process, this system can assist healthcare providers in early identification and intervention, enabling timely treatment and management of the condition.

The research project will involve several key steps. Firstly, a comprehensive dataset of retinal images will be collected, consisting of images from patients with varying stages of diabetic retinopathy as well as images from individuals

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without the condition. These images will be preprocessed to enhance their quality and remove noise, ensuring optimal input for the subsequent analysis. Next, feature extraction techniques will be employed to extract relevant features from the retinal images. These features may include blood vessel abnormalities, microaneurysms, exudates, hemorrhages, and other characteristic signs of diabetic retinopathy. The extracted features will serve as inputs to the machine learning algorithms. Various machine learning algorithms will be evaluated and compared for their effectiveness in diabetic retinopathy detection. Algorithms such as support vector machines, random forests, and convolutional neural networks will be trained on the labeled retinal image dataset, learning to differentiate between different stages of the disease. The performance of these algorithms will be evaluated using standard metrics such as accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC).

Additionally, the research project will explore the potential integration of the developed system with telemedicine platforms. This integration will enable remote diagnosis and monitoring of diabetic retinopathy, facilitating access to healthcare services for individuals in underserved areas and reducing the burden on healthcare professionals. The outcomes of this research project have the potential to significantly impact diabetic retinopathy management. The development of an automated system for detection and classification can enhance the efficiency and accuracy of screening programs, enabling early intervention and improving treatment outcomes. By leveraging machine learning techniques, this research aims to contribute to the field of diabetic retinopathy detection and provide a valuable tool for healthcare professionals in combating this vision-threatening condition.

II. RELATED WORK

Several studies have been conducted in the field of diabetic retinopathy detection using machine learning techniques. These studies have focused on developing automated systems that can accurately classify retinal images and assist healthcare professionals in early diagnosis and intervention. The following section provides an overview of some notable research works in this area.

One notable study by Abramoff et al. (2016) presented an automated system for diabetic retinopathy detection based on deep learning. The researchers trained a deep convolutional neural network (CNN) on a large dataset of retinal images, achieving high accuracy in detecting diabetic retinopathy and distinguishing between different disease stages. The study demonstrated the potential of deep learning algorithms in improving the efficiency and accuracy of diabetic retinopathy screening.

In a similar vein, Gulshan et al. (2016) developed a deep learning algorithm for the detection of diabetic retinopathy using a large dataset of retinal images. Their algorithm achieved high sensitivity and specificity, outperforming human experts in the diagnosis of the disease. The study highlighted the potential of deep learning models in providing reliable and efficient screening for diabetic retinopathy.

Another relevant study by Raju et al. (2019) explored the use of machine learning techniques for diabetic retinopathy detection in teleophthalmology settings. The researchers developed an automated system that could classify retinal images into different stages of diabetic retinopathy using a combination of feature extraction and machine learning algorithms. The system demonstrated promising results in remote diagnosis and monitoring of the disease, enhancing accessibility to healthcare services in underserved areas.

In addition to deep learning approaches, traditional machine learning algorithms have also been employed for diabetic retinopathy detection. Li et al. (2017) utilized a support vector machine (SVM) classifier to distinguish between normal retinal images and those with different stages of diabetic retinopathy. Their study achieved high accuracy and highlighted the potential of SVM-based approaches in the detection of the disease.

Furthermore, feature extraction techniques have played a crucial role in diabetic retinopathy detection. Akram et al. (2018) proposed a method that combined wavelet-based features with machine learning algorithms to classify retinal images into different stages of diabetic retinopathy. Their approach demonstrated promising results in accurately detecting and classifying the disease, providing an alternative solution to deep learning-based methods.

While these studies have made significant contributions to the field, there are still challenges and opportunities for further research. Improving the interpretability and explainability of machine learning models, addressing issues related

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to imbalanced datasets, and exploring the integration of multimodal data sources are some of the areas that require attention in future studies.

In summary, previous research works have showcased the potential of machine learning techniques, particularly deep learning models, in the automated detection and classification of diabetic retinopathy. These studies have demonstrated high accuracy, sensitivity, and specificity, paving the way for more efficient and accessible screening programs. However, there is still a need for further investigations and advancements to develop robust and reliable systems that can be seamlessly integrated into clinical practice.

III. DATASET

In the context of diabetic retinopathy detection, the severity of the condition is commonly classified into several classes. Here are the classes typically used for diabetic retinopathy detection in research projects:

1. Class 0: No diabetic retinopathy
   Description: This class indicates that no signs of diabetic retinopathy are present in the retinal images. It represents a healthy condition of the retina.
2. Class 1: Mild non-proliferative diabetic retinopathy (NPDR)
   Description: This class denotes the early stage of diabetic retinopathy, characterized by the presence of microaneurysms, small retinal hemorrhages, and mild abnormalities in the blood vessels.
3. Class 2: Moderate non-proliferative diabetic retinopathy (NPDR)
   Description: This class represents the progression of diabetic retinopathy, where there is a greater number of microaneurysms, retinal hemorrhages, and more pronounced abnormalities in the blood vessels compared to Class 1.
4. Class 3: Severe non-proliferative diabetic retinopathy (NPDR)
   Description: This class signifies the advanced stage of non-proliferative diabetic retinopathy, characterized by widespread abnormalities in the retinal blood vessels, including beading, venous dilation, and intraretinal microvascular abnormalities (IRMAs).
5. Class 4: Proliferative diabetic retinopathy (PDR)
   Description: This class represents the most severe stage of diabetic retinopathy, where the retina experiences extensive ischemia. It is characterized by the growth of abnormal new blood vessels (neovascularization) on the surface of the retina and optic disc.

It is important to note that the specific classification scheme may vary slightly across different datasets or studies, but the above classes provide a general framework for grading the severity of diabetic retinopathy.

Classes	Number of images
No DR	572
Mild DR	572
Moderate DR	594
Severe DR	286
Proliferative DR	198
Total	2222

Figure 1: Table of classes and number of images in each class

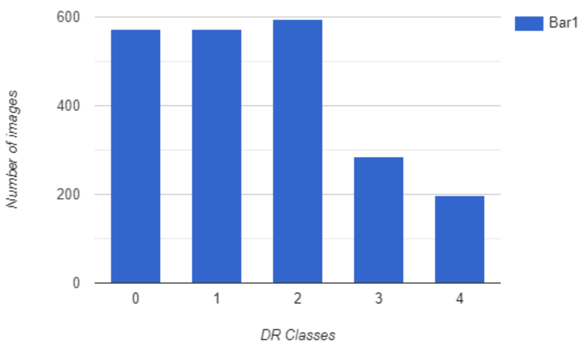

Figure 2: Graph of DR classes vs Number of images

IV. RETRIEVING THE IMAGES

Retinal images used in diabetic retinopathy detection projects are captured using imaging techniques like fundus photography and optical coherence tomography (OCT). These images provide a detailed view of the retina, allowing for the identification of specific features and abnormalities associated with diabetic retinopathy. Fundus photography involves capturing images of the back of the eye, including the retina, blood vessels, optic disc, and macula. This technique provides a wide-field view of the retina, enabling the identification of lesions, hemorrhages, exudates, and other characteristic signs of diabetic retinopathy. The images obtained through fundus photography are typically high-

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resolution and provide valuable information for both manual and automated analysis. Optical coherence tomography (OCT) is another imaging technique used in diabetic retinopathy detection. OCT produces cross-sectional images of the retina, providing detailed structural information. This technique allows for the assessment of retinal thickness, identification of fluid accumulation, and visualization of the layers within the retina. OCT images offer additional insights into the structural changes occurring in diabetic retinopathy and can complement the analysis based on fundus photographs. The retinal images used in diabetic retinopathy detection projects often come with associated ground truth labels provided by ophthalmologists.

V. SPLITTING THE DATASET

The dataset splitting process involves dividing the available diabetic retinopathy dataset into three main subsets: the training set, the validation set, and the test set. Each subset serves a specific purpose in the model development and evaluation pipeline.
1. Training Set: Around 60-80% of the dataset is allocated for training purposes.
2. Validation Set: Around 10-20% of the dataset is allocated for validation purposes.
3. Test Set: Around 10-20% of the dataset is allocated for testing.

VI. METHODOLOGY

INCEPTION V3 ARCHITECTURE:

Inception-v3 is a popular convolutional neural network (CNN) architecture that has been widely used in various computer vision tasks, including diabetic retinopathy detection.
1. Convolutional Layers: Inception-v3 consists of multiple convolutional layers that capture different levels of image features. These layers use small filters of different sizes (1x1, 3x3, 5x5) to extract spatial information from the input images.
2. Inception Modules: The core innovation of the Inception-v3 architecture lies in its Inception modules. These modules allow for the efficient combination of filters of different sizes and dimensions within a single layer. This helps in capturing both local and global information from the input images.
3. Factorization: Inception-v3 utilizes factorization to reduce computational complexity. Instead of applying large convolutional filters directly, it factorizes them into multiple smaller filters. This reduces the number of parameters and computational cost while maintaining expressive power.
4. Pooling Layers: Throughout the network, pooling layers are used to downsample the spatial dimensions of the feature maps. This helps in reducing the computational burden and makes the model more robust to image transformations.
5. Auxiliary Classifiers: Inception-v3 includes auxiliary classifiers at intermediate stages of the network. These classifiers are inserted to combat the vanishing gradient problem during training. They provide additional supervision signals and gradients to the lower layers of the network.
6. Fully Connected Layers: Towards the end of the network, fully connected layers are employed to map the extracted features to the desired output classes. These layers capture high-level semantic information and make the final predictions.
7. Regularization Techniques: Inception-v3 incorporates various regularization techniques, such as dropout and weight decay, to prevent overfitting and improve generalization performance.
By leveraging these design principles and components, Inception-v3 has shown strong performance in a variety of image recognition tasks, including diabetic retinopathy detection.

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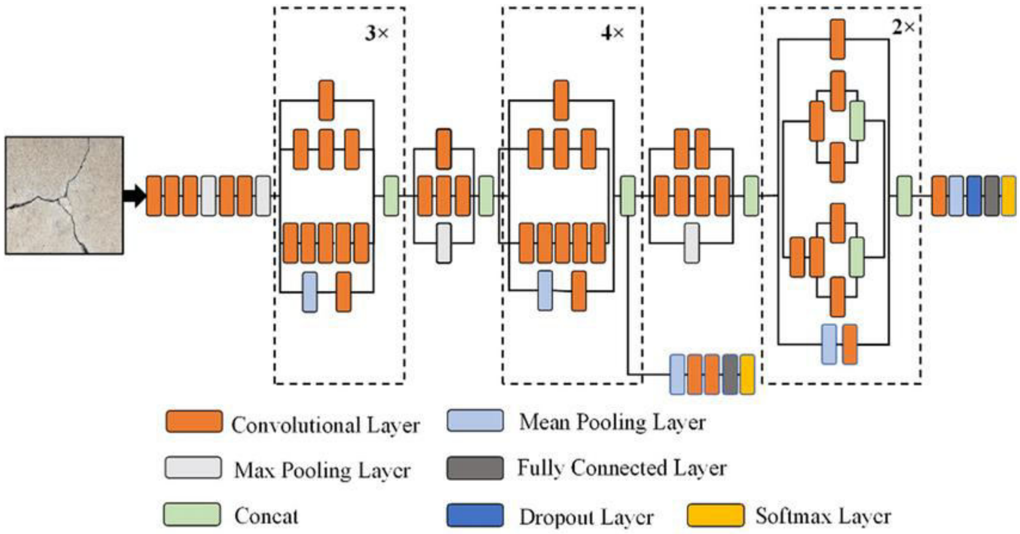

Figure 3: Inception V3 main architecture

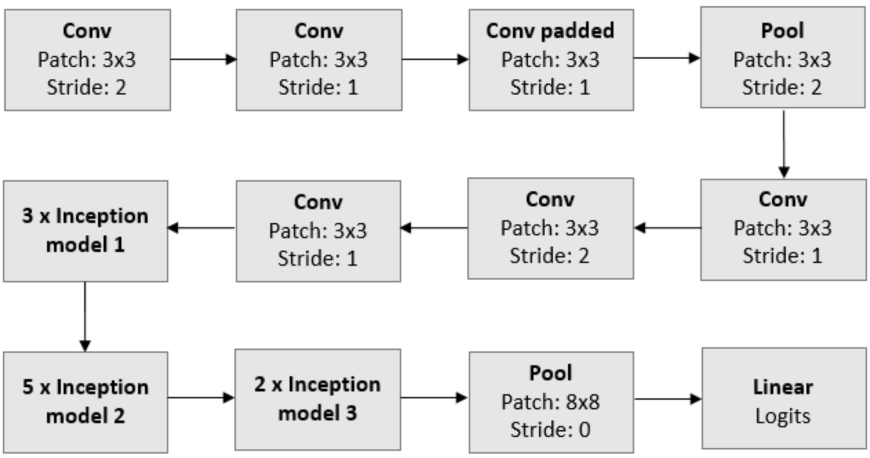

Figure 4: Inception V3 basic architecture

VI. SYSTEM ARCHITECTURE

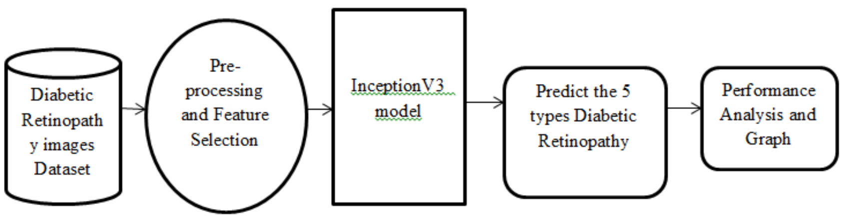

Figure 5: System Architecture of Diabetic Retinopathy Detection using Inception V3

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Data Flow Diagram:

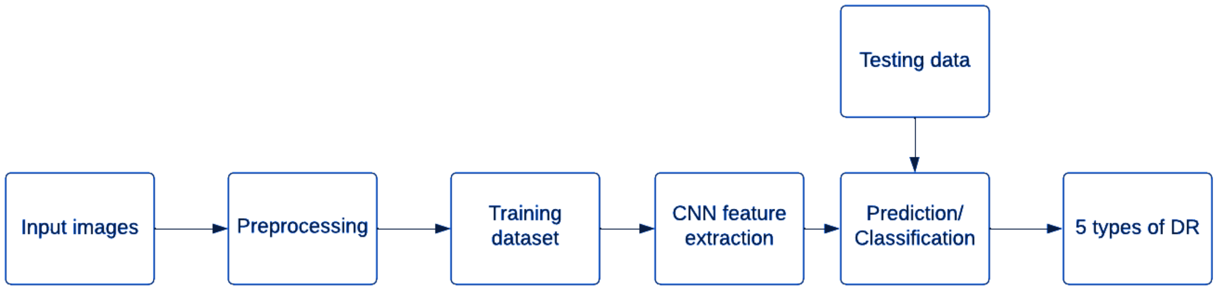

Figure 6: Data Flow Diagram for Diabetic Retinopathy Detection system

The Level 0 DFD provides an overview of the major processes and data flows in the diabetic retinopathy project. It illustrates the main components and interactions within the system.
The Level 1 DFD breaks down the "Screen for Diabetic Retinopathy" process into more detailed subprocesses.
The Level 2 DFD further expands on the "Analyze Retinal Images" subprocess to provide more detail about the steps involved.

Class Diagram:

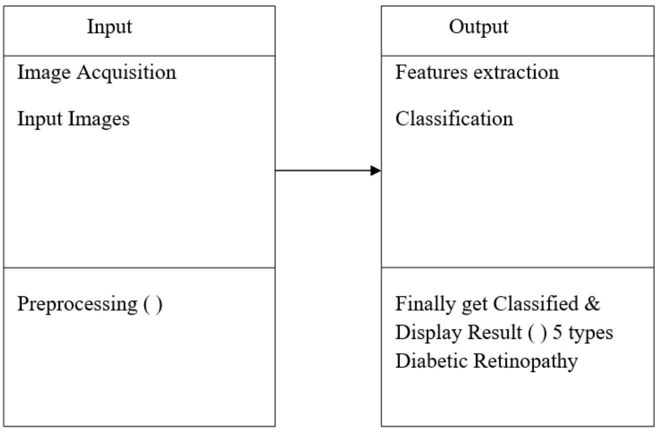

Figure 7: Class diagram of Diabetic Retinopathy System

A type of diagram used in software engineering to show the structure of a system is known as a class diagram. It is a static structure diagram in the Unified Modelling Language (UML) that displays the system's classes, operations, attributes and their relationships. It clarifies the class that holds the information.

Use Case Diagram:

A use case diagram is a visual representation that depicts the interactions between various actors (users) and a system. In the context of a diabetic retinopathy project, the use case diagram outlines the primary functionalities and interactions of the system involved in diagnosing and managing the condition.

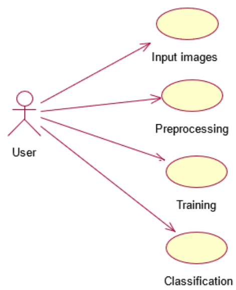

Figure 8: Use Case Diagram

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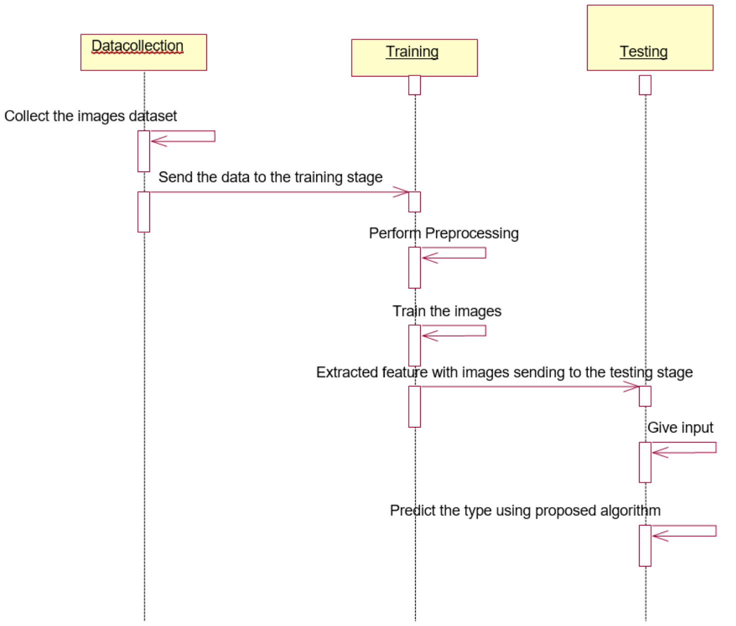
Sequence and Activity Diagram:



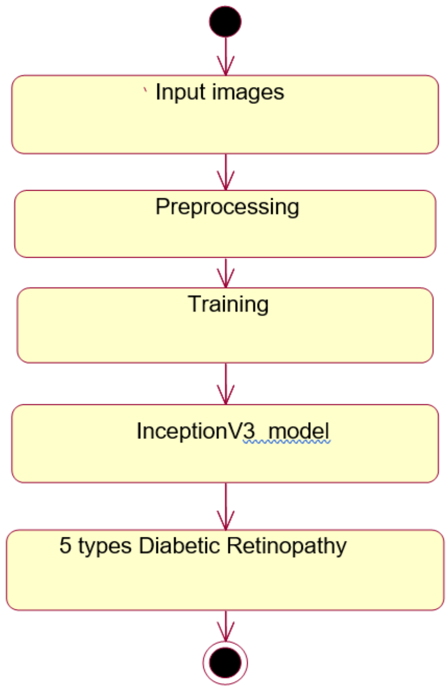
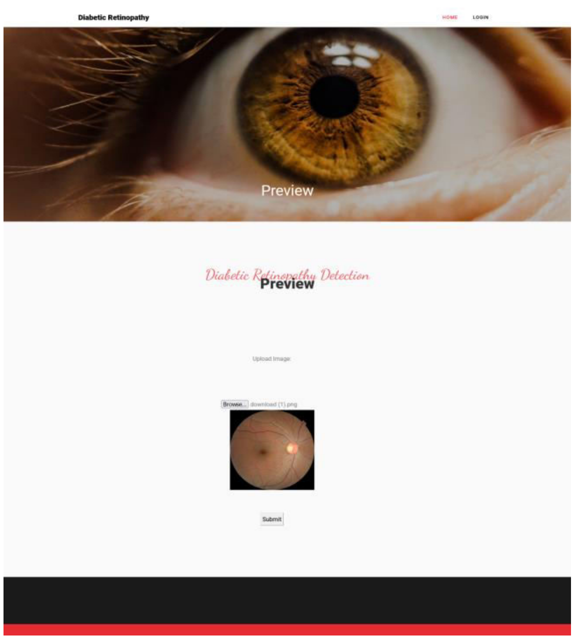


Figure 9: Sequence Diagram for the whole process

Figure 10: Activity Diagram of DR system

VII. RESULTS AND SCREENSHOTS

After assembling the model and implementing it with the fit function, we can generate accuracy and loss graphs and obtain a mean training accuracy of 97.35% and a mean validation accuracy of 95.64%. When testing, we achieve an accuracy of 97.3%.



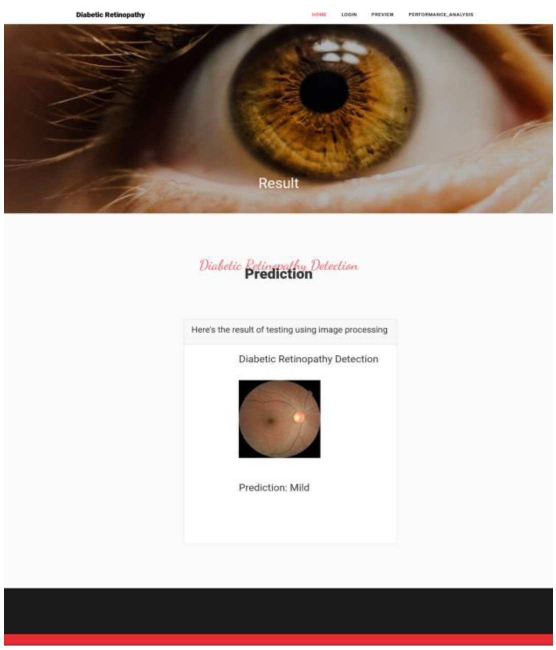


Figure 11: Screenshot of giving input image

Figure 12: Screenshot of detection of type of DR

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VI. CONCLUSION

The scarcity of clinicians for detecting DR manually could be addressed with an automated approach that can significantly decrease the amount of manual work essential for the diagnosis. Using Deep CNN, the presented model categorizes retinal images in a way that is less reliant on manual feature extraction, resulting in a comprehensive approach to detecting DR. After assessing the model using different criteria and taking into account the intricacy of the dataset, it can be concluded that the model is acceptable. The precision can be enhanced by increasing the dataset and retraining the neural network with additional retinal images. Improving the model is widely achieved through this commonly utilized practice. Patients and medical professionals can both benefit from improving the system, even if it is not yet trusted by the patients it affects. The system can help patients receive accurate diagnoses while reducing the workload for doctors.

REFERENCES

1. Z. A. Omar, M. Hanafi, S. Mashohor, N. F. M. Mahfudz and M. Muna'im, ”Automatic diabetic retinopathy detection and classification system,” 2017 7th IEEE International Conference on System Engineering and Technology (ICSET), Shah Alam, 2017, pp. 162-166.
2. A. Herliana, T. Arifin, S. Susanti and A. B. Hikmah, ”Feature Selection of Diabetic Retinopathy Disease Using Particle Swarm Optimization and Neural Network,” 2018 6th International Conference on Cyber and IT Service Management (CITSM), Parapat, Indonesia, 2018, pp. 1-4.
3. K. K. Palavalasa and B. Sambaturu, ”Automatic Diabetic Retinopathy Detection Using Digital Image Processing,” 2018 International Conference on Communication and Signal Processing (ICCSP), Chennai, 2018, pp. 0072-0076.
4. S. Kanth, A. Jaiswal and M. Kakkar, ”Identification of different stages of Diabetic Retinopathy using artificial neural network,” 2013 Sixth International Conference on Contemporary Computing (IC3), Noida, 2013, pp. 479-484.
5. A. Chandran, K. K. Nisha and S. Vineetha, ”Computer aided approach for proliferative diabetic retinopathy detection in color retinal images,” 2016 International Conference on Next Generation Intelligent Systems (ICNGIS), Kottayam, 2016, pp. 1-6.
6. Karan Bhatia, Shikhar Arora, Ravi Tomar, “Diagnosis of Diabetic Retinopathy using Machine Learning Classification Algorithm”.
7. M. Manjramkar, ”Survey of Diabetic Retinopathy Screening Methods,” 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, 2018, pp. 1-6.
8. S. Kumar and B. Kumar, ”Diabetic Retinopathy Detection by Extracting Area and Number of Microaneurysm from Colour Fundus Image,” 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN), Noida, 2018, pp. 359-364.
9. Martina Melinscak, Pavle Prentasic, and Sven Loncaric, “Retinal vessel segmentation using deep neural networks”. pages 577–582, 2015.
10. E. V. Carrera, A. Gonz´alez and R. Carrera, ”Automated detection of diabetic retinopathy using SVM,” 2017 IEEE XXIV International Conference on Electronics, Electrical Engineering and Computing (INTERCON), Cusco, 2017, pp. 1-4.
11. M. Chetoui, M. A. Akhloufi and M. Kardouchi, ”Diabetic Retinopathy Detection Using Machine Learning and Texture Features,” 2018 IEEE Canadian Conference on Electrical & Computer Engineering (CCECE), Quebec City, QC, 2018, pp. 1-4.