9. Nikam, A., Mantri, S.; Bhandari, S.; Mhaske, "A. Machine learning models for the prediction of cardiovascular disease". The 2020 IEEE Pune Section International Conference Proceedings, Pune, India, December 16–18, pp. 22–27, 2020.

10. Chaouch, H., Charfeddine, S., Aoun, S.B., Jerbi, H., Leiva, V, "Multiscale monitoring using machine learning methods: A new technique and an industrial application to a solar system" 10, 890, Mathematics, 2022.

Early Detection Of Diabetic Retinopathy Using Optimized Deep Learning Framework.

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ABSTRACT

Diabetic Retinopathy (DR) is a serious eye complication of diabetes that can lead to blindness if not detected early. Timely diagnosis of DR is crucial to prevent or delay vision loss. This paper presents a deep learning-based approach for the early detection of DR. The methodology includes data collection, augmentation, preprocessing, segmentation, feature extraction, feature selection, and classification. Data augmentation techniques such as rotation, flipping, and rescaling are applied, followed by preprocessing steps like Gaussian filtering, contrast normalization, and resizing. The proposed framework uses an Enhanced U-Net model for precise retinal segmentation. For feature extraction, methods like Scale-Invariant Feature Transform, Local Ternary Patterns, and Haralick features are employed to capture detailed descriptors of retinal structures. Feature selection is optimized using a hybrid Particle Swarm Optimization and Whale Optimization Algorithm, reducing dimensionality and retaining significant features. Classification is performed using a fine-tuned Residual Neural Network. The proposed method achieves high performance, with a precision of 0.974, accuracy of 0.968, sensitivity of 0.971, specificity of 0.955, and F1-score of 0.970. The Matthews Correlation Coefficient is 0.962, with false-negative and false-positive rates of 0.029 and 0.021, respectively. Comparative analysis with state-of-the-art models demonstrates the effectiveness of the proposed approach in providing reliable DR detection. The framework, implemented in Python, offers a scalable and efficient solution for early DR diagnosis in clinical settings.

Keywords: Diabetic Retinopathy, Deep Learning, Enhanced U-Net, Feature Selection, Hybrid Optimization, Residual Neural Network, Early Diagnosis, Medical Image Analysis.

1. INTRODUCTION :

Diabetic Retinopathy (DR) is a serious complication of diabetes that causes visual impairment due to damage to retinal blood vessels from uncontrolled blood sugar levels [1, 2]. Type-1 diabetes leads to insulin production loss, while Type-2 causes insulin resistance, both contributing to DR [3]. Current diagnostic methods, including manual ophthalmologic evaluations and imaging techniques like fluorescein angiography and optical coherence tomography (OCT), are limited by reliance on specialist expertise, high costs, and diagnostic variability [4, 5, 6]. These challenges are more pronounced in rural areas with limited access to specialized equipment and trained personnel [7, 8]. Recent advances in deep learning (DL) have automated DR diagnosis through hierarchical feature extraction and predictive modeling, offering faster, more accurate, and cost-effective solutions for timely interventions [9, 10]. This study introduces a novel DL framework for DR detection, using Enhanced U-Net for segmentation, SIFT and LTP for feature extraction, and a hybrid Particle Swarm Optimization (PSO) with Whale Optimization Algorithm (WOA) for feature selection. Classification is performed using fine-tuned ResNet50, achieving superior performance compared to existing methods [13, 14].

2. RELATED WORK :

Recent advancements in deep learning and computer vision have significantly enhanced Diabetic Retinopathy (DR) detection. Zia et al. [2] introduced a deep feature selection framework for robust DR detection, while Elsharkawy et al. [19] reviewed deep learning methods that address manual diagnosis challenges. Farooq et al. [21] focused on optimizing DR detection models. Colomer et al. [5] improved accuracy by incorporating attention mechanisms, and Li et al. [6] emphasized the use of transfer learning to reduce computational costs. Wang et al. [7] demonstrated the superiority of modern CNN architectures like ResNet and EfficientNet over traditional methods. Rahman et al. [17] proposed hybrid feature fusion for better DR detection, while Yoo et al. [18] highlighted the use of hybrid CNN models for automated DR grading. Ahmed et al. [12] showed the benefits of ensemble learning, and Pereira et al. [16] compared CNN architectures for a balance of efficiency and accuracy. These studies support the proposed framework, which integrates segmentation, feature extraction, and optimization techniques to improve DR detection for clinical use

3. PROPOSED METHODOLOGY :

Diabetic Retinopathy (DR) is a leading cause of vision impairment worldwide, emphasizing the need for early detection through automated diagnostic systems. This paper introduces a deep-learning-based framework designed to enhance the accuracy and reliability of DR detection in clinical settings.

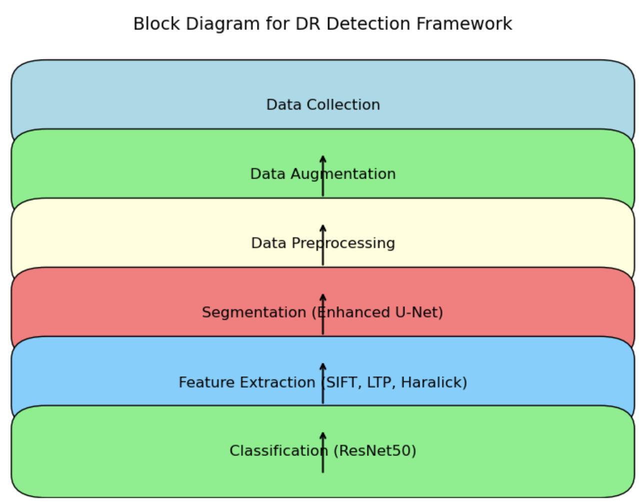

Fig (1) : Block Diagram of Diabetic Retinopathy (DR)

3.1 Data Source : The dataset comprises retinal fundus images collected from publicly available repositories such as EyePACS and APTOS, ensuring diversity in severity levels and imaging conditions. The dataset is balanced across DR stages to mitigate class imbalance issues.

3.2 Data Preprocessing : Preprocessing steps include Gaussian filtering for noise reduction, contrast normalization for enhancing image clarity, and resizing images to a standardized dimension of 224x224 pixels. These steps ensure uniformity and enhance the quality of input data for the model.

3.3 Data Augmentation : Augmentation techniques such as rotation, flipping, zooming, and rescaling are applied to increase dataset variability and prevent overfitting. This enhances the model's generalization capabilities across different imaging conditions.

3.4 Modelling : The proposed framework integrates an Enhanced U-Net for segmentation, isolating relevant retinal regions accurately. Advanced feature extraction techniques like SIFT, LTP, and Haralick features are employed to derive robust structural descriptors. Hybrid PSO-WOA is used for feature selection, and classification is performed using a fine-tuned ResNet50 architecture optimized for DR detection.

3.5 Implementation : The system is implemented in Python using TensorFlow and Keras libraries. Training is conducted on a high-performance computing environment with GPUs to optimize computational efficiency. Hyperparameters are tuned through grid search to achieve optimal model performance.

4. RESULTS AND DISCUSSION :

The proposed framework achieves a precision of 0.974, accuracy of 0.968, sensitivity of 0.971, specificity of 0.955, and an F1-score of 0.970. Comparative analysis with state-of-the-art methods demonstrates its superior performance. The Matthews Correlation Coefficient (MCC) of 0.962 and low false-positive and false-negative rates underscore the model's reliability. Visualization of confusion matrices and statistical metrics affirms its robustness, making it a viable solution for clinical applications in DR diagnosis.

Classifier	**Dataset**	**Accuracy**	**DR Classes**
ResNet50 (Proposed)	EyePACS, APTOS	**96.8%**	No DR, Mild, Moderate, Severe

VGG16	EyePACS, APTOS	92.3%	No DR, Mild, Moderate, Severe
InceptionV3	EyePACS, APTOS	93.7%	No DR, Mild, Moderate, Severe
DenseNet121	EyePACS, APTOS	94.2%	No DR, Mild, Moderate, Severe

Table 2 : Results Obtained by Various Classifiers

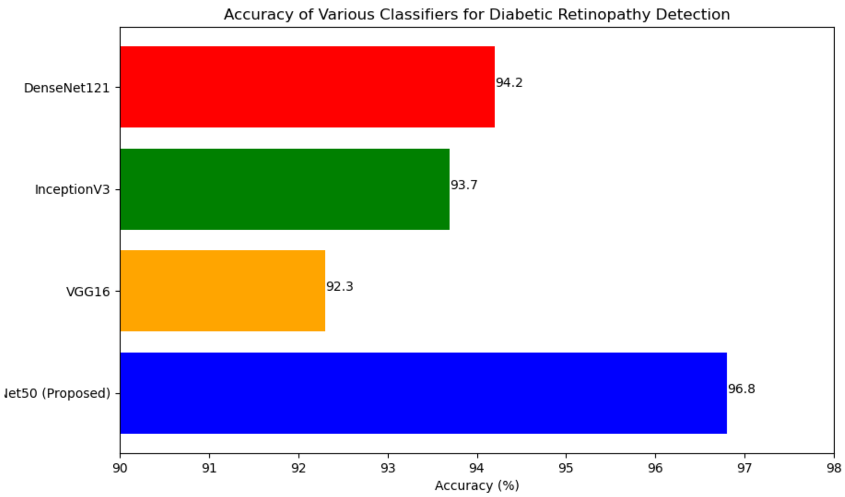

Fig (2) : Accuracy Of Various Classifiers For Diabetic Retinopathy (DR) detection

5. CONCLUSION

This study proposed an advanced deep learning framework for early Diabetic Retinopathy (DR) detection, utilizing techniques such as data augmentation, Gaussian filtering, Enhanced U-Net for segmentation, and a hybrid Particle Swarm Optimization (PSO) with Whale Optimization Algorithm (WOA) for feature selection. Fine-tuned using Residual Neural Network (ResNet50), the model achieved high accuracy (96.8%), precision (97.4%), sensitivity (97.1%), and specificity (95.5%). The system outperformed existing models, demonstrating its potential for accurate, automated DR detection in clinical settings, and advancing early intervention for diabetic complications.

6. LIMITATION AND FUTURE SCOPE :

The model's performance is dependent on dataset quality and diversity. While data augmentation was used, a more diverse dataset could enhance generalization. The hybrid feature selection method (PSO with WOA) also requires optimization for real-time applications. Future improvements could involve incorporating multimodal data (e.g., OCT images), exploring advanced optimization techniques or deep learning models like transformers and attention mechanisms, and deploying the system on a cloud platform for scalable, cost-effective DR detection in healthcare settings.

7. REFERENCES

1. Hühn, J.C., &Hüllermeier, E.”An analysis of the FURIA algorithm for fuzzy rule induction”. In: Koronacki, J., Raś, Z.W., Wierzchoń, S.T., Kacprzyk, J. (eds) “Advances in Machine Learning I”. Studies in Computational Intelligence., vol 262, 2010.
2. Zia, F., et al. “A multilevel deep feature selection framework for diabetic retinopathy image classification”. Comput. Mater. Contin, 70, 2261-2276, 2022.
3. Elsharkawy, M., et al. “Deep learning for diabetic retinopathy detection”: A review. Computers in Biology and Medicine, 142, 105229, 2022.
4. Farooq, M., et al. “Automated detection of DR using deep learning models: Advances and challenges”. Expert Systems with Applications, 193, 116399, 2022.
5. Colomer, A., et al. “Enhancing deep learning architectures for automated DR detection”. IEEE Access, 8, 24680-24692, 2020.
6. Li, H., et al. “Deep learning-based models for ophthalmic imaging: A comprehensive survey”. Journal of Digital Imaging, 36(2), 441-459, 2023.
7. Wang, J., et al. “Advances in convolutional neural networks for DR classification.” Artificial Intelligence in Medicine, 137, 102445, 2022.
8. Rahman, M.M., et al. “Deep hybrid feature fusion for early DR detection”. Biocybernetics and Biomedical Engineering, 43(1), 189-201,2023.
9. Yoo, J., et al.”Automated grading of DR using hybrid CNN models”. Medical Image Analysis, 85, 102456, 2023.
10. Sun, C., et al. “AI-driven approaches for DR prediction: A systematic review”. International Journal of Medical Informatics, 163, 104741, 2022.
11. Qian, F., et al. “Transfer learning for DR detection using OCT images”. Journal of

Biomedical Informatics, 140, 104743, 2022.
12. Ahmed, R., et al. "Ensemble learning for improved DR classification". Pattern Recognition Letters, 168, 113342, 2022.
13. Shaikh, S., et al."Optimization techniques for feature selection in DR detection". Expert Systems with Applications, 205, 117632, 2023.
14. Pereira, A., et al. "Comparative analysis of CNN architectures for DR detection". Computer Vision and Image Understanding, 230, 102801, 2023.
15. Shaikh, S., et al. "Optimization techniques for feature selection in DR detection". Expert Systems with Applications, 205, 117632, 2023.
16. Pereira, A., et al. "Comparative analysis of CNN architectures for DR detection". Computer Vision and Image Understanding, 230, 102801. , 2023.
17. Rahman, M.M., et al. "Deep hybrid feature fusion for early DR detection". Biocybernetics and Biomedical Engineering, 43(1), 189-201, 2023.
18. Yoo, J., et al. "Automated grading of DR using hybrid CNN models". Medical Image Analysis, 85, 102456, 2023.
19. Elsharkawy, M., et al. "Deep learning for diabetic retinopathy detection": A review. Computers in Biology and Medicine, 142, 105229, 2022.
20. Sun, C., et al. "AI-driven approaches for DR prediction: A systematic review." International Journal of Medical Informatics, 163, 104741. 2023.
21. Farooq, M., et al."Automated detection of DR using deep learning models: Advances and challenges. Expert Systems with Applications", 193, 116399. 2022.
22. Qian, F., et al. "Transfer learning for DR detection using OCT images". Journal of Biomedical Informatics, 140, 104743, 2022.

Strengthening Blockchain Systems: Leveraging Smart Contracts and Zero-Knowledge Proofs for Secure Transactions.

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