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Review on ANN-based IRIS Detection and Analysis for Diabetes Detection

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ABSTRACT :

Diabetes is a global health issue that requires early diagnosis to avoid serious complications. Recent attention has been given to iris-based diagnostic methods as a non-invasive and cost-effective approach for the identification of diabetes. Artificial Neural Networks are pivotal in the analysis of iris patterns and subtle features associated with diabetes, offering promising potential for accurate and efficient diagnosis. This paper gives an extensive review of ANN-based techniques for iris detection and diabetes analysis, with their methodologies, applications, and performance metrics. We evaluate the state-of-the-art approaches in medical imaging, including Incremental Modular Networks (IMNets), hybrid deep learning frameworks, and adaptive machine learning techniques, to be highly adaptable to iris analysis. These methods have shown high accuracy, precision, and scalability in diabetic retinopathy detection using fundus images. Through an extrapolation of their principles, this review extends their applicability to iris-based diabetes detection. The combination of preprocessing techniques, attention mechanisms, and hybrid architectures ensures robust feature extraction and reliable predictions. Despite these gains, the development of the required datasets, standardization, and computational efficiency remains a challenge in real-time applications. The present review points out the gaps and proposes future directions, including developing standardized iris datasets and lightweight ANN models for mobile diagnostics. In addition, applying explainable AI can improve both trust and usability among healthcare professionals. This review captures the transformative possibility of ANN-based iris detection systems in diabetes diagnosis, which should be a catalyst for further studies and innovation involving non-invasive medical imaging technologies.

Keywords— Artificial Neural Networks, Iris Detection, Diabetes Diagnosis, Medical Imaging, Incremental Modular Networks, Hybrid Architectures, Preprocessing Techniques, Attention Mechanisms, Non-invasive Diagnostics, Explainable AI.

Introduction

Diabetes mellitus is also known simply as diabetes. This is a chronic metabolic disorder of elevated blood glucose levels caused either by inadequate production of insulin or because the tissues are resistant to insulin. The World Health Organization (WHO) estimates that globally, 422 million adults are affected by diabetes, which can lead to some serious health and economic challenges with severe complications like cardiovascular diseases, kidney failure, and vision loss. Early detection and management of diabetes are critical for minimizing these risks, hence the need for innovative diagnostic techniques that are accurate, non-invasive, and cost-effective. Recent breakthroughs in artificial intelligence (AI) have dramatically altered healthcare, mainly in terms of disease diagnosis and forecasting. Of all AI methods, the power bestowed on an Artificial Neural Network (ANN) in the sense that it could analyze varied complex data and detect hidden patterns that might not be detectable to the naked eye has inspired the use of ANNs in medical imaging in the detection of many health conditions. Although there has been extensive research on fundus imaging for the diagnosis of diabetic retinopathy, iris-based diagnostics is still in its infancy. Iris recognition, previously used solely for biometric identification, has the advantage of being non-invasive and having patterns rich in distinctiveness that could indicate underlying health conditions. The basis behind this practice finds ground in iridology; iridology relates iris pattern formation with overall body health disorder, which over time has lost standard scientific authentication due to some unknown reasons but gives it hope and new visions today by application of modern imagery technologies and advanced techniques based upon the analysis of an ANN. It is possible to obtain meaningful features from an iris image by the use of advanced computational models, with the precision of detecting diabetes with its progression into its subsequent stages.

Importance of Non-Invasive Diagnostic Methods

Traditional diabetes testing, such as blood glucose monitoring and HbA1c analysis, while successful, is invasive and may reduce the likelihood of regular screening for patients due to discomfort. Alternative non-invasive diagnostic techniques like iris analysis would be beneficial and promote early diagnosis and regular check-ups. Diagnostics based on the iris have several advantages; they are easily implemented, economical, and versatile enough to cater to the wide population base including people in isolated or resource-poor regions. ANNs, being learning and generalization from data, are robustly framed to be used in the iris-based diagnostic systems. ANNs are superior for image recognition tasks and can be very helpful in the identification of intricate patterns and textures in the iris. Such systems, once trained on a dataset of labeled iris images, can classify and predict diabetes with minimal human intervention, providing a scalable solution for large-scale screening programs.

Relevance of Artificial Neural Networks (ANNs) in Medical Diagnostics

ANNs closely model the brain in terms of the structure and functions, composed of layers of connected nodes called neurons that compute on and evaluate information. It is surprising to know how such neural networks are found to perform spectacularly in numerous applications: from speech recognition, natural language processing, image classification, to various medical diagnostic processes. Here, ANNs stand out by catching patterns that appear in medical imaging data which many traditional algorithms have difficulty catching. Advances in deep learning architectures have led to an increase in the application of ANNs in healthcare. Amongst the ANN architecture types is CNN, specialized in analyzing images, with high-performance capability in diagnosing diabetic retinopathy and other cancers by extracting images. In iris-based diagnostics, these ANNs could extend the possibilities into non-invasive, automated diabetes detection, while remaining highly accurate.

Current Research in Iris-Based Diagnostics

Although most studies in the imaging of diabetes relate to the identification of diabetic retinopathy by analyzing fundus images, there is a possibility that iris images could be equally or even more promising. A human iris comprises very complex structures, including the muscle fibers and crypts and variations in pigmentation, that may be biomarkers for systemic conditions. Improvements in imaging devices, including cameras with high resolutions and optical coherence tomography (OCT), make it possible to capture the details of iris images for ANNs to analyze. Some works have shown that iris patterns could be used as a means for medical diagnostics. For example, certain correlations between systemic conditions, including diabetes, have been reported from iris characteristics. These findings are integrated with the ANN-based framework to develop a system that can scan iris images and detect diabetes. Advanced preprocessing techniques involving noise reduction, contrast enhancement, and region-of-interest segmentation help make these systems more reliable and accurate.

Challenges in Iris-Based Diabetes Detection

Despite its promises, the development of ANN-based iris diagnostics for detecting diabetes has been encumbered by several drawbacks. The major obstacle is that standard datasets used in training and testing are largely not available. Most the currently available datasets relate to biometric identification, so the applicability in medical diagnosis is limited. Building high-quality datasets annotated exclusively for iris-based health analysis can improve this sector further. Another issue is the inherent variability of iris images, sometimes influenced by lighting conditions and the size of the pupils, and sometimes by eyelashes or reflections creating occlusions. These would necessitate the need for robust preprocessing techniques and application of data augmentation, the aim of which would be to improve the model's generalizability. Additionally, explainable AI models are essential for enabling trust and transparency in clinical applications. Healthcare professionals need to understand the rationale behind predictions made by the system.

Opportunities and Future Directions

ANN-based iris diagnostics have many promising applications within health systems towards the better detection and care for diabetic patients. For example, lightweight neural networks-based solutions would use mobile platforms and implement real-time image analysis directly from iris images captured through smartphone cameras to extend access to healthcare services into remote or other under-served locations.Also, integration of ANN-based iris diagnostics with other diagnostic modalities such as fundus imaging or blood biomarkers could be even more holistic in its approach towards detection of diabetes. Multimodal systems that rely on data coming from multiple sources will enhance diagnostic precision and decrease the rate of false positives or false negatives. Explainable AI models are the other promising area: they could help clinicians explain and validate what the system produces. Such a model could promote trust by presenting features and parts of the iris that lead to the diagnosis so that clinicians will be more able to embrace such a system.

Objective of This Review

The current review is a deep analysis of the ANN-based approach for iris detection and its applicability to diabetic diagnosis. Considering state-of-the-art methodologies, challenges, and future directions in reviewing, the paper discusses how ANN-based iris diagnostics may lead to a new breakthrough tool for non-invasive diabetes detection. This review also deals with the issue of appropriating techniques already developed for other medical imaging applications, such as fundus analysis, to the field of iris diagnostics, which could offer insights in the development of scalable and efficient systems for real-world clinical use. Thus, in conclusion, artificial neural networks in combination with iris-based diagnostics holds tremendous promise to revolutionize diabetes detection. AI and the medical imaging advance may help tackle current challenges toward the development of accurate, accessible, and non-invasive diagnostic tools for ANN-based systems and may improve the outcome of the patients and the burden of the global disease burden due to diabetes.

literature Review

Literature in ANNs and its applications on medical images has developed multi-fold within the recent past by documenting a large number of methodologies pursued for diagnosing diseases as well as disease classification. It particularly portrays an application of ANNs in intricate analysis of images of an iris or a fundus image that gives the ability for developing a non-invasive device for the detection of diseases. Presented below are some recognized studies that focused on ANN-based approaches for diagnosis in medicine: methodology, performance, and relevance of detection of diabetes.

Ali et al [1] the use of deep learning in medical imaging provides a new avenue of breaking the shackles of current diagnostic accuracy and treatment planning with the help of sophisticated computational models. Ali et al. proposed Incremental Modular Networks - A novel modality of modular approach towards deep learning to facilitate incremental learning of specific aspects. IMNets are designed to grow adaptively by adding modules and are focused on specific patterns or characteristics relevant to a given medical imaging task. In particular, the complexity of medical data, such as fundus or histopathological images, calls for this kind of adaptability. The authors showed that the IMNets can optimize both computational efficiency and accuracy in order to address the challenges of limited data in medical applications. However, the authors set the stand clear that such systems are tools to complement a human's expert rather than a replacement for healthcare professionals. The reliability and accuracy of AI in augmented collaboration with human judgment will ensure proper care of the patients.

Menaouer et al. [2] proposed a robust hybrid deep learning framework for diabetic retinopathy (DR) classification addressing the complexities of identifying multiple severity levels of the disease. The authors applied VGG16 and VGG19 architectures on fundus images and performed complex feature extraction, which made it possible to classify the images into five categories: no DR, mild, moderate, severe, and proliferative DR. Validation of the model was performed by the researchers using an amalgamated dataset from APTOS-2019, Messidor-2, and locally sourced public datasets. Large-scale experimentation clearly establishes the reliability of the model because the accuracy turns out to be 90.6%, an F1 score of 94%, and the recall is up to 85%. These show that the proposed framework has all the potential of picking up weak signals of DR and classifying the progression accurately. Another pertinent conclusion drawn by this study is that diverse data should be incorporated in order to make the generalization of the model better. A hybrid approach of a scalable and efficient way to an early detection of the DR will definitely be significant for preventing the further loss of vision.

Gunasekaran et al. [3] investigate deep RNNs as an alternative tool to predict diabetic retinopathy from fundus images by formulating a novel framework to cope with challenges arising during early diagnosis. Unlike CNN-based models that rely more on spatial feature extraction, their RNN-based framework used the temporal dependencies within the image data to discover hidden patterns that would suggest DR. Standardizing image quality through preprocessing techniques, including noise reduction, ensured there was consistent input data that would enhance the performance of the model significantly. The developed framework provided an excellent precision of 95.5%, which means it is highly probable to diagnose the patients with diabetes as susceptible to DR, while the paper discussed the scalability of the model, where the focus is on processing more data and the application in real time for clinical practice. This paper focuses on developing new architectures for neural networks that can enhance diagnosis and avoid avoidable blindness.

The deep learning models such as VGG-Net, ResNet, and InceptionV3 were considered and studied by Khan et al. [4] in a thorough manner to classify DR from the fundus images. The preprocessing technique was further stressed upon using the Gaussian method in order to eliminate noise and thus improve the image quality; thus, making the most important features of interest within the data that the model should focus upon. For each deep learning architecture, the capability to extract and interpret complex patterns from the retinal images was measured. Amongst the tested models, InceptionV3 was the most efficient with an accuracy of 81.2% for training and 79.4% for testing. These results further emphasized the higher generalization capability and pattern recognition ability of InceptionV3. The research findings show how appropriate architectures and preprocessing methods would be critical for improvements in the DR classification task. The strength and weaknesses of the various deep models that lead to further optimizations will be highlighted from these results for the clinical application of the project.

Fang et al. [5] presented an innovative Directed Acyclic Graph network for classifying diabetic retinopathy from fusing the multi-features that are extracted from fundus images. It utilized key indicators of retinal hemorrhagic plaques, varices, and neovascularization along with some feature extraction algorithms that are highly specialized. In this way, the DAG network merged all the characteristics together for an overall view of the retinal condition, and thus proper classification was achieved. The model has been stringently tested on real-time data as well as on the open-source DIARETDB1 dataset. Its performance has also significantly been demonstrated in identifying various stages of DR with maximum accuracy. Thus, the DAG network has established a robust model to solve this limitation in single-feature models, and the solution obtained here signifies the urgency in combining different features for medical image analysis. The work proposed here is a scalable and effective clinical deployment framework for early diagnosis and disease management.

Elloumi et al. [6] developed a mobile-based system for DR detection using NasNetMobile, a lightweight deep neural network optimized for mobile devices. The system was designed to overcome the challenges posed by low-quality fundus images captured by handheld devices commonly used in resource-limited settings. The architecture of NasNetMobile was such that it was processed and executed with great performance despite constrained computational resources. Through the dataset used, which involved 440 images, the developed model was successful in achieving its expectations: 95.91% accuracy, 95.71% precision, 94.44% sensitivity, and a sensitivity of 96.92%, specifying that the devised system is absolutely reliable for diagnosis and suitable enough to be used as a real scenario in clinical setting. The possibility of using it in remote rural areas was an added advantage on the mobile based solution, hence establishing advanced medical equipment limited access. This study illustrates the potential of lightweight AI models to bridge gaps in healthcare accessibility and improve early diagnosis and treatment outcomes for patients at risk of vision loss.

A broad comparative study by Kanakaprabha et al. [7] aims to identify relative strengths and relative suitability of these models for diabetic retinopathy prediction. Here, the comparative study was made on CNN, VGG16, VGG19, InceptionV2, ResNet50, MobileNetV2, and DenseNet, each representing a highly diverse range of architectures optimized for different image processing tasks. The performance of every model was measured in terms of its ability to extract and process features from the fundus images, which forms a critical criterion for DR detection. The work pointed out specific advantages of each model, including the lightweight characteristic of MobileNetV2 to enable faster processing and the deeper layers of DenseNet to pick up intricate patterns. By comparing these architectures, the study presented valuable information about the application for DR classification; thus, it was useful to researchers and practitioners in choosing the most suitable model according to specific clinical and computational requirements.

Sridhar [8] proposed a new CNN-based architecture to detect diabetic retinopathy (DR) and classify the severity of the disease. The model was trained on public Kaggle datasets to ensure robust training with access to a large diversity of annotated fundus images. This CNN-based architecture captures the critical features of images for accurate classification of DR at various stages. The study highlighted preprocessing techniques, that is standardizing the data and enhancing image input quality, so consistency of training and testing phases is ensured. The results in the study proved high accuracy; thus, the model could relyably identify DR and differentiate severities. This research contributed not only to advancing automated DR detection but also underscored the role of CNNs in medical imaging applications, where accurate and early diagnosis can significantly improve patient outcomes.

Das et al. [9] proposed a CNN-based model for DR classification using segmented fundus image features to aid in boosting detection accuracy. One part of their approach was preprocessing. For image boundary refinement, it used morphology operations, and adaptive histogram equalization was employed to improve contrast. Such data was used as input so that the CNN could optimize feature extraction. In extensive testing on the DIARETDB1, a benchmark used in the area, it reported a precision of 97.2% and an accuracy of 98.7%. In this respect, the proposed methods of preprocessing together with the architecture of the CNN were capable of capturing essential features for DR classification. This work confirms the feasibility of combining advanced preprocessing of images by deep learning with enhancing medical image diagnostic ability and developing it into a scallable, clinically deployable solution. From this work it is confirmed further that data pre-processing quality greatly matters in image analysis.

Vives-Boix et al. [10] presented synaptic metaplasticity in CNNs as a novel concept for DR detection. A model that has been based on the InceptionV3 architecture incorporated mechanisms related to neural plasticity for enhancing learning efficiency and adaptability. The capability of the model to dynamically adjust learning rates across the layers could basically enforce optimal feature extraction and pattern recognition. The performance metrics were excellent, with an accuracy of 95.56%, a recall of 90%, and a precision of 98.9%. The paper established the potential for biologically inspired mechanisms to be integrated into CNNs to make them more adept at handling complex medical imaging tasks. Demonstrated as a highly innovative learning method in the study, the researchers thus showed how improved DR detection paved the way toward far more adaptive and efficient AI systems for both medical diagnostics and other high-stakes applications.

Luo et al. [11] overcame the limitations of single-view-based classification of diabetic retinopathy using the single view of a fundus image by incorporating a novel multi-view approach. Generally, a single view model often fails to extract some critical features due to the limited view of a fundus image. To handle this, the proposed model includes multi-view data, which encapsulates more information regarding wider angles. The attention mechanisms were included in the model, which enabled the focus on salient features such as lesions or microaneurysms. In this regard, the model dynamically focused on the regions of interest and assigned weights to the most critical information that would contribute the most in the classification process. Its performance was tested using a multi-view DR dataset and found to outperform existing single-view approaches by reaching higher accuracy and robustness. This further pointed out the power of multi-view datasets and more advanced feature prioritization techniques; therefore, it has promising directions for further research in the detection of DR as well as many other complex medical imaging tasks.

Adriman et al. [12] did the evaluation of binary classification techniques applied for detecting diabetic retinopathy (DR) by texture features and various architectures including deep learning. Their models are used at ResNet, DetNet, and DenseNet models to the benchmark dataset called APTOS 2019 for detection of blindness. The study employed texture-based feature extraction to enhance the representation of fundus images in a manner that subtle patterns related to DR were well captured. From the tested models, ResNet proved to be the most accurate with an impressive accuracy of 96.25%. The results indicated that ResNet could effectively learn hierarchical features, making it especially suitable for medical image classification tasks. This study shows that it is possible to combine texture features and deep learning models to improve the ability of detection in DR. Analysis and comparison between architectures were helpful in showing strength in models at the task of binary classification of medical images.

Fatima et al. [13] presented the hybrid neural network for the detection of diabetic retinopathy, which applied a novel method of entropy enhancement to improve the quality of medical images. By optimizing the step of entropy enhancement, the contrast as well as the detailed features of a fundus image could be such that microaneurysms and hemorrhages would appear clearly enough for better detection. Hybrid neural network continued processing enhanced images based on feature extraction and high-precision classification architecture. The model proposed was experimented with known datasets like MESSIDOR-2 and APTOS and thus presented superior performance concerning accuracy and robustness. This method is excellent for picking up minor DR severity variations, and thus proved helpful for early detection and monitoring purposes. It points to the fact that pre-processing methods, such as entropy enhancement, can make the difference between improvements and significant impact in the performance of deep learning models, making a potent solution that would be worthwhile in precise DR diagnosis in diversifying clinical environments.

An advanced active deep learning convolutional neural network was presented for the automated extraction of features and regions of interest in the images for detection of diabetic retinopathy, as proposed by Qureshi et al. [14]. Here, a state-of-the-art multi-layer architecture has been able to capture the intricate pattern of microaneurysms, exudates, and hemorrhages relevant to the detection of DR from fundus images. The active learning mechanisms used to dynamically refine the feature extraction process have yielded an improved classification accuracy with successive iterations. With rigorous evaluation on the benchmark dataset EyePACS, the model reached an accuracy of 98%. This signified high performance and capability in the system in terms of classification into various stages of DR with the aid of fundus images. Further, inclusion of segmentation made the relevance to the most critical regions of the retina even stronger, which increased the reliability and stability in diagnosis of the system. Therefore, the study opens up the possibility of using CNN architectures combined with active learning to provide an efficient and scalable solution for the automated detection of DR in the clinical setting.

Kalyani et al. [15] applied capsule networks to DR detection and classification from retinal fundus images and focused on overcoming the disadvantages of CNNs that could not adequately address spatial hierarchies and feature inter-relationships. The approach proposed a use of convolutional layers to get initial features followed by a layer of capsule networks for maintaining spatial information and dependency between the features for accurate DR stage classification. The ability to present spatial hierarchies did seem to best help differentiate subtler variations of abnormalities in retinal cases. Extensive evaluation of the proposed method was conducted using a benchmark dataset specifically developed for research on DR known as MESSIDOR. High accuracy with respect to precision: 97.98% on healthy retina samples and 98.62% on DR samples of stage 3. This high level of precision demonstrated the potential of capsule networks in capturing intricate details in medical images, providing a powerful tool for DR diagnosis and classification. The study highlighted the benefits of advanced architectures in medical imaging tasks.

Gayathri et al. [16] proposed a hybrid approach to diabetic retinopathy (DR) classification, combining the strengths of multipath convolutional neural networks (CNNs) with traditional machine learning classifiers such as Random Forest (RF), Support Vector Machine (SVM), and J48. The multipath CNNs were employed to extract both local and global features from fundus images, ensuring a comprehensive representation of the retinal structure. These features were then fed into machine learning classifiers for final classification, leveraging their capability to handle structured data efficiently. The hybrid model was evaluated using IDRiD and MESSIDOR datasets, two prominent datasets for DR research. The approach demonstrated strong performance across various metrics, including accuracy, precision, and recall, validating its effectiveness in detecting and classifying DR stages. By combining deep learning with machine learning, the study presented a scalable and efficient solution for DR detection, offering a framework adaptable to other medical imaging applications.

Bodapati et al. [17] introduced an advanced model for diabetic retinopathy (DR) severity classification by integrating gated-attention mechanisms with composite deep neural networks (DNNs). The model leveraged pre-trained convolutional neural networks (CNNs) to extract robust feature descriptors from retinal fundus images. To enhance the model's focus on critical regions, gated-attention mechanisms were incorporated, allowing the network to dynamically prioritize features associated with DR severity, such as lesions, hemorrhages, and exudates. This approach ensured that the model paid greater attention to diagnostically significant areas while minimizing the influence of irrelevant features. The framework was trained and validated using the APTOS-2019 dataset, a widely recognized benchmark for blindness detection challenges. The results demonstrated a substantial improvement in classification performance, with the attention blocks significantly contributing to the model's ability to detect and classify DR stages accurately. This study underscored the potential of attention mechanisms in enhancing the interpretability and precision of deep learning models for medical imaging.

Math et al. [18] proposed an innovative adaptive machine learning-based diabetic retinopathy (DR) classification system that leveraged the power of pre-trained convolutional neural networks (CNNs). Their approach utilized a pre-trained CNN as a feature extractor, which allowed the model to focus on intricate details in fundus images, such as microaneurysms and hemorrhages. This transfer learning strategy enhanced the system's efficiency by reducing the need for extensive computational resources and large datasets. The system was trained and validated using the Kaggle dataset, a widely used benchmark for DR detection research. The model achieved a sensitivity and specificity of 96.37%, demonstrating its ability to reliably identify both positive and negative cases of DR. This high performance underscores the importance of adaptive machine learning frameworks in medical imaging, offering a robust solutiossn for early diagnosis. The study also highlighted the scalability of the system, making it suitable for integration into clinical workflows.

Gao et al. [19] applied advanced deep learning models, including VGG16 and DenseNet, to fundus fluorescein angiography images for diabetic retinopathy (DR) grading, focusing on the progression of the disease. Fundus fluorescein angiography, a specialized imaging technique, captures detailed images of retinal blood vessels, providing valuable insights into DR-associated vascular abnormalities. The models were trained on the Xian and Ningbo datasets. These two well-curated resources encompass various stages of DR. Through extensive experimentation, the DenseNet architecture demonstrated superior performance, achieving an accuracy of 94.17%. This high accuracy highlights the model's ability to extract and process complex features from angiographic images, such as neovascularization and leakage. Gao et al.'s research emphasized the potential of combining deep learning with advanced imaging modalities to improve the grading and diagnosis of DR, paving the way for more precise and efficient automated diagnostic tools in ophthalmology.

Kobat et al. [20] proposed a new method of detection of diabetic retinopathy using DenseNet, a deep learning model with great parameter efficiency in feature extraction. To improve the resolution of the feature extraction process, the authors divided the fundus images into smaller patches that allowed the model to pay more attention to microaneurysms and hemorrhages. This patch-based approach enabled the model to look at fine-grained details within each segment of the image, thus enhancing its overall performance. The approach was tested using 10-fold cross-validation, a robust method to assess the generalizability and consistency of the model. DenseNet achieved an accuracy of 84.9%, which demonstrated its ability to detect DR effectively. The approach yielded potential for improving feature localization and detection in complex medical imaging tasks, though it yielded a little less than the best accuracy in these methods. This study discussed the significance of innovative preprocessing techniques that enhance deep learning models in DR detection.

Summary of Systematic Review

The systematic review synthesizes findings from existing literature, focusing on ANN-based methodologies for disease diagnosis and their specific applications in diabetes detection. By analyzing a wide range of studies, the review identifies trends, innovations, and challenges in the field, offering a comprehensive understanding of current advancements and their implications for future research. The section aims to distill key insights from diverse research efforts, emphasizing the adaptability of ANN models for non-invasive diagnostics and highlighting the potential of iris-based approaches in complementing traditional diagnostic techniques.

Systematic Review

Sr. No.	Author(s)	Title of the Project	Methodology	Key Findings	Technical Aspect
1	Ali et al.	Incremental Modular Networks for Medical Imaging	Incremental Modular Networks (IMNets)	Optimized computational efficiency and accuracy for medical imaging tasks.	Incremental learning of specific features, modular architecture.
2	Menaouer et al.	Hybrid Deep Learning Framework for DR Classification	VGG16 and VGG19 hybrid framework	High reliability with 90.6% accuracy and diverse dataset generalizability.	Feature extraction using VGG architectures.
3	Gunasekaran et al.	Deep RNN for DR Prediction	Deep Recurrent Neural Networks (RNN)	Precision of 95.5%, scalable for real-time applications.	Temporal dependencies for hidden pattern detection.
4	Khan et al.	Comparative Analysis of DL Models for DR Classification	VGG-Net, ResNet, InceptionV3	InceptionV3 achieved 81.2% training accuracy.	Gaussian preprocessing for noise reduction.
5	Fang et al.	Directed Acyclic Graph Networks for DR	Directed Acyclic Graph (DAG) Networks	High accuracy with multi-feature fusion approach.	Feature prioritization through fusion.
6	Elloumi et al.	Mobile-Based DR Detection using NasNetMobile	NasNetMobile architecture	95.91% accuracy, efficient processing for mobile devices.	Lightweight architecture optimized for low-resource environments.
7	Kanakaprabha et al.	Comparative Analysis of DL Models for DR Prediction	CNN, VGG16, VGG19, InceptionV2, ResNet50, MobileNetV2, DenseNet	Insights into model-specific strengths for feature extraction.	Evaluation of diverse architectures.
8	Sridhar et al.	CNN for DR Detection and Severity Classification	Convolutional Neural Networks (CNN)	High accuracy for multi-stage DR classification.	Preprocessing for standardized data inputs.
9	Das et al.	Segmented Fundus Features for DR Classification	CNN with segmented features	Precision of 97.2%, accuracy of 98.7%.	Adaptive histogram equalization for feature enhancement.
10	Vives-Boix et al.	Synaptic Metaplasticity in CNNs for DR	InceptionV3 with synaptic metaplasticity	Accuracy of 95.56%, enhanced adaptability in learning.	Layer-specific learning rate adjustments.
11	Luo et al.	Multi-View DR Classification with Attention Mechanisms	Multi-view data integration with attention mechanisms	Superior accuracy and robustness over single-view models.	Attention mechanisms for feature prioritization.
12	Adriman et al.	Binary Classification Methods for DR Detection	ResNet, DetNet, DenseNet	ResNet achieved 96.25% accuracy.	Texture-based feature extraction.
13	Fatima et al.	Hybrid Neural Networks for DR Detection	Entropy enhancement with hybrid NN	Exceptional performance on MESSIDOR-2 and APTOS datasets.	Preprocessing with entropy enhancement.
14	Qureshi et al.	Active Deep Learning for DR Classification	Active Deep Learning CNN	Accuracy of 98%, improved segmentation capabilities.	Dynamic feature extraction refinement.
15	Kalyani et al.	Capsule Networks for DR Detection	Capsule Networks	High precision and spatial hierarchy preservation.	Preservation of spatial dependencies.
16	Gayathri et al.	Multipath CNNs and ML Classifiers for DR	Multipath CNNs with Random Forest, SVM, J48	Strong performance in DR classification.	Local and global feature extraction.
17	Bodapati et al.	Gated-Attention Mechanisms with Composite DNNs	Gated-attention mechanisms with DNNs	Enhanced focus on diagnostically significant areas.	Gated attention for critical feature emphasis.
18	Math et al.	Adaptive Machine Learning-Based DR Classification	Transfer learning with pre-trained CNN	96.37% sensitivity and specificity.	Feature extraction via transfer learning.
19	Gao et al.	DL Models for DR Grading with Fundus Angiography	VGG16 and DenseNet on fundus angiography	DenseNet achieved 94.17% accuracy.	Feature extraction from angiographic images.
20	Kobat et al.	Patch-Based DR Detection using DenseNet	Patch-based DenseNet	84.9% accuracy, improved feature localization.	Patch-based analysis for detailed feature extraction.

RESEARCH GAP

Despite all the progress that has been achieved in the use of ANNs for medical diagnosis, there are some critical research gaps in the field of iris-based diabetes detection. The first of these is a significant lack of publicly available high-quality datasets particularly prepared for medical applications of iris imaging. Most of the available datasets are created for biometric identification purposes, which makes them less suitable for health diagnostics. Variability in iris images, based on lighting conditions, pupil dilation, and occlusions in images, is a challenging factor for the generalizability of models. Although some preprocessing techniques have been explored, no standardized framework for addressing these variations has been developed.

The third area is the integration of multimodal approaches that combine iris imaging with any other modality, including fundus imaging or blood biomarkers, whereby such systems might improve diagnostic accuracy and aid in more comprehensive evaluation of diabetes with complications. Lastly, the explainability of the AI models developed for iris-based diagnostics is lacking. Clinical adoption and trust require systems to be transparent and explainable to healthcare professionals to understand why certain predictions or decisions are being made. These gaps can only be bridged by research and innovation targeting these specific issues to push forward the development and realize the potential of ANN-based iris diagnostics in the detection of diabetes.

Discussion

Surveys for ANN-based diabetes detection methodologies give big evidence of great progression in the realm of medical image processing and AI. Studies of various diabetes condition detection through classification using neural networks have indicated many architectures along with preprocessing to establish accuracy and robustness in various applications. Incremental modular networks, as an example, offer adaptive architectures that enable growing in modules allowing the network to focus on specifics features pertinent for medical imaging applications. The method is more versatile for analysis where complex data have to be scanned, including analysis of fundus and iris images.

Hybrid frameworks combining deep learning architecture, including VGG16 and VGG19 with machine learning-based classifiers, have promising prospects in improving diagnostic accuracy. Such hybrid frameworks, which extract complex features by including classifiers within the model, overcome the weakness of a single model. Furthermore, lightweight models like NasNetMobile provide ease of mobile-based applications, and an immediate real-time diagnostic can be made in resource-poor settings.

Attention mechanisms and feature fusion techniques, as mentioned in studies on DAG networks, further improve the interpretability and performance of ANN-based models. These methods allow systems to focus on important regions in images, ensuring that diagnostically relevant features are focused on during the analysis. The approach has been very effective in the detection of diabetic retinopathy and has good potential for iris-based diagnostics.

Despite such advancements, the field still poses challenges. Variability in image quality, lack of standardized datasets, and computational limitations significantly hinder wide-scale adoption. Addressing these issues with the application of robust preprocessing, data augmentation, and transfer learning techniques could enhance model generalizability. Finally, clinical trust and usability can be assured in high-stakes applications like diabetes diagnosis only by developing the explainable AI models.

Future research directions include the development of standardized iris datasets for medical diagnostics, multimodal approaches integrating data from various sources, and lightweight models on mobile platforms. In this regard, ANN-based systems have the potential to revolutionize diabetes detection by making it accurate, non-invasive, and accessible for global healthcare.

Conclusion

This review underlines the revolutionary scope of ANNs in enhancing iris-based diagnostics to detect diabetes. Although the use of ANN-based models has had great success in medical imaging, their application in iris analysis remains an unexplored but promising domain. Utilizing the subtle patterns of the iris and incorporating advanced neural network architectures can yield non-invasive and highly accurate diagnostic tools.

The study underlines some of the significant developments that are being done: hybrid models, attention mechanisms, and lightweight architectures to make diagnostics more accessible and efficient. But it also brings to the forefront several critical gaps in the area: the absence of standardized datasets, variability in image quality, and the need for explainable AI frameworks to build clinical trust.

The next step is to fill these gaps: focusing on developing superior-quality annotated iris datasets, exploring multimodal diagnostic systems, and preparing transparent AI models. Using mobile-friendly ANN-based solutions can greatly enhance healthcare accessibility in such regions.

Conclusions: ANN-based iris diagnostics represents a promising way toward non-invasive, accurate, and scalable solutions for detecting diabetes. Existing challenges can be addressed and build on current developments in this area, which potentially revolutionizes care for diabetes: to improve early detection and management with reduced global disease burden.

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