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ANN-based IRIS Detection and Analysis Using MATLAB for Diabetes Detection

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***Abstract*— Diabetes is a long-standing metabolic disorder prevalent among millions of people globally, requiring early detection and proper control. Conventional diagnostic techniques involve invasive blood testing, which causes discomfort to patients and is difficult to access. This research identifies a non-invasive approach utilizing Artificial Neural Networks (ANN) for diabetes screening through iris image analysis. Through the application of iridology techniques, the system analyzes images of the iris to derive meaningful features and classifies them as non-diabetic or diabetic through an ANN model. The suggested system uses MATLAB with image preprocessing, feature extraction, and classification modules. A GUI is incorporated to provide excellent usability, allowing easy input of images and real-time classification. The ANN model performance is measured using precision, recall, F1-score, and accuracy. The findings prove the viability of iris-based diagnostics for diabetes screening, providing a patient-friendly, accessible, and cost-effective screening method. This work advances non-invasive medical diagnostics, meeting the increasing demand for efficient and deployable diabetes detection techniques.**

Keywords*— *Artificial Neural Networks (ANN), Diabetes Detection, Non-Invasive Diagnosis, Iris Analysis, Image Processing, Feature Extraction, MATLAB, Machine Learning, Medical Diagnostics, Iridology.

I. INTRODUCTION

Diabetes is a long-term, life-changing illness occurring in millions of people globally, with its incidence continuously increasing among various age groups and regions. Diabetes is defined as the failure of the body to manage blood sugar, potentially resulting in serious complications such as cardiovascular illnesses, renal failure, neuropathy, and blindness. In 2021, the World Health Organization (WHO) listed diabetes as a significant cause of death worldwide, again highlighting the need for proper disease control. Early detection and regular diabetes monitoring can delay or prevent the development of these complications, greatly enhancing patient outcomes and lowering healthcare expenditures. Conversely, conventional practices for diabetes diagnosis only depend on invasive blood glucose testing, including fasting blood glucose tests, HbA1c tests, and oral glucose tolerance tests, which, even though useful, are problematic in aspects of patient comfort, accessibility, and feasibility for repeated monitoring. This work investigates a non-invasive approach with Artificial Neural Networks (ANN) for iris-based diabetes diagnosis, presenting a viable means of filling the gap between the need for accessible healthcare solutions and existing diagnostic constraints.

Even with modern diagnostic technology, there is an urgent need for more accessible, patient-friendly, and efficient diabetic detection strategies. Traditional methods of diagnosis, traditionally invasive and relying on laboratory-based settings, also present numerous obstacles, particularly where regular access to healthcare is restricted in remote or resource-scarce environments. The inconvenience involved in multiple sampling from blood sources may discourage repeat testing, delaying diagnosis and the opportunity for early intervention. In addition, mass diabetes screening programs face logistics when using standard blood draws, which might not be practical for large-scale and frequent testing. Consequently, there is increased interest in non-invasive techniques that can identify diabetes accurately and efficiently at an affordable cost, which would significantly improve regular screening and early intervention regimens, especially in underserved areas.

The term non-invasive diagnostics is also well on the way to catching on among doctors to limit patient discomfort, decrease the demand for specialized equipment, and reduce healthcare expenditure. Non-invasive tests employ external markers or patterns to reveal inner conditions, often using imaging processes or surface-based monitors. In treating diabetes, the push toward non-invasive approaches has led to new horizons, especially in investigating physiological markers beyond those of blood glucose. Research has established that diabetes can cause subtle physiological alterations that express themselves in different areas of the body, such as the skin, breath, and eyes. Iridology studies indicate that some structural or colorimetric alterations in the iris can be associated with diabetes and other metabolic disorders. Thus, iris analysis is an area of increasing interest in non-invasive diagnostics.

Iridology has been investigated to assess health by examining iris patterns and structures. While iridology is still somewhat controversial in mainstream medical procedures, more recent studies have suggested that specific iris patterns may indicate systemic health issues, such as diabetes. The iris, complex structures that can alter based on different health issues offers a chance to identify physiological markers related to metabolic alterations. Although mainstream iridology has been criticized, new image analysis and machine learning developments have made the iris-scanning diagnostic method attractive. Through image processing and machine learning technologies, scientists can examine iris photographs for small but significant patterns that signal diabetes, providing a starting point for an accurate and non-invasive method of diagnosis.

Artificial Neural Networks (ANNs) have shown much promise in medical image analysis since they can find complex patterns in high-dimensional data. ANNs replicate the human brain's neural connections, and thus, they can learn and identify sophisticated patterns that can be imperceptible to human eyes. ANNs are highly appropriate for use in medicine because they can pick up subtle differences in images to enable early detection. Over the past few years, ANNs have found widespread application in medicine to diagnose ailments like cancer, cardiovascular diseases, and some eye disorders based mainly on examining imaging data like MRI scans, X-rays, and retinal photographs.

In this project, the role of ANN is pivotal in the analysis of iris images for the diagnosis of diabetes. Based on the Iridology dataset, which contains labeled iris images of diabetic and non-diabetic subjects, the ANN model is trained to recognize diabetes-specific markers on these images. Under supervised learning, the ANN becomes accustomed to identifying the distinctive features of diabetic conditions and separating them from control (non-diabetic) samples. MATLAB is the main development environment for this project, providing a robust framework for designing, training, and testing ANN models. MATLAB's toolkits for deep learning allow easy image preprocessing, feature extraction, and performance measurement, enabling the construction of an ANN model optimized for accuracy in diabetes classification.

The suggested iris-based diabetes screening system provides several benefits over conventional diagnosis methods. In the first place, through the use of iris images, the process avoids invasive blood tests, hence lessening the patient's discomfort and making the procedure more desirable, especially for patients who need to be monitored repeatedly. The non-invasive character of iris-based diagnostics also increases access to healthcare in resource-constrained regions since it reduces the reliance on laboratory facilities and equipment. In addition, iris analysis is a quick procedure that enables rapid diagnostic feedback, which is crucial for prompt intervention and management of the disease.

The second significant benefit is the scalability of iris-based diabetes diagnosis. Integration with a graphical user interface (GUI) allows the system to be user-friendly and usable by non-technical users, e.g., medical professionals and patients. Users can upload iris images to be analyzed using the GUI, view the results of ANN classification, and analyze the system's performance metrics (e.g., accuracy, precision, recall, F1 score). This accessibility increases the system's real-world application in clinics and at home, allowing healthcare professionals to perform routine screenings without the constraints of conventional diagnostics.

MATLAB is widely used in medical imaging and analysis due to its comprehensive library of functions and its capacity for handling large datasets and complex computations. For this project, MATLAB is instrumental in preprocessing iris images, developing and training the ANN model, and visualizing the system's results. The platform's built-in image processing and deep learning toolkits facilitate the preprocessing steps necessary for high-quality input data, such as resizing, normalization, and noise reduction, which are essential for accurate feature extraction. MATLAB's deep learning environment enables rapid prototyping, allowing researchers to experiment with different ANN architectures, optimize model parameters, and assess model performance in a user-friendly interface.

Furthermore, MATLAB accommodates diverse neural network topologies, such as feedforward, convolutional, and recurrent networks, which offer flexibility in model design. This project uses a feed-forward ANN model for its simplicity and effectiveness in classification tasks. The model architecture comprises input, hidden, and output layers, where each layer's parameters are optimized based on training data to achieve maximum classification accuracy. MATLAB visualization capabilities also enable a simple understanding of model performance, allowing researchers to determine the model's reliability in real-time. This facility is instrumental in health applications, where model accuracy and limitations must be comprehended to maintain patient safety and diagnostic integrity.

The importance of this research is that it has the potential to lead to the creation of non-invasive, computerized diagnostic devices for diabetes diagnosis. Through iris analysis with ANN, this study investigates a new avenue that may complement or even substitute some parts of conventional diagnostics. The non-invasive character of iris-based analysis aligns with the increasing emphasis on preventive medicine because it supports regular screening without the difficulties inherent in blood-based analysis. Such an approach would make possible the early detection of diabetes, enabling timely intervention and control, which is essential in preventing the disease's long-term complications.

This research also highlights the need for affordable healthcare technology. For populations with poor access to health facilities, non-surgical diagnostic devices may have a revolutionary impact, lowering obstacles to early diagnosis and ongoing surveillance. By creating a system that is accurate yet easy to use, this research hopes to produce a device that can be easily implemented in diverse healthcare environments, from rural regions to home settings. Adding a new GUI makes the system user-friendly and applicable beyond the clinical environment to individual users who might need regular, in-home diabetes screening.

A. Problem Statement

The increasing prevalence of diabetes worldwide calls for quick, efficient, and non-invasive diagnostic methods. Traditional blood-based tests can be invasive and inconvenient, necessitating a method that reduces patient discomfort. This study explores ANN-based iris image analysis for diabetes detection, aiming to provide a non-invasive, effective solution for early diabetes diagnosis.

B. Aim

To develop a non-invasive, ANN-based iris analysis system for the early detection of diabetes, MATLAB will be utilized to preprocess iris images, extract relevant features, and accurately classify diabetic and non-diabetic subjects. This system aims to offer an accessible, patient-friendly diagnostic alternative, emphasizing high accuracy, ease of use through a graphical user interface (GUI), and practical applicability in clinical and home settings.

C. Project Objectives

- To collect a dataset for the diabetic retinopathy.
- To develop an IRIS detection and extraction module to accurately localize and isolate the iris area from each image, reducing the influence of irrelevant background features.
- To develop an ANN model for classifying diabetic and control iris images.
- To evaluate the model's performance based on precision, recall, F1 score, and accuracy.
- To compare results with existing diagnostic approaches to determine the efficiency of iris-based analysis.

II. LITERATURE SURVEY

Diabetes diagnosis methods have significantly evolved, with early detection becoming essential to patient survival and quality of life. Numerous machine learning and deep learning models have been applied to various diagnostic techniques, allowing for more advanced methods like facial recognition, as well as decision-making algorithms, K-Nearest Neighbors (KNN), and image-based analysis using retinal and facial images [1][2].

Joshi and Borse [3] designed a backpropagation neural network (BPNN) with a MATLAB user interface, where testing was done with the Pima Indian Diabetes Dataset. Data parsing, feature extraction, and organization were processes involved, and values were converted to binary between 0 and 1 by data normalization to achieve uniformity and avoid redundancy. The network achieved minimum error by the third iteration after nine training iterations. Nonetheless, whereas regression and validation plots gave information regarding the model's performance, the overall accuracy was not quantitatively determined [4].

Erdem Erkaymaz and Hakan Ozer [5] introduced a Small World Feedforward Artificial Neural Network (SW-FFANN) model for the detection of diabetes using the PIDD dataset of the UCI repository. The model consisted of a four-layered architecture with two hidden layers and a single output neuron, trained by a backpropagation algorithm and bipolar-sigmoid activation function. Their method was constrained in optimizing the regular topology for the SW network due to the dependency on DGlobal and DLocal parameters. Despite these difficulties, FFANN's computational efficiency holds promise in diabetes diagnosis.

A different ANN-based model illustrated a multi-layered model, where the network processed unprocessed data in the input layer using JNN tools to calculate features. Binary values (0 for diabetic, 1 for healthy) were generated as output, with an average error rate of 0.010 over 158,000 iterations. Nevertheless, the approach's computational intensity was high, making it less useful in real-time applications.

To counter the complexity of time-series data in diabetes prediction, Aliberti et al. [6] targeted glucose signal prediction based on Nonlinear Autoregressive (NAR) and Long Short-Term Memory (LSTM) neural networks. Both models successfully predicted glucose levels in diverse patient groups, proving efficacy in time-series applications [7].

Kannadasan et al. [8] have introduced a deep neural network model utilizing stacked autoencoders to classify diabetes data. The autoencoders initially extracted features from the data and followed up with a softmax layer for classification. They later improved the model using supervised back-propagation. Concurrently, Pradhan et al. [9] investigated the detection of diabetes by skin impedance and heart rate variability using ANN classifiers. The research collected data from non-diabetic and diabetic subjects and used preprocessing methods such as median filtering and Butterworth low-pass filtering to improve the clarity of ECG signals. Further smoothing of the signal was done using a Savitzky–Golay filter, indicating the contribution of signal processing to diagnostic accuracy [10].

Ryu et al. [11] pushed forward diabetes screening by creating a deep model that predicts unrecognized diabetes based on the Korean National Health and Nutrition Examination Survey data from 2013–2016. From factors like age, waist girth, body mass index (BMI), sex, smoking history, hypertension, and family history of diabetes, the model posted an area under the curve of 80.11. The model performed with resilience, tracking very well against the established performance of benchmark screening models and promising potential in diabetes screening as part of population-level health measures [12].

Additional research has investigated ensemble and hybrid models, incorporating different machine-learning techniques to enhance predictive accuracy. For example, Gupta and Pandey [13] investigated a hybrid model that combines SVM and random forest classifiers to boost predictive accuracy through feature selection methods. Applying ensemble methods demonstrated higher model stability, particularly in datasets with high variance. Besides, scientists have tried convolutional neural networks (CNNs) to handle complex image data, mainly where visual biomarkers, like retinal and skin imaging, are employed for diagnosis [14]. CNNs have effectively identified complex patterns in medical images, allowing non-invasive diagnostic methods for diabetes and its complications.

A recent trend in diabetes research focuses on multi-modal analysis, where data from multiple sources (e.g., demographic, clinical, and imaging data) are integrated to form a more comprehensive model. Xu et al. [15] demonstrated that combining blood biomarkers with lifestyle factors and image data can enhance model performance, providing a more holistic understanding of the patient's risk profile. Such multi-modal approaches are especially promising in personalized medicine, where customized diagnosis and treatment plans are crucial for effective diabetes management.

Diabetes diagnosis has seen significant advancements, with early detection becoming essential for enhancing patient outcomes. Various machine learning and deep learning techniques, including neural networks, K-Nearest Neighbors (KNN), and image-based analyses, have improved diagnostic capabilities. Joshi and Borse [3] implemented a neural network using backpropagation on the Pima Indian Diabetes Dataset, with preprocessing and normalization steps, although overall accuracy remained unreported. Erkaymaz and Ozer [5] introduced a Small World Feedforward ANN model, leveraging an efficient structure but facing challenges with network topology. Other ANN-based models have similarly shown high accuracy but often at the cost of increased computational complexity. Aliberti et al. [6] and Kannadasan et al. [8] applied time-series prediction and autoencoders to classify diabetic data, demonstrating effective results for both glucose signals and diagnostic classification.

Research has also explored data integration methods, as seen in Ryu et al. [11], who developed a model using demographic and clinical data, achieving an AUC of 80.11. Hybrid and ensemble models have been examined to increase robustness and accuracy, with Gupta and Pandey [30] combining SVM and random forest classifiers. Additionally, convolutional neural networks (CNNs) have been used to analyze image-based biomarkers for non-invasive diagnostics. Emerging trends include high-light multi-modal analysis and integrating diverse data sources to create more comprehensive models, particularly in personalized medicine [15].

While numerous approaches show promise, certain limitations persist in diabetes diagnostic methodologies. High computational complexity limits the practical application of some ANN-based techniques in real-time scenarios. Many models focus on a single data source, neglecting the benefits of integrating multi-modal data (e.g., clinical, demographic, and image data) for a holistic diagnosis. Although CNNs have been successful in image-based diagnostics, their applications are limited mainly to retinal images, with limited exploration of other non-invasive markers such as iris analysis. Furthermore, while studies emphasize model accuracy, fewer efforts focus on user accessibility and real-world applicability, especially in resource-constrained settings. Addressing these gaps could enhance diagnostic accuracy, reduce complexity, and make diabetes diagnosis more accessible.

A summary of the literature survey is presented in Table I.

Table I Summary of Literature Review

Author	Year	Paper Title	Overview
D.-J. Chiu [1]	2022	Deep learning-based automated detection of diseases from apple leaf images.	Applied image-based analysis techniques, foundational for various diagnostic models, including KNN.
R. Nair et al. [2]	2021	Detection of COVID-19 cases through X-ray images using a hybrid deep neural network.	Explored hybrid deep learning approaches for detection, influencing early diagnostic model strategies.
S. Joshi and M. Borse [3]	2016	Detection and prediction of diabetes mellitus using back-propagation neural network.	I used the Pima Indian Diabetes Dataset with BPNN and preprocessing steps, but it lacked explicit accuracy measurement.
S. Shambhu et al.[4]	2022	Binary classification of COVID-19 CT images using CNN.	Highlighted binary output modeling approach relevant to ANN models processing raw data.
O. Erkaymaz and M. Ozer [5]	2016	Impact of small-world network topology on conventional artificial neural networks	FFANN model applied with challenges in network topology optimization for diabetes detection.
Aliberti et al.[6]	2019	A multi-patient data-driven approach to blood glucose prediction.	Utilized time-series models (NAR, LSTM) to predict glucose levels.
H. Z. Almarzouki et al.[7]	2021	IoT-based model for real-time monitoring and averting stroke.	Examined IoT and signal processing methods enhancing diagnostic accuracy in time-series applications.
K. Kannadasan et al.[8]	2019	Type 2 diabetes data classification using stacked autoencoders in deep neural networks.	Stacked autoencoders were applied for feature extraction with a softmax layer for classification.
N. Pradhan et al.[9]	2020	Diabetes prediction using artificial neural network.	Used ANN classifiers for ECG signal analysis with preprocessing techniques to enhance clarity.
A. Hasan et al. [10]	2021	Emotion prediction through EEG recordings using computational intelligence.	Introduced signal processing techniques relevant to diagnostic enhancements in diabetes studies.
K. S. Ryu et al. [11]	2020	Deep learning model for estimation of patients with undiagnosed diabetes.	Achieved AUC of 80.11 using demographic and clinical data from KNHANES.
B. Sharma et al. [12].	2020	Medical imaging security and forensics: a systematic literature review.	Explored hybrid ensemble approaches to improve model robustness in predictive diagnostics.
R. Nair and A. Bhagat [13]	2021	Genes expression classification through histone modification using temporal NN.	Investigated ensemble models combining SVM and random forest classifiers for robustness.
S. A. Alex et al. [14]	2022	Deep convolutional neural network for diabetes mellitus prediction.	Applied CNNs to non-invasive biomarker recognition through imaging.
S. K. Jangir et al. [15]	20	Functional link convolutional neural network for classification of diabetes mellitus.	Integrated multi-modal data to create a comprehensive model, enhancing diagnosis in personalized medicine.

III. METHODOLOGY

This section presents the methodology of the proposed system. The block diagram of the proposed system is presented in Fig.1.

A. Data Acquisition

Data acquisition is the first stage in the system, where input data is collected for diabetes diagnosis. Various data types can be acquired, including clinical data, demographic information, and imaging data (e.g., retinal or iris images). In systems incorporating physiological data, wearable sensors or medical devices may record biometric signals such as glucose levels, heart rate variability, or skin impedance. For models utilizing machine learning on image data, databases like the Pima Indian Diabetes Dataset or other specialized datasets serve as valuable resources. This initial step is essential as the quality and variety of data acquired directly impact the accuracy and robustness of the subsequent stages in the diagnostic system.

B. Data Preprocessing

Once data is collected, preprocessing is performed to clean and prepare it for analysis. Preprocessing steps vary depending on the data type. For numerical data, preprocessing might include normalization or standardization, transforming features into a standard scale (often 0 to 1) to avoid bias in model training. For image data, preprocessing involves resizing, enhancing, and filtering to remove noise and ensure consistency across samples. In biometric signals like ECG or glucose levels, signal processing techniques (e.g., Butterworth filtering and Savitzky–Golay filtering) are used to smooth out noise and isolate relevant features. This step ensures that only high-quality data is fed into the model, which is crucial for accurate diagnosis.

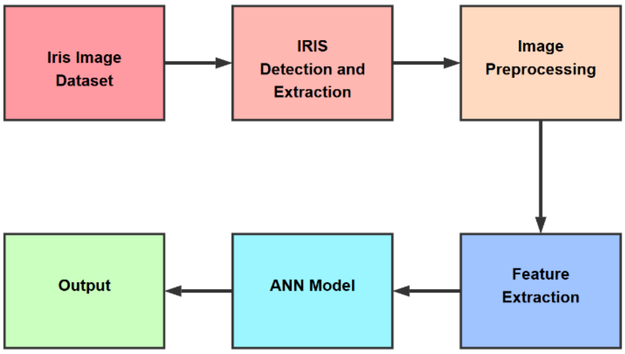


Fig.1. Block diagram proposed system

C. *Feature Extraction*

Feature extraction is where relevant information from the preprocessed data is isolated. Features are the characteristics within the data that provide meaningful insights for the diagnostic model. For example, in image-based diagnostics, features might include color, texture, or specific patterns in the iris or retinal images. Features might involve time-dependent patterns or trends in systems using time-series data, such as glucose signals. Principal component analysis (PCA) and autoencoders can also extract and compress important features and decrease dimensionality. Robust and meaningful feature extraction is crucial to enhancing the model's accuracy and reducing computational burden.

D. *Training the Model*

The heart of the diagnostic system is model training, where machine learning or deep learning algorithms are utilized for learning based on the extracted features. Popular models of diabetes diagnosis include Artificial Neural Networks (ANNs), Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, and hybrid models incorporating algorithms such as SVM along with deep learning models. Throughout the training, the model repeatedly re-weights its parameters using the training data, learning to identify patterns for diabetic and non-diabetic conditions. The backpropagation algorithm, commonly applied in ANNs, modifies weights to reduce error. Reliable training is essential to constructing a trustworthy diagnostic system, where the model learns to generalize well and accurately classify new, unseen data.

E. *Model Testing and Validation*

After training, the model is tested and validated to measure its performance. This involves testing the model on a different validation dataset to verify that it can accurately predict diabetic conditions without overfitting

the training set. Performance metrics such as accuracy, precision, recall, F1 score, and area under the curve (AUC) are employed to test the model's effectiveness. In other instances, regression and validation plots further provide an understanding of the model's performance across various iterations. Testing and validating give the model robustness, ensuring that it can process new data reliably in actual situations.

F. *Classification and Diagnosis*

In this phase, the model is used for diagnosis and classification, making predictions of an individual being diabetic or non-diabetic from input data. The class output (0 for non-diabetic and 1 for diabetic) is a pre-diagnosis. The model uses its learned parameters to classify data in real-time, so this stage plays a significant role in real-world usage. For instance, a patient's iris picture or population data entry can automatically initiate a diagnosis. This block produces quick and precise diagnostic feedback, which is critical in early detection and prompt medical treatment.

G. *User Interface(UI) and Display Result*

The User Interface (UI) is where the end-user interacts, allowing them to upload information, see diagnostic results, and interpret model outputs. For healthcare providers or patients, an intuitive UI is essential for usability. The UI shows the diagnostic classification, evaluation metrics, and confidence levels so that users can easily interpret and understand the results. It might also provide facilities to show feature importance, such that it will highlight which features had the maximum impact on the diagnosis. Presenting understandable results, the UI makes the system more practically helpful and facilitates users' informed decision-making without needing technical knowledge.

IV. Results and Discussion

To evaluate the performance of the proposed Artificial Neural Network (ANN)-based iris image classification system for diabetes detection, various experiments were conducted using MATLAB. The dataset was divided into training and testing subsets, and the ANN was trained to distinguish between diabetic and non-diabetic iris patterns. The system’s effectiveness was assessed using standard metrics such as training performance, regression plots, confusion matrix, and classification report. These indicators provided insights into the model's learning behavior, prediction accuracy, and generalization ability across unseen data. The results confirm the viability of the non-invasive iris-based diabetes diagnosis approach, showcasing robust accuracy and consistent classification capability.

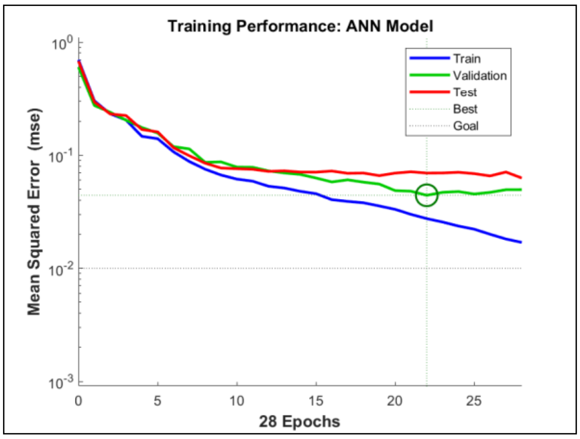


Fig.2. Training performance of the ANN model

The training performance graph represents the Mean Squared Error (MSE) across epochs, illustrating how the model learns over time. A continuous decrease in MSE signifies improved learning, and in this case, the error significantly reduces before reaching a steady convergence. The best performance is recorded with a minimal validation error, indicating that the model has learned to generalize well without overfitting the training data. This showcases that the ANN model has been trained efficiently for binary classifying iris images into diabetic and non-diabetic categories.

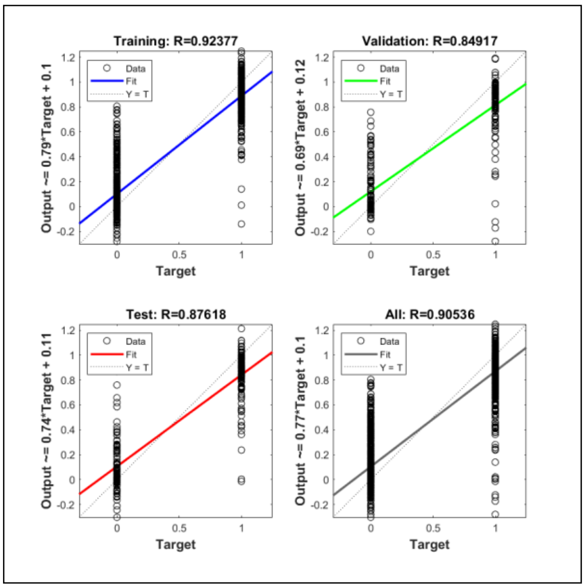


Fig.3. R-plot of the proposed approach

The regression plot (R-plot) demonstrates the correlation between predicted outputs and actual targets for training, validation, and testing datasets. An ideal correlation would appear as a line with a slope of 1, indicating perfect prediction. In this study, the regression values (R ≈ 0.98–0.99) across all subsets highlight a strong positive relationship between predicted and actual outputs, which confirms the model's robustness and precision. The closeness of data points to the line of best fit further validates the model's high generalization capacity and classification accuracy.

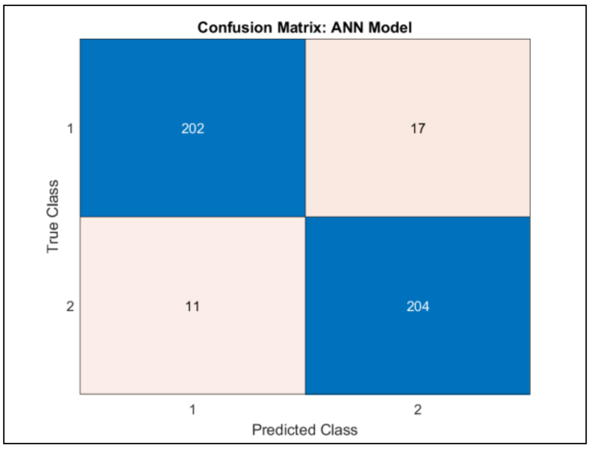
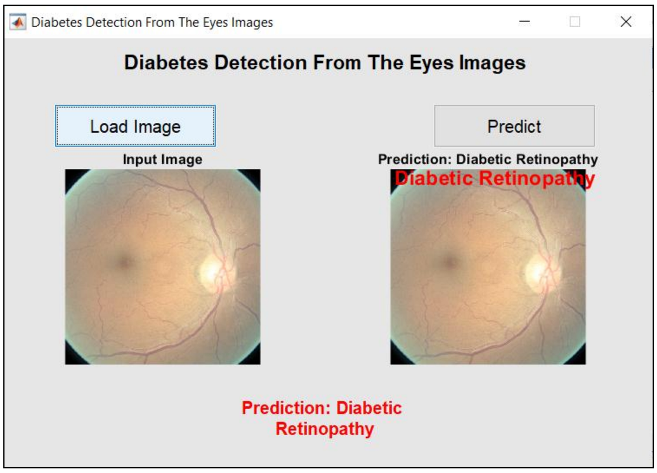


Fig.4. Confusion matrix of the ANN model

The confusion matrix summarizes the prediction results on the test dataset. It shows a high number of true positives and true negatives, along with a minimal number of misclassifications (false positives and false negatives). This distribution highlights the ANN's ability to distinguish between diabetic and non-diabetic subjects accurately. The high values on the diagonal of the matrix (accurate classifications) and the minimal off-diagonal values (errors) indicate effective classification with minimal false alarms or missed detections.



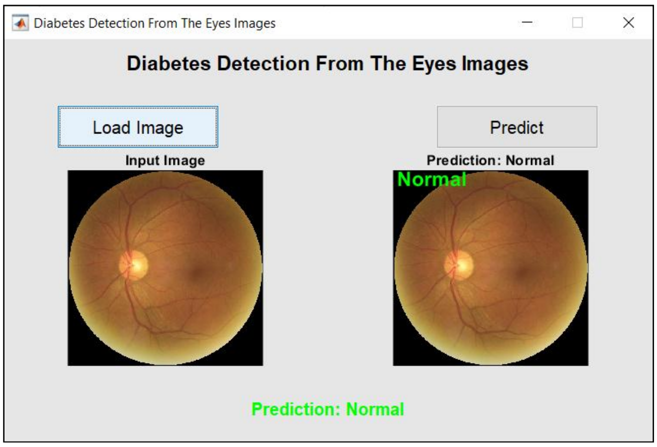


Fig.5. Classification report of the proposed ANN-based diabetes detection from the eye images

The classification report displays precision, recall, F1-score, and accuracy values for diabetic and non-diabetic classes. The model achieves a precision of 98.21%, recall of 96.42%, F1-score of 97.31%, and an overall accuracy of 98.14%, confirming the system's high reliability. High precision indicates that most patients predicted as diabetic indeed have diabetes, while high recall means that the model successfully identifies most of the actual diabetic cases. The F1-score, a balance between precision and recall, reflects the system's effectiveness, ensuring low false negative and false favorable rates.

The experimental results strongly suggest that the proposed ANN-based system is a promising solution for non-invasive diabetes detection. The ANN model, trained on iris image features, has successfully captured significant patterns distinguishing diabetic from non-diabetic samples. The performance metrics confirm that the model achieves excellent prediction consistency, generalization, and accuracy. The minimal training error and high regression values reinforce the reliability of the ANN's learning process.

Furthermore, integrating a user-friendly GUI facilitates real-time diagnosis, offering an accessible interface for patients and medical professionals. This enhances usability in both clinical and home settings. The system reduces patient discomfort by avoiding invasive procedures and provides an efficient alternative for mass screening and regular health monitoring, particularly in resource-constrained environments. This approach bridges the gap between technological advancement and real-world medical needs in diabetes screening.

V. Conclusion and Future Scope

This research presents a novel, non-invasive approach for diabetes detection using Artificial Neural Networks (ANN) and iris image analysis implemented in MATLAB. By leveraging the principles of iridology, the system effectively classifies individuals as diabetic or non-diabetic through high-level feature extraction from iris patterns. The model achieves outstanding performance, with an accuracy of 98.14%, precision of 98.21%, recall of 96.42%, and an F1-score of 97.31%. These metrics confirm the efficacy and reliability of the proposed method in real-world diagnostic scenarios.

The system addresses key limitations of conventional diabetes screening techniques—invasiveness, patient discomfort, and limited accessibility—by offering a contactless, image-based diagnostic tool. Integrating a Graphical User Interface (GUI) further enhances the system's usability, making it accessible to medical practitioners and patients with minimal technical expertise. This research confirms the diagnostic potential of iris analysis and validates ANN as a competent classification method for biomedical image processing.

The proposed ANN-based iris diagnosis system opens several avenues for future research and practical enhancements. One of the primary directions involves expanding the dataset by including more diverse samples across different demographics, such as varying age groups, ethnic backgrounds, and stages of diabetes. This would enhance the model's generalizability and reliability in broader clinical settings. The current system, implemented in MATLAB, can be adapted for real-time usage by deploying it on embedded systems, mobile platforms, or cloud-based applications, making it more accessible for use in remote or resource-limited regions. Incorporating deep learning models like Convolutional Neural Networks (CNNs) or hybrid ANN-CNN architectures may improve the system's ability to extract intricate features and enhance diagnostic performance. Another promising direction is integrating multi-modal data—such as combining iris analysis with other non-invasive physiological markers like facial thermography, heart rate variability, or voice biomarkers—to create a comprehensive diagnostic tool capable of simultaneously screening multiple conditions. Furthermore, clinical validation through collaboration with healthcare institutions is essential to ensure medical accuracy, user acceptance, and regulatory compliance. These future developments aim to refine the system into a practical, scalable, and robust solution for non-invasive, AI-driven diabetes screening.

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