An investigation into the use of deep learning and image processing in the domain of diabetic medical care

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ABSTRACT

Diabetic retinopathy condition may be better identified in the future by studying how several eye features, including the lens, macula, and retina, might be used for diagnosis. It guarantees the correct administration of medicine to prevent eye damage and aids in the early diagnosis of diseases that pose a danger to vision. A number of computer vision applications have begun to use deep learning due to its enormous popularity. When it comes to detecting diabetic disease and retinal MRI, these apps outperform humans. Machine learning can investigate previous events autonomously using supervised, unsupervised, and semi-supervised learning techniques. By obtaining better generalisation than fully connected layers, this model is able to do object identification by extracting very abstract features. Due to its efficient weight transfer between neurones, Convolutional Neural Networks (CNNs) are preferred over other models, allowing for a reduction in training parameters. During training, CNNs are able to avoid overfitting since they use a minimal number of parameters. The learning process cannot be completed without the classification and feature extraction steps. Using traditional models like Artificial Neural Networks, the problem of creating very precise forecasts for diabetic disease is addressed. A greater need for computer vision technology is being driven by advancements in core decision-making techniques, such as those in the medical, social, and other fields. Image processing allows object detection in computer vision frameworks by simulating visual experience. In this study, we build a convolutional neural network (CNN) that uses deep learning to divide diabetes images into five groups. Convolutional neural networks (CNNs) are tested on GPU-powered supercomputers.

KEYWORD: *Diabetic Disease predication, CNN, Deep Learning, Machine Learning and Image Processing.*

I. INTRODUCTION

In 2030, diabetes will be the sixth most common cause of death worldwide, according to WHO research. It is estimated that diabetic retinopathy accounts for 2.6% of blindness. Even if the percentage may be negligible, it is estimated that there are 3.5 times as many people with diabetes now as there were in 1980, or 118 million people, as opposed to 424 million people. These figures indicate a sharp rise in diabetic retinopathy cases shortly. Another major factor contributing to blindness in adults over 60 is glaucoma. The WHO reports that glaucoma is the second most common cause of blindness.

Fundus images of the retina or images of the human eye taken with a fundus camera are used to diagnose both glaucoma and DR. Ophthalmologists seek physiological changes in the components of the eye when examining the fundus images of the retina. The relevant disease (DR or Glaucoma) symptoms are confirmed based on the alterations and treatment is planned. An automated diagnosis approach for eye disorders is required since the number of qualified ophthalmologists with knowledge of retinal issues is not equal to the forecast for the condition. The availability of cutting-edge imaging and processing technology has enabled the development of a Computer Aided Diagnosis (CAD) system for a quicker and more precise diagnosis of eye disorders. By removing

various eye elements and measuring the physiological changes that take place in the removed portions, the CAD system helps experts detect diabetic retinopathy.

The timely identification of the diabetes disease has emerged as a prominent global issue, prompting the growing use of deep learning models for this objective. The primary objective of this work is to examine a sophisticated deep-learning approach in order to get insights on the early detection of diabetes, a prevalent worldwide health concern. Due to the inherent limitations of deep learning models in handling numerical medical information, it is essential for healthcare practitioners to promptly detect and diagnose this intricate medical ailment.

The diagnosis of diabetes presents significant challenges owing to its complex characteristics. However, advancements in data mining tools targeted at early diabetes prediction have shown substantial advances and are increasingly gaining traction. In order to effectively manage diabetes, it is essential to strictly stick to a prescribed medication and exercise routine, since the only method of addressing the condition is via abstaining from any type of medical intervention. The health of overweight adults is often compromised by their engagement in behaviours that pose a risk, such as smoking and excessive alcohol use. These behaviours have been linked to their self-reported diminished levels of life satisfaction and overall pleasure. The notion of a global urban lifestyle pertains to the contemporary pattern of existence that emerged in major urban centres and has subsequently expanded to smaller, historically underdeveloped metropolitan areas. Diabetes has a significant impact on the population, necessitating individuals to adopt proactive strategies in order to prevent the onset and progression of this condition. It is important to effectively manage these illnesses, since they have the potential to exacerbate one another's symptoms.

Diabetes is a pathological condition characterised by dysregulation of insulin levels inside the human body, represented emblematically by a syphon. Diabetes has a very extensive historical lineage, with its origins dating back to 1550 B.C. It has an impact on the urinary process and results in significant and recurring weight loss in those affected by this condition.

Diabetes has been widely recognised as a significant and sometimes fatal ailment throughout the course of history, often referred to as "sus" in Latin or as a Cynic variant thereof. The rationale for this is because fluids throughout the body are always in motion, never effectively attaining a state of equilibrium. Urination is a relatively uncomplicated bodily function, however it has the potential to elicit sensations of unease in those in close proximity. The excretion of a substantial portion of the beverage via urine may be attributed to inadequate intake of essential nutrients and an excessive presence of meat in the formula.

II. REVIEW OF LITERATURE

Larocca & Chiu (2011) Utilized Graph cut and dynamic programming to achieve precise segmentation of the three corneal layer borders on SDOCT pictures of healthy eyes. Their algorithm is very resistant to artefacts. The process of dividing 2D photos into segments was carried out. This method may also be used to 3D images, where more data can be gathered from neighbouring voxels, resulting in improved accuracy. However, the computational expense was elevated.

Emirhan et al. (2011) formulated a perfect data mining model for planning an appropriate quantity for diabetes patients. The model was developed with the help of Adaptive Neuro-Fuzzy Inference Systems (ANFIS) and theory of rough set. Around 89 different patient records were studied and 318 diabetes instances were extracted from those records. The ANFIS technique is the combination of ANN algorithms and fuzzy technique for characterization of input space to output space. The process of a Fuzzy Inference System (FIS) comprises some membership functions, if-then rules and logic operators. Fuzzy rules of type Takagi and Sugeno are used to ensure that the outcome of the framed rules is a linear combination of input variables with a constant period. From the obtained results, it is observed that the ANFIS is the effective and most reliable method when compared with the Rough Set method.

Mythili et al. (2012) designed a new approach for diagnosing diabetes disease which involves two different stages such as Case-Based Reasoning (C), Neural (N) and fuzzy (F) as integrated approach and the concluding stage as the rule-based algorithm. The major advantage in applying this methodology is that this method yields higher accuracy when compared to other methods which implement only the initial prediction stage. The rule-based

algorithm helps in classifying and predicting certain and uncertain data. Once the results are obtained from the initial stage, the rulebased algorithm is applied to the obtained results for achieving higher accuracy.

Fayssal Beloufa & Chikh (2013) as a means of detecting diabetes. The method produces a fuzzy classifier that is effective. The classifier supports doctors in their decision-making as well. Additionally, the programme offers a few intriguing fuzzy rules. The modified ABC algorithm's efficacy is shown using the Pima Indian diabetes dataset. The experimental findings demonstrated the effectiveness of the fuzzy technique with a modified artificial bee colony in diagnosing diabetes.

Sonu Kumari and Archana Singh (2013) simulated Neural Network using MATLAB for diagnosing the diabetes mellitus. The established methodology helps patients avoid testing for blood, checking systolic, diastolic pressure level and diagnosing symptoms in primary stages of DM and physical conditions. The author developed the reverse neural network propagation scheme for early disease prediction. Out of 100 datasets chosen for analysis, 70 were used to train the NN and 30 were applied to examine the NN system. The entire contains 28 nodes out of which1node is output node, 13 nodes are input nodes and 14 nodes are hidden nodes. If the output of the system is 0, it reveals that the person is not affected by diabetes and vice-versa. The system gives an accuracy rate of 92.8 %.

Ke Yan et al. (2014). Certain breath sensors are used to identify biomarkers in the breath. The suggested method has a higher accuracy level for predicting blood glucose levels. With the help of the suggested subject-specific prediction model, blood glucose screening level monitoring and diabetes screening are carried out with increased accuracy and decreased mistake rate.

Narges et al. (2015). The results prevented the patient from undergoing unnecessary tests (diabetes). Reliability is not high. Additionally, it is anticipated that this effort will assist patients in reducing the registration and control measure economy.

Han Wu et al. (2016) proposed a DMT-focused programme to visualise T2D. Two notable problems that were attempted to be solved were enhancing the forecast model's accuracy and making the cluster adaptable to multiple datasets. The clusters were divided into two sections, each focused on a collection of preprocessing methods: i) a K-means calculation; and ii) a relapse calculation. To compare the findings with those of different analysts, the PID Dataset and Waikato essentially for Data inspection toolbox were used. In comparison with other models, it seems that this technique achieved the most notable prediction accuracy of about 3.04%. Additionally, this demonstrated that the dataset's quality was enough.

Perveen et al. (2016) developed the bagging and AdaBoost ensemble method which used C4.5 as the key classifier algorithm to identify diabetic patients based on diabetic risk factors. The dataset is collected on various asymptotic adults in the Canadian Primary Care Sentinel Surveillance network. The ‘chi-square' measure was used to determine the ages of the various classes. According to the preliminary report, older people have a greater risk of developing diabetes than younger people. The holdout approach is used to assess the accuracy of the classifier. The dataset is divided into two parts such as training and testing to achieve accurate results.

Jaspreet Singh and Sonia (2016) employed the J48 decision tree algorithm and Naïve Bayes Algorithm for the prediction of diabetic and heart diseases from a huge dataset. The decision tree algorithm works on the available information from all the attributes and Naïve Bayes works based on the probability by counting the frequency of the values and the combination of the values present in the data. By analyzing the regular dataset of diabetes and heart disease, common attributes are chosen and a new dataset has been framed and the same has been analyzed with the aforesaid algorithms. The accuracy obtained by J48 is 95.53% and Naïve Bayes is 85.34%. The error rate is found to be 4.5354 and 14.4344 with J48 and Naïve Bayes respectively.

Suvarnamukhi et al. (2017) introduced a machine learning technique (MLT) data processing model for diabetes prediction. This task is divided into four phases: pre-processing, prediction, attribute selection, and data collecting. Diabetes prediction is achieved by using an extreme learning machine classifier. When the work's output is contrasted with other previous findings, it becomes evident that the MLT produces outcomes that are efficient when evaluated in terms of exactness, accuracy, and evoke.

Jayanthi et al. (2017). Different kinds of prediction models were explained. clinical prediction models, predictive analytics, and so on. The prediction model has a number of holes that the author claimed the researchers need to fix. Larger dataset utilisation, outlier identification, enhanced prediction model, integration of optimisation

approaches, multiple class dataset, type 1 diabetes prediction model, and prediction of additional illnesses that may be utilised on mobile devices are the areas of weakness.

Peng Zhang et al. (2018) committed to looking into T1D selfmanagement in two ways. Fundamentally, it receives dynamic ML approaches to look at whether information focussed on important, time-varying and psychological components associated to persistent self-management. Additionally, it built ML classifiers that evaluate the "two" T1D self-management techniques of affront organisation and SMBG (self-monitoring of BGL) using EMA components. The findings suggested the fundamental effects of psychosocial characteristics on such behaviours as well as the value of using ML techniques to EMA data.

Changsheng Zhu et al. (2019). This model makes use of the PIMA dataset. The K-means clustering approach is used to cluster the data, which leads to restricted logistic regression model performance. The findings of the experiment demonstrated that Principal Component Analysis improved the accuracy of the logistic regression classifier and the k-means clustering technique in comparison.

Namrata Singh and Pradeep Singh (2020) Maximising classification accuracy while minimising ensemble complexity was the goal of an optimisation applied to the base learner range, which aids in base learner selection. A metaclassifier called K-nearest neighbour (KNN) was used to compile the basic learner's predictions. This system achieved the highest possible levels of sensitivity, specificity, f-score, and accuracy, as shown by the experimental results.

Luca Carenzo et al. (2021) Conducted a research on the physical and mental symptoms that occur after a severe COVID-19 infection. Following their release, a significant number of individuals exhibited indications of stress, prompting the implementation of a bodily function assessment and a concise walking examination as part of the testing protocol. Additionally, it included inquiries conducted two months after the first assessment. The cohort research found that while the patients had physical recovery, their psychological recovery from stress and anxiety was not as rapid as their physical recovery. It took a period of nearly six months for them to completely regain their health.

Raja Krishnamoorthi et al. (2022) Suggested a machine learning framework for forecasting healthcare conditions associated with diabetes. The dataset has 768 rows and 9 columns, with 90% of the data designated for training and 10% for testing. Furthermore, they performed hyper-parameter tweaking to assess the machine learning models and used it to improve accuracy. The optimum method was determined among the five options, and hyper-parameter tuning was used to increase accuracy, resulting in an 86% enhancement.

III. DIABETIC RETINOPATHY

Diabetic Retinopathy (DR) is a type of retinopathy instigated by diabetes problems that prolong to impaired vision. According to a report submitted by „WHO", 347 million people of the total population suffers from diabetes and some 40-45% of them have DR. Progression to vision loss can be slacked down or prevented if DR is sensed and treated on time. In the present scenario, the DR detection process is done manually with the help of trained clinicians investigating the fundus images of digital form which generally leads to misunderstandings and further ends in late treatment. The objective behind this work is to classify the severity of DR under the categories Mild, Moderate and Severe. A novel technique is developed that combines the deep learning and machine learning methods for efficient classification of DR under mentioned categories.

Diabetic Retinopathy (DR), otherwise referred to as DED Diabetic Eye Disease is a medical condition where the retinal blood vessels will get damaged due to the complications of DM. When left untreated, the disease can lead to blindness. Under regular monitoring and successful treatment of underlying diabetes, early impaired vision is usually avoidable. DR is the primary cause of blindness and the risk of diabetes. The retina is the tissue protecting the eye's back. This is particularly lightsensitive. It turns any light that enters the eye into signs that the brain can perceive. This process produces sensory impressions which is how the eye functions. Blood vessels in the retinal tissue are impaired by diabetic retinopathy, which leaks fluid and obstructs vision. It is the initial stage of the disease where NPDR might have mild or even no symptoms. The blood vessels of the retina are enfeebled in NPDR. Small swells, termed microaneurysms, can leak fluid into the retinal blood vessels which also can lead to swelling of macula. Nerve fibres may start to swell in the retina. Sometimes swelling begins at the centre of the retina (macula), a condition requiring treatment. Proliferative Diabetic Retinopathy (PDR) is one of the severe diseases that occurs when the blood sugar level is irregular for many years. New blood vessels begin to grow over

the retinal surface and so the name „proliferative". These blood vessels become brittle and due to this the blood or fluid will leak. This leads to retinal damage and long-term vision loss. The scar tissue stimulated by new blood vessel growth can ultimately lead to the separation of the retina from the back of our eye. The normal flow of fluid from the eye can increase the pressure within the eyeball. The above process can cause severe problem to the nerves which carry images from eye to brain, resulting in glaucoma.

High blood sugar levels harm the back of the eye and result in the diabetes condition known as diabetic retinopathy. If untreated and undetected, it may result in blindness. Ants would gather near it, making the urination pleasant and easier to recognise. They also observed that those who enjoyed consuming sugary and fatty meals and were lethargic, obese, and gluttons were more likely to get the condition. Exercise and a large intake of veggies are recommended treatments for obesity. For those who were underweight, food was provided. The dominant idea was that only plants could produce glucose. The blood was thought to solely contain sugar or be in a pathological condition like diabetes after meals. Due to the liver's ability to convert a starch-like material into sugar when necessary, glucose was still present in the blood even after hunger. Glycogen is a substance that resembles starch.

IV. MACHINE LEARNING AND DEEP LEARNING

A group of eye-related diseases known as glaucoma can cause blindness without any warning or symptoms. First of all, untreated glaucoma increases Intra Ocular Pressure (IOP) and has the potential to spontaneously kill the optic nerve, affecting vision, if it is not caught early enough. An essential component of the fundus, the position of the Optic Disc (OD), is utilized to assess the severity of glaucoma. Blood vessels originate in the optic disc centre, which is generally seen as bright spots on fundus images. OD can be categorized based on form, vessel pattern, and margin sharpness. The OD structure may be segmented using the Snake-based contour refining, template matching, and the shape regression approach. The Optic Cup (OC) proposed by Shinde Rutuja (2021), a center bright zone, and the neuroretinal rim, a peripheral area, are two ways that OD can be differentiated. Convex hull, boundary segmentation, shape regression, r-bends information, threshold level set approach, and others may all be used to recognize cups.

The K-NN algorithm determines whether a data point belongs in group A or group B based on the states of the neighbouring data points. If a large proportion of the data points are in group A, it is definitely likely that the particular data point is in group A and vice versa. Here are some of the limitations of the KNN algorithm, As the number of instances grows, the time required to find the nearest neighbors also take time, making it difficult to understand the specific visual. Support Vector Machine is a machine learning approach for analysing the data for classification and regression analysis, that obsers the data point close to the hyperplane. By transforming the data into a high-dimensional feature space, SVM can identify data points even when the data are not usually linearly separable. The data are changed to allow for the hyperplane representation of the separator after a dividing line between the categories has been found. SVM are widely used in image processing tasks such as classification, object detection, and segmentation. However, SVMs have certain limitations when applied to image processing like computational complexity, parameter selection. The genetic algorithm is a technique for tackling both confined and unconstrained optimisation problems. It depends on natural selection, the procedure that drives biological evolution. The genetic algorithm continuously modifies a population of distinct solutions. Genetic Algorithm have been used successfully in various fields, including image processing. However, like any other technique, GAs have certain limitations when applied to image processing problems. Here are some common limitations of genetic algorithms in image processing have complexity problems, leading to longer processing times, incomplete image processing results.

DEEP LEARNING

Because of its low cost, high processing capability, and outstanding advancements in learning algorithms, deep learning has seen a large acceptance in the AI field. As can be shown in Figure 1.2, the deep learning method was formulated by taking cues from neurones and the working processes of the human brain. In a typical neural network element, the input context or already established connections may activate the activation of each neurone. A collection of neurones with several hidden layers that evaluate the characteristics retrieved from input data represented by various designs is what makes up an artificial neural network (ANN) (Shrestha & Mahmood 2019). The activation function and numerical value of each neurone are defined at the input layer. In addition, every neurone contains a processing function-containing buried layer. The activity levels of each neurone in a hidden layer are sent down from the layer above it. Which feature should be passed on to the subsequent layer is decided by optimising the present layer's weights and biases. The activation function (Ding et al., 2018) is used to maintain the model's stability. The two most common activations used in neural networks are the self-contained Rectified

Linear Unit (ReLU) and the Sigmoid function. The last hidden layer before the output layer uses a cost function to determine the time-dependent cost.

Because of their superiority in managing large diabetic patients and distributing the burden over several patients, Collaborative Diabetics Management Applications are quickly becoming indispensable in the fight against these limitations. Working together efficiently improves the Diabetics Management Applications' ability to identify disease by integrating and analysing data from several sources. A Diabetes Management Application (DMA) that allows users to engage with their diabetes diet plan must first be developed. The Diabetic software promotes trust and ensures the integrity of the system by providing an diet plan, randomly generated way of storing and delivering diet across several patients. Artificial intelligence algorithms may also improve the effectiveness of diabetes management apps by spotting new and changing dangers. Machine learning has the potential to analyse network data for unusual patterns, which might help in detecting and fixing threats. Through the integration of these techniques, a detection system that is both effective and extensible might be created. The collaborative DMA can improve the accuracy and efficiency of detecting diabetic disease breaches by using dynamic management apps and machine learning methods. This will guarantee the system's accuracy. A major technological shift has occurred in diabetes management apps due to the intricate and delicate nature of computer systems running on open, decentralised networks. Centralised, monolithic Diabetics Management Applications (DMAs) are becoming more unsustainable in the modern society landscape because to the proliferation of unwanted diet access and food habits. Data analysis and the timely delivery of worldwide warnings are both improved by Collaborative Diabetics Management Applications, which use several nodes deployed over the network [1].

An continuing problem in distribution management architectures is the establishment of components that cooperate to improve efficiency. Several components within the network architecture must function in tandem for intrusion detection to be remarkably efficient. Also, since distinct parts could have different designs, configurations, and operating systems, it might be difficult to integrate them all into a single, working system. Finally, making sure the data is secure and intact is critical since the system's correctness and dependability are dependent on the data quality. Data tampering or alteration may lead to skewed results and can affect the system's overall performance [3]. If these issues persist, Diabetic technology may be able to help. When it comes to storing and exchanging sensitive information, the Diabetic technology offers a solution that is safe, transparent, and decentralised. Building a trustworthy disease predication where every patient can access and verify the same data is made possible using DMA Making use of technology directed at people with diabetes. The safe transfer of data and the promotion of increased trust among all diabetic patients are two features offered by diabetes management applications. In addition, it allows for the creation of an immutable record of each data transmission, which guarantees the data integrity throughout the world [4]. A Diabetics Management Application's analytical component determines how well it detects harmful activities. Analytical methods based on machine learning make use of computer algorithms with the ability to learn from data and become more efficient over time. Extensive and complex datasets may be examined using these analytical methods to extract meaningful information. Different analytical approaches exist, and they all have their pros and cons. Combining the two analytical methods could help overcome their weaknesses while capitalising on their strengths. An autoencoder may pre-train a deep neural network (DNN) by acquiring a compressed version of the input before supplying data for tasks like categorisation. This program makes it possible to integrate autoencoders with deep neural networks (DNNs). This method improves the DNN's performance, which is a huge plus in cases when annotated data is scarce. Deep neural networks (DNNs) may benefit from autoencoder integration in terms of data quality. A randomisation technique that involves scaling, rotating, or cropping the input data may be used to train an automatic coder to recreate modified data [5]. At its core, this creates fresh examples from which the Deep Neural Network (DNN) may learn. By combining the two methods of analysis, this methodology improves detection accuracy by decreasing the probability of false positives and false negatives. It offers and executes a suite of cooperative Diabetics Management Applications built on Daibetic technology to provide safe data transfer and promote confidence among all connections. The Diabetics Management Application is able to identify and prohibit unauthorised access across open, dispersed, and infinite networks thanks to these technologies.

V. RESEARCH PROPOSAL

In diabetic individuals, Diabetic Retinopathy causes blindness. Therefore, detecting diabetic retinopathy at an early stage decreases vision loss. A successful approach for diabetic retinopathy prediction is discussed in this article. In the beginning, the input images of human retinal fundus images are preprocessed using histogram equalization followed by Gabor filtering to reduce noise for enhancement. Then, using the Watershed method, segmentation is performed, and the features are retrieved through feature extraction. The best optimal features are selected using the PCA (Principal Component Analysis) approach. The morphological-based post-processing scheme was employed to further enhance the quality of selected features. At last, the classification approach is

carried out with the utilization of a Google NET CNN classifier to classify/predict the retinal image as normal, abnormal, or severe. Google NET CNN has been developed with limited preprocessing steps to distinguish visual features directly from image pixels. The findings are then evaluated and the efficiency of the new method is compared with other current methods. The quantitative findings were evaluated for accuracy, precision, reliability, positive predictive levels, and false predictive levels in parameters and were seen to deliver better results than current techniques.

"Deep learning is a particular kind of machine learning that achieves great power and flexibility by learning to represent the world as a nested hierarchy of concepts, with each concept defined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones." As more number of hidden layers increases the abstraction level leads to the improvement in medical imaging. As DNN are constructed as a hierarchical stacks of multiple layers and neurons that form a feature representation of the input data. The number of layers can be extended to more than thousand in DL as it has the capability of huge modeling. It also efficiently memorizes all feasible mappings that obtained by the successful training with an adequately large knowledge database, therefore to make intelligent predictions. Consequently, DL is causes significant influences in computer vision and medical imaging. As DL approach based on CNN is considered to be one of the great implementations for computer vision problems. The ability of DL techniques got improved such that learning the image data directly without performing the process of object segmentation and feature extraction, which is makes this approach different from any of the ML approach and therefore make the deep learning approach more powerful. It is significantly more efficient in development of model with higher performance in classification. (Yasaka K et al (2018)) In DL technique images themselves are used for learning process and the most important features of the given input images are learnt automatically.

CONCLUSION

Early diagnosis of diabetic retinopathy is one of the most challenging problems in the medical industry. Based on the innovative method, this study attempts to predict and classify diabetic retinopathy. With the suggested approach, diabetic retinopathy may be detected by examining optic fundal images. The main goal of this effort is to give an efficient and early approach to diagnose diabetic retinopathy, while also saving money and time. So that can be evaluate the effectiveness of the developed technique, it is compared with two alternative ways, one of which has just been suggested. Compared to previous approaches, the suggested method performs well. As a result, the suggested method effectively predicts Diabetic Retinopathy soone.

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