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Diabetic Retinopathy Detection and Classification Approach using Deep Convolutional Neural Network

U.Pavan Kumar, Sk. Sunheer, Md. Ayesha Sumran, M. Sravan, N.T.S. Sarvani

Department of Electronics and Communication Engineering, Narayana Engineering College, Nellore, Andhra Pradesh, India

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ABSTRACT

Diabetic Retinopathy (DR) is a complication caused by diabetes that affects the human eye. It is caused by the mutilation of the blood vessels of the light-sensitive tissue at the back of the human retina. It's the most recurrent cause of blindness in the working age group of people and is highly likely when diabetes is poorly controlled. Although, methods to detect Diabetic Retinopathy exist, they involve manual examination of the retinal image by an Ophthalmologist. The Proposed approach of DR detection aims to detect the complication in an automated manner using Deep Learning. The model is trained using a GPU on35126 retinal images released publicly by eye PACS on the Kaggle website and achieved an accuracy of approximately 81% through deep convolutional neural network

KEYWORDS: Deep Learning, Dataset, Convolutional Neural Network(CNN), Data Training, Testing and Evaluation, preprocessing.

1. INTRODUCTION

Deep learning is also known as deep structured learning is part of a broader family of machine learning methods based on artificial neural networks with representation learning. Learning can be supervised, semi-supervised or unsupervised. Deep-learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks and convolutional neural networks have been applied to fields including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, climate science, material inspection and board game programs, where they have produced results comparable to and in some cases surpassing human expert performance. Artificial neural networks (ANNs) or connectionist systems are computing systems inspired by the biological neural networks that constitute animal brains. Such systems learn (progressively improve their ability) to do tasks by considering examples, generally without task-specific programming. For example, in image recognition, they might learn to identify images that contain cats by analysing example images that have been manually labelled as "cat" or "no cat" and using the analytic results to identify cats in other images. They have found most use in applications difficult to express with a traditional computer algorithm using rule-based programming.

2. LITERATURE SURVEY

Researchers have been working on methods to automate the process of DR detection. Diabetic retinopathy is a common eye disease in diabetic patients and is the main cause of blindness in the population. Early detection of diabetic retinopathy protects patients from losing their vision. Thus proposes a computer-assisted diagnosis based on the digital processing of retinal images in order to help people detecting diabetic retinopathy in advance. The main goal is to automatically classify the grade of non-proliferative diabetic retinopathy at any retinal image. For that, an initial image processing stage isolates blood vessels, micro neurons and hard exudates in order to extract features that can be used by a support vector machine to figure out the retinopathy grade of each retinal image. This proposal has been tested on a database of 400 retinal images labelled according to a 4-grade scale of non-proliferative diabetic retinopathy. As a result, we obtained a maximum sensitivity of95% and a predictive capacity of 94%. Robustness with respect to changes in the parameters of the algorithm has also been evaluated Diabetic retinopathy (DR)[1] is a medical condition due to diabetes mellitus that can damage the patient retina and cause blood leaks. This condition can cause different symptoms from mild vision problems to complete blindness if it is not timely treated. Hemorrhages, hard Exudates, and Micro-aneurysms (HEM) that appear in the retina are the early signs of DR. Early diagnosis of HEM is crucial to prevent blindness. Textures features such as LBP have been widely used in the past as a technique for DR detection. In this work, we introduce the use of different texture features for DR, mainly Local Ternary Pattern (LTP) and Local Energy-based Shape Histogram (LESH). We show The methods used to detect DR features, namely exudates, hemorrhages and blood vessels can be categorized into several stages which are image pre-processing, vessel and hemorrhages detection, optic disc removal and exudate detection. However, the detection for blood vessel and hemorrhages was performed simultaneously due to similar intensity characteristics. The proposed algorithm was trained and tested using 49 and 89 fundus images, respectively. The images used in training were obtained from Hospital Serdang, Malaysia while images used in the testing were obtained from DIARETDB1 database.

3. METHODOLOGY

Researchers have been working on methods to automate the process of DR detection. Enrique Carrera et al in their paper proposed a technique based on SVM to help diagnose diabetic retinopathy in advance. Martina Me linscak et al implemented a deep convolutional neural network to segment blood vessels. The model was made up of 10 layers which achieved an accuracy of 94% onthe publicly available DRIVE dataset. Satish Kumar et al in their paper proposed a DR detection technique based on a linear support vector machine. A.Herliana et al applied the particle swarm optimization (PSO) technique to determine the best Diabetic Retinopathy feature from the dataset images. The selected attribute is further characterized using Artificial Neural Network.

In existing approaches still need improvement in accuracy of prediction. Most of the aforementioned approaches were limited due to lack of large volumes of annotated data

In the proposed System, we presents model for classifies the retinal images using Deep CNN which relies less on manual feature extraction thus providing a wholesome approach to DR detection. Convolutional Neural Networks are a type of Neural Network which are particularly designed to work with Image Recognition applications. CNNs work better because they have filters that act like “feature detectors” that somewhat mimic the human visual system. The model is evaluated with various metrics and considering the complexity of the dataset the model is satisfactory. Accuracy can be further improved by

1 Advantages of proposed system It improves prediction accuracy in prediction of Diabetic Retinopathy. The proposed model relies less on manual feature extraction thus providing a wholesome approach to DR detection.

Technical Feasibility

This project, Diabetic Retinopathy Detection by means of Deep Learning needs the support to python technology being implemented for other useful systems in our company. It requires PC’s and NIC Card with normal configuration for Intranet access. Almost all administrators have their own PContheir desk. Thus it is technically feasible to implement the new system here.

Economic Feasibility

“Diabetic Retinopathy Detection by means of Deep

Learning" is an in-house project. It is very much useful for the company to maintain their knowledge assets. The infrastructure for the development of their new system is available in the campus itself. The system is developed at no additional cost. Hence it is economically feasible for the new system to be implemented.

Operational Feasibility

This system is being automated on the request of the technical department of our company. This new system meets their requirement and covers all aspects required much better than the old manual system. Most of the people involved in this branch are computer literate and do not need much training if this system is implemented. Hence it is operationally feasible.

SYSTEM DESIGN

The most creative and challenging phase of the life cycle is system and design. The term design describes a final system and the process by which it is developed. It refer to the technical specifications that will be applied in implementation the candidate system. The design may be defined as "the process of applying various techniques and principles for the purpose of defining a device, a process or a system in sufficient details to permit its physical realization". The design's goal is how the output is to be produced and in what format samples of the output and input are also presented. Second input data and database files have to be designed to meet the requirements of the proposed output. The processing phase is handled through the program construction and testing. Finally details related to justification of the system and an estimate of the impact of the candidate system on the users and the organization are documented and evaluated by management as a step toward implementation. The importance of software design can be stated in a single word "Quality". Design provides us with representation of software that can be assessed for quality. So it is an essential phase in the development of a software product.

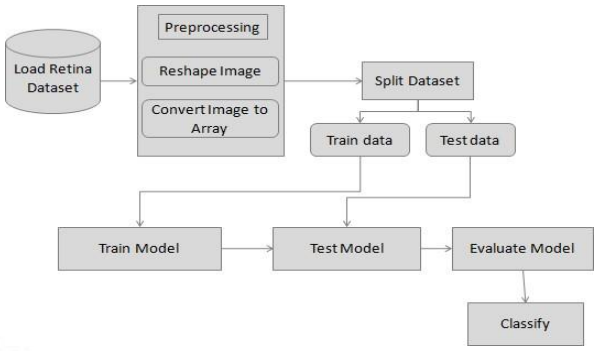


Figure 1. System Workflow

INPUT &OUTPUT REPRESENTATION

Input design

Input design includes data mediums used for inputting data and validations that are to be done during data entry. Different messages regarding data are given to guide users during data entry. Validation checks are done for each input. Data entry screens are designed so that the system interacts with the user in providing an effective dialogue. Fields in the screen are logically arranged to help the user. The design is the process of converting the user-originated inputs into a compute-based format. The goal of the input design is to make the data entry easier, logical and free from error. Errors in the input data are controlled by input design. The application has been developed in a user-friendly manner. The windows have been designed in such a way that during the processing the cursor is placed in the position where the data must be entered. If any of the data going into the system is wrong then the process and output will magnify these error

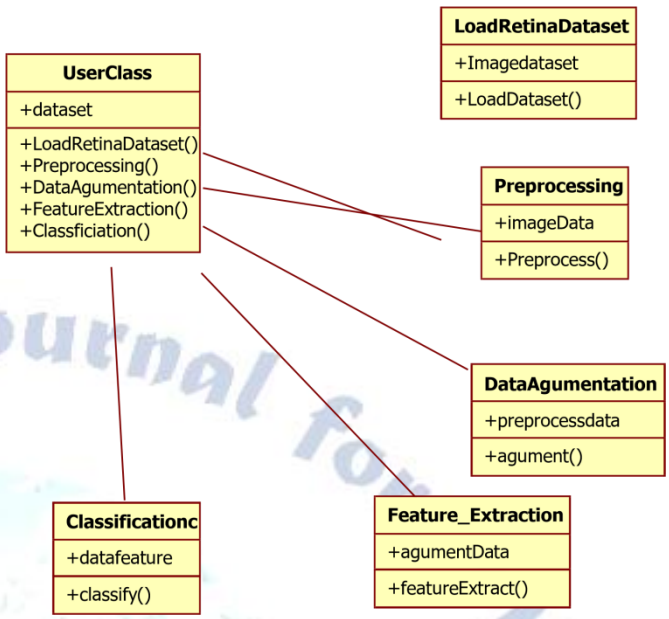
UML DIAGRAMS

The overall logical structure of a database can be expressed graphically by an ER diagram. The relative simplicity and pictorial clarity of this diagramming technique may well account in large part for the widespread use of the E-R model. Such a diagram consists of the following major components. Rectangles: Represent Entity Sets. Ellipses: Represent attributes. Diamonds: Represent relationship sets Lines: Link attributes to entitysets and entitysets.

Data flow tools

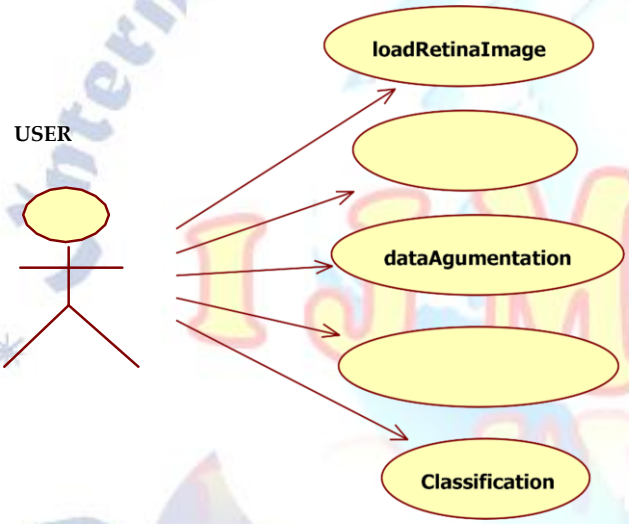
A graphical tool used to describe and analyze the moment of data through a system manual or automated including the process, stores of data, and delays in the system. Data Flow tools are the central tools and the basis from which other components are developed. The transformation of data from input to output, through

processes, may be described logically and independently of the physical components associated with the system. The DFD is also know as a data flow graph or a bubble chart.



Use case diagram

Use case diagram shows a set of use cases and actors (a special kind of class) and their relationship. Use case diagrams address the static use case view of a system. These diagrams are especially important in organizing and modeling the behavioral of a system both sequence and collaboration diagrams are kind of interaction diagram.



4. RESULTS

CLASS DIAGRAM

Class diagrams area unit the foremost common diagrams employed in UML. Category diagram consists of categories, interfaces, associations and collaboration. Category diagrams primarily represent the thing directed read of a system that is static in nature. Active category is employed in a very category diagram to represent the concurrency of the system. Class diagram represents the thing orientation of a system. Therefore it's usually used for development purpose. This can be the foremost wide used diagram at the time

The dataset contained nearly 35126 images from desperate patient population with extremely varied levels of lighting in the fundus photography. The lighting affects pixel intensity values within the images and creates unnecessary variation unrelated to classification levels. A contrast limited adaptive histogram equalization filtering algorithm, using the kaggle package was applied to address this result. Results from this pre-processing step are visually depicted in Fig. 7.1. We discovered that mostly moderate classifier sensitivity for the mild case increased from 0 to 0.02, while this measure was approximately the same for the remaining two classes moderate and proliferative DR with 0.6 and 0.05 respectively. Digital image pre-processing technique enabled improved detection of pinpoint subtle features and micro nerves via convolutional filters, which were previously

imperceptible by the deep convolutional neural networks

5. CONCLUSION

With the limited availability of clinicians for manual detection of DR, an automated approach can greatly reduce the manual labour required for diagnosis. The model presented classifies the retinal images using Deep CNN which relies less on manual feature extraction thus providing a whole some approach to DR detection. The model is evaluated with various metrics and considering the complexity of the dataset the model is satisfactory. Accuracy can be further improved by augmenting the dataset even more and by retraining the neural network with new retinal images. This is a widely used practice and helps improve the model. Although at this level the system may not gain the confidence of affected patients, further improvement can act as a boon for both the doctors and the patients. Patients can rely on the system for proper diagnosis and doctors can rely on the system for reducing their heavy workload.

FUTURE SCOPE

In future work, we study optimization technique in pre-process stage to further improving the performance of the model in classifying the Diabetic Retinopathy image dataset with in less time and with more exact estimated classification approach of detecting diabetic retinopathy. And also future efforts will focus on refining the DR classification by utilizing the latest deep learning algorithms instead of human grading to identify cases with diabetic retinopathy

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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