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A CNN BASED APPROACH TO DETECT THE INHERITED RETINAL DISEASES USING PUPILLOMETRY

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Abstract:

Generally there are many genetic disorders; Retinal disease is one of the conditions that cause substantial visual deficits. If not detected earlier, they may cause retinal issues like damage in retinal layers and may result in loss of vision in infants. If clinical treatment is followed, it became complex, which is a time taking process to get the result and sometimes result can be less accurate. To overcome this, we have pupillometry technique which measures the pupil diameter with response to stimulus. The pupillometer is a portable device that provides quantitative pupil measurement by capturing 30 frames per second of the pupil's response to light stimuli and does not require eye contact with the infant. For early cure, we employ a pre-trained VGG-16 Convolution Neural Networks (CNN) model instead of machine learning. This model is trained and tested on both the eye images of infant collected from pupillometry dataset. The accuracy achieved for our model is 90.04%.

Keywords:- *Genetic disorders, retinal disorder, pupillometry, VGG-16, Machine Learning, and Inherited Retinal Diseases.*

I. Introduction

A gene is the simplest physical unit of heredity, consisting of a nucleotide sequence of DNA that encodes the synthesis of gene products. When your gene is mutated, you develop a genetic disorder. It is not always the case that when you mutate, you will become ill. Therefore, a child can receive half of the gene from each biological parent and inherit the gene mutation from either or both the parents [4].The eye is the most important sensory organ in our body. Lens, retina, and the optic nerves are all vital components of the eye. Inherited Retinal illnesses impact every portion of the retina, and damage to the retina's layers can result in blindness. The symptoms of this disease might sometimes get worse. Some of the retinal diseases are retinitis pigmentosa, early onset retinal dystrophy (EORD), cone-rod dystrophy etc [8].To avoid this, the disease must first be identified. It is advisable to see an ophthalmologist on a regular basis to help identify early signs of serious retinal disease. Parents may consider genetic testing before or during pregnancy to determine if their child is at risk of inheriting the disease. If clinical approach is followed, it becomes complex which is a time taking process to get the result and sometimes the result can be less accurate. This requires eye contact of infant to detect the disease. So, the approach to diagnose the disease is Pupillometry. It detects the disease by measuring the diameter of infant's pupil in presence of stimulus. The pupillometer is a portable device that provides quantitative pupil measurement by capturing 30 frames per second of the pupil [24].

II. Methodology

In deep learning, convolutional neural networks (CNN) are a type of deep neural networks applied to classify the images, image & video analysis which consists of a Input layer, hidden layers and output layer. Layers present in between the input and output layers are called hidden because the activation function and final convolution hide their inputs .CNN pre-trained model called VGG-16 (Visual Geometry Graph) is a 16 layers deep with 13 convolutional layers, 2-fully connected and 1 softmax used for classification and detection.VGG architecture is given in Fig.1.The VGG-16 architecture consists of blocks, each block consists of 2D convolution layer and Max pooling layers.VGG a ConvNet accepts only 224*224 RGB image. Preprocessing layer takes the RGB image with pixel values in the range of 0-225 and subtracts the mean image which is calculated over the entire Image Net training set.VGG16 has a total of 138 million parameters. It's worth noting that all of the conv kernels are 3x3, while the maxpool kernels are 2x2 with a stride of two. Pupillometry dataset consists of four classes. The class labels are no disease, mild, moderate, severe, extremely severe. Each class consists of up to hundreds of images. Existing system is made up of two separate Support Vector Machines each represents the left eye and right eye of infant's images. The outputs of both the classifiers are combined by an OR logical operator to predict the final classification result. The limitations are choosing the right kernel is necessary for svm, more computational power is required to detect the disease images. This model is not supported for checking more and more images and faces more ambiguity. In our system, we used neural networks consists of 16 layers where the input layer accepts the image only in RGB format with pixel values in the range of 0-255, data pre-processing was done to resize the image and rescaling to transform the every pixel value. Images from the training dataset are fed to the CNN model i.e.VGG-16.In output layer activation function used is softmax function which predicts the final classification result from the both eye models. This process was done two times separately for the both left and right eye models. As we used neural networks, they are more powerful than machine learning algorithms have less computational power, and no ambiguity in detecting the retinal disease and achieved correct results when more and more images added and tested other than the images from pupillometry dataset achieved an accuracy of 90.07% .

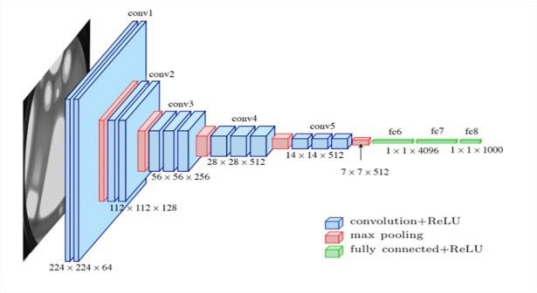

Fig.1.VGG-16 Architecture

III. Review of the Literature

A.Learning-based approach to segment pigment signs in fundus images for Retinitis Pigmentosa analysis

Authors-N.Brancati, M.Frucci, D.Gragnaniello, D.Riccio, F.Simonelli and V.Di Iorio.

They concentrated on segmenting pigmented signals in retinal fundus images, which is a crucial step in diagnosis and monitoring of retinitis pigmentosa and proposed a monitored segmentation technique for detecting pigment signs in fundus images. Random Forest and AdaBoost.M1 are used in an ensemble classifier of bagging and boosted decision trees. The ensemble classifier is trained using feature vectors that encode the information about the set of areas produced by separating the preprocessed image into individual regions and labeling each one. as a normal fundus or colored symbol. The results show the high effectiveness of the machine learning approach as a suitable tool for automated retinitis pigmentosa analysis.

B.An effective approach to detect lesions in color retinal images Authors- Wang, H., Hsu, W., Goh, K. G., and Lee, M. L.

Diabetic eye disease is one of the common causes of blindness. They reduced manual analysis by medical professionals. The system combines digital image processing with machine learning techniques to perform pattern recognition and classify diabetic retinal images. Exudates and lesions, which are common in diabetic eye disease, are recognized utilizing a

combination of brightness conditioning, statistical classification, and a local feature-based validation procedure. The dataset consisted of 100 normal images and 54 abnormal images, and the system identified retinal images containing exudates 100 times more accurately. The achieved accuracy was 70% in the classification of normal images in the dataset

C.Detecting age-related macular degeneration in fundus images Authors:-A.Garcia, O.Caacho-Nieto and C.Yanez-Marquezo

Age-related macular degeneration is the dangerous disease which affects above 60 years old people and was related to the presence of drusen (yellow deposits under the retina). It is diagnosed by detecting the drusen in input fundus images using pattern recognition technique. They proposed a new robust method called Support Vector Machine (SVM) which combines digital image processing and mathematical morphology. But the dataset is very small which consists of 27 healthy and 24 with drusen. The final classification resulted by the SVM is either positive or negative.

D.Automatic detection of diabetic retinopathy using an artificial neural networks Authors-G.Gardner, D.Keating, T.H.Williamson and Elliott.

The major objective is to determine whether neural networks can detect diabetes characteristics in fundus images. A fundus camera was used to capture 147 diabetic photos and 32 normal images, which were then stored on a computer and analysed using a back-propagation neural network. The network was taught to distinguish retinal image features. The effectiveness of digital filtering technology and various network variables was evaluated. The researchers then used 200 diabetes photos and 101 normal images to evaluate the diabetic-retinopathy detection network for ophthalmologists. The network's accuracy in diagnosing diabetic retinopathy was superior to that of ophthalmologists. As a result, this technique can be used to help detect diabetic retinopathy in patients. Neural networks are more powerful because of their deep layers and complex structure and gives better results than traditional machine learning techniques.

IV.Conclusion

An innovative technique for aiding clinical decision-making in the diagnosis of retinitis pigmentosa in pediatric patients is described in this research. This begins with a study of pediatric patients' pupil responses to chromatic light stimulation. A pre-trained VGG-16(CNN) model detects the disease image without any ambiguity and very less computational power was required. So, considering the whole acquisition protocol, this procedure would benefit the systems to capture the attention of young patients. Both the left and right eyes, performances were analysed or trained the optimal combination for each infant. Finally, with the help of labels (No disease, Mild, Moderate, Severe, Extremely Severe) classes are allocated to each eye. As a result, our system achieved an accuracy of 90.7 percent to 91.4 percent. Training and testing are performed on a limited image of the retinal eye. Our model predicted the correct results tested on the images which are not present in dataset. The trying out of the equal approach with different devices may be a part of future scope. As far as the signal acquisition phase is connected, the problem revealed by considerable evidence is the frequent presence of motion artifacts. This is due to the unique design of the device and the young age of the people employed for the research A survey of devices of various frame types, including mobile phone-based systems, will be conducted. In addition, the length of time the pediatric patient spends in the hospital is taken into account. Applications are Ophthalmology, Hospitals, Eye clinics, Optical shops and earliest treatment is possible when patient joined in critical care or emergency.

V.References

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