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Detection of Diabetic Retinopathy

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***Abstract*—The Eyewhich is considered as the most important sense organ. The eye is an organ that responds with perceptions of light, color, and depth. The iris, pupil, cornea, and retina are some of the components of the eye. The human body's most delicate organ, it is also. While certain eye issues may be treatable, others could result in irreversible vision loss. Illnesses that are frequently seen include, age-related macular degeneration (ARMD),diapetic retinopathy, abnormalities of the optic nerve such glaucoma, loss of sharp vision due to diabetes, etc. The goal of this initiative is to identify diabetic retinal disease.**

To accurately diagnose DR and characterise its severity using digital fundus images, to suggest using CNN. To construct a deep learning netwrok with CNN architecture that can recognise the complicated elements needed for the classification of images or any data which is supported by CNN, such as micro-aneurysms, exudate, and haemorrhages on the retina, in order to automatically deliver a diagnosis when the user enters the image.

To developing a highly efficient chatbot for the user's convenience so that it may serve as a one-stop shop for all the solutions needed to treat diabetic retinopathy in order to make practical use of the forecasts.

Deploy the application and server to cloud so that is will be accessed by all an also to maintain privacy and security.

I. INTRODUCTION

Diabetic retinopathy, which is brought on by high blood sugar levels, damages the network of tiny blood vessels that delivers blood to the retina. It occurs from changes in the blood vessels of the retina. Blood leakage may occur if these blood vessels get damaged, which may encourage the growth of weak new vessels. Vision impairment is brought on by changes in cell damage. These modifications may result in blurred vision, ocular haemorrhage, or, if untreated, retinal detachment. Microaneurysms, Retinal edoema and hard exudates, Cotton wool spots, Dot and blot haemorrhages, and Macular edoema are a few of the linked causes of diabetic retinopathy. Diabetic retinopathy is uncommon before the age of 10, and the risk increases with diabetes duration.

Long-term type 2 diabetics—who are frequently middle-aged or older at the time of diabetes diagnosis—have a more rapid development of visual impairments due to diabetic retinopathy. Despite the fact that early diabetic retinopathy may not present with any symptoms, it is critical to start treatment as soon as possible to prevent any vision loss. Non-proliferative and proliferative diabetic retinopathy fall into two main groups. Non-proliferative diabetic retinopathy is the name given to early diabetic retinopathy without neovascularization. The aberrant growth of blood vessels in the retina is known as neovascularization (NPDR). When the condition worsens, proliferative diabetic retinopathy (PDR), which is characterised by neovascularization and has a greater potential for catastrophic visual outcomes, may appear. Difference between a person with normal eyesight and one who has diabetic retinopathy.

Diabetic retinopathy has four phases, which might each occur at different times. These are listed below.

*Mild non-proliferative retinopathy:*At this first stage of the disease, small patches of balloon-like swelling in the retina's microscopic blood vessels are known as micro aneurysms. The fluid from these micro aneurysms could seep into the retina. Your vision is unaffected at this time, but you have a larger chance of later experiencing vision issues. This diabetic retinopathy stage can be depicted by the figure.

*Moderate non-proliferative retinopathy:*The retina's blood vessels may expand and change shape as the condition worsens. Moreover, they can stop being able to carry blood. Both disorders may lead to diabetic macular edema and both alter the retina in distinctive ways (DME). numerous micro aneurysms, dot-and-blot haemorrhages, venous beading, and/or cotton wool patches are some of its distinguishing features.

*Severe non-proliferative retinopathy:*At this point, countless more blood vessels get blocked, which results in the loss of blood supply to multiple areas of the retina. To promote the growth of new blood vessels, these retinal areas connect with the body.

*Proliferative diabetic retinopathy (PDR):*At this point, the retina's nutritional signals lead to the growth of new blood vessels. the immature, deformed, and fragile blood vessels. The outside of the clear vitreous gel that makes up the eye's interior, as well as the retina, are where they grow. If left untreated, these new blood vessels might bleed, obstruct vision, or even damage the retina. The signs of non-proliferative diabetic retinopathy include cotton wool patches or microvascular abnormalities.

In essence, chat-bots let users communicate with computers in the same way they would with actual people by simulating human speech and writing and analysing it (either written or spoken). Whether they are straightforward programmes that react to straightforward questions or complex digital assistants that respond in real time to inquiries with a single line of code, chatbots learn and adapt as they gather and analyse information to give increasing degrees of personalisation.

Chatbots used to be text-based and programmed to react to straightforward questions with previously written responses created by the bot's creators. While they performed well for the specific questions and solutions they had been educated on, they fell short when confronted with

challenging or novel issues. Their functioning was comparable to that of an interactive FAQ.

II. Literature Survey

[1] Ting, D. S. W., Cheung, C. Y. L., Lim, G., Tan, G. S. W., Quang, N. D., Gan, A., ... & Wong, T. Y. (2017). Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes.

[2] Abràmoff, M. D., Lou, Y., Erginay, A., Clarida, W., Amelon, R., Folk, J. C., &Niemeijer, M. (2016). Improved automated detection of diabetic retinopathy on a publicly available dataset through integration of deep learning.

[3] Gargeya, R., &Leng, T. (2017). Automated identification of diabetic retinopathy using deep learning.

[4] Rajalakshmi, R., Subashini, R., Anjana, R. M., Mohan, V., &Deepa, M. (2018). Automated diabetic retinopathy detection in smartphone-based fundus photography using artificial intelligence.

[5] Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., ...& Webster, D. R. (2016). Development and validation of a deep learning algorithm for detection of DR in retinal fundus photographs.

[6] Simonyan, K., &Zisserman, A. (2015). Very deep convolutional networks for large-scale image recognition.

[7] Wang, Y., Chen, H., Liu, Z., Zhang, L., &Peng, Y. (2020). Diabetic retinopathy screening using deep learning: a systematic review and meta-analysis.

[8] Li, Z., Keel, S., Liu, C., He, Y., Meng, W., Scheetz, J., ...& Ting, D. (2019). An automated grading system for detection of vision-threatening referable diabetic retinopathy on the basis of color fundus photographs.

[9] Roychowdhury, S., Koozekanani, D. D., &Parhi, K. K. (2019). Deep learning based retinal diagnosis systems: a survey.

[10] Tufail, A., Rudisill, C., Egan, C., Kapetanakis, V. V., Salas-Vega, S., Owen, C. G., ...& Lee, A. Y. (2017). Automated diabetic retinopathy image assessment software: diagnostic accuracy and cost-effectiveness compared with human graders.

[11] Keel, S., Lee, P. Y., Scheetz, J., Li, Z., Kotowicz, M. A., &MacIsaac, R. J. (2018). Feasibility and patient acceptability of a novel artificial intelligence-based screening model for diabetic retinopathy at endocrinology outpatient services: a pilot study.

[12] Burlina, P., Joshi, N., Pekala, M., Pacheco, K. D., Freund, D. E., Bressler, N. M., &Denninghoff, K. R. (2018). Automated grading of age-related macular degeneration from color fundus images using deep convolutional neural networks.

III. Proposed System

One of the main reasons for vision loss is diabetic retinopathy (DR), which is brought on by issues with diabetes that harm the retina. Early diagnosis and better DR therapy may arise from examination of the retinal images for important DR traits. Automated DR detection in retinal pictures is a solution to this problem. The automated algorithms were developed to detect early DR and are designed to suggest an ophthalmologist referral for any patient with DR. The development of an automated system for the identification of DR aids in early diagnosis and minimises the harm caused by diabetic retinopathy. This automated model's objective is to assess the degree of the disease visible in the submitted fundus image. This technology analyses a retinal image as an input and recognises the illness stage present. The model is trained using a classification method, and it uses the input fundus image to classify the disease stage that is present.

Advantages

- Automated method
- Less Time for Prediction
- Good Accuracy

A. Overview of architecture

Fig 1 Everyone can see thatto collect the data and to pre-process that data and to extract the feature and build a model to know the diabetic retinopathy.

B. Related work

In "Development and Validation of a Deep Learning Algorithm for Identification of Diabetic Retinopathy in Retinal Fundus Photos" published in JAMA [2016], VarunGulshan et al. describe a deep learning approach for DR diagnosis using retinal fundus photographs. Using a dataset which consists of 128,175 retinal images, the authors demonstrated the good sensitivity and specificity of their method for DR identification.

A hybrid approach that combines feature selection approaches and machine learning techniques is suggested in the Sensors article "Detection of Diabetic Retinopathy Using Machine Learning, Ensemble, and Feature Selection Techniques" by M. Usman Akram et al. in 2019. The researchers demonstrated how their algorithm diagnosed the severity levels of DR using a dataset of 1,500 retinal images.

In "Automated Detection of Diabetic Retinopathy Severity Using Deep Learning Algorithms," by Nikhil Pujari et al., published in Scientific Reports in 2020, a deep learning-based approach for automated DR severity categorization is provided. The scientists used a collection of 39,308 retinal images to accurately classify the different DR severity levels.

C. Data Collection

The neural network is aadvance machine learning method that is based on the structure and functionality of biological neural networks. To simulate how the brain works, this concept was developed. The distinct, tiny units that make up brain networks are called neurons. Neurons are grouped in groups called layers (see diagram above).

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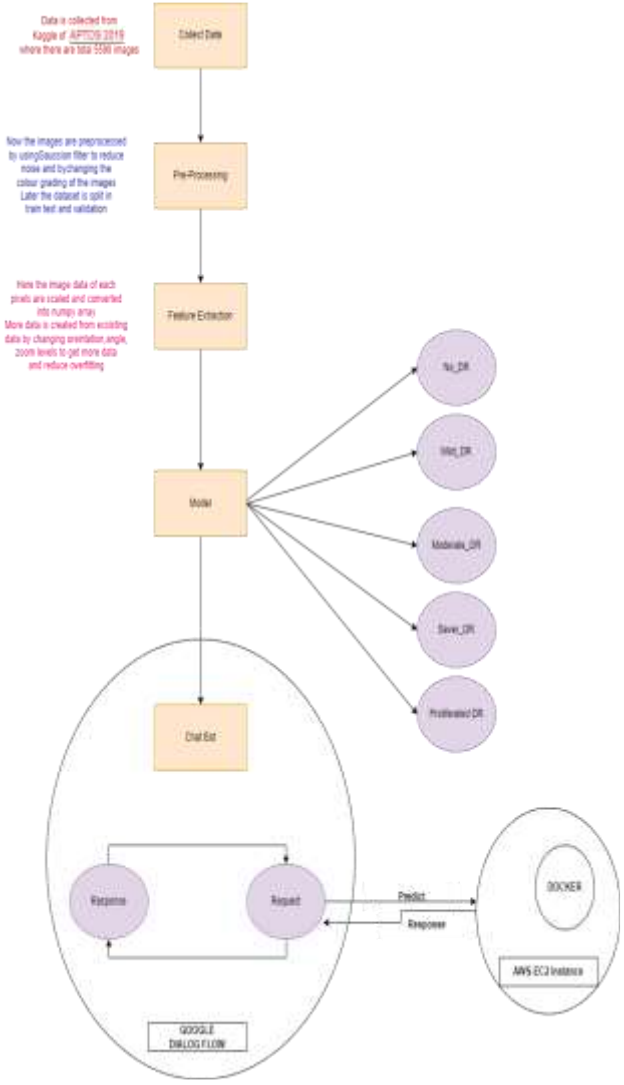
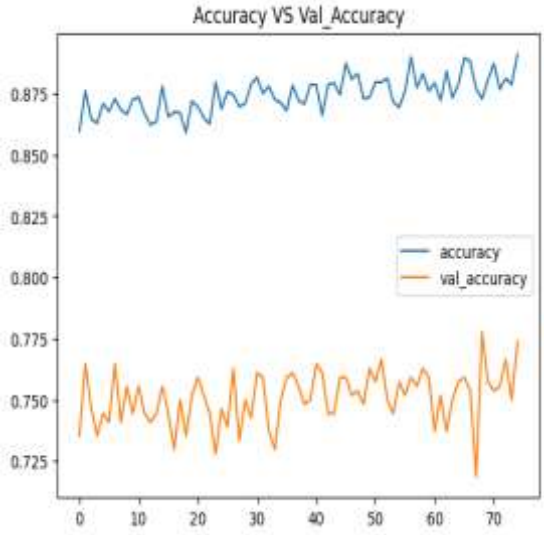
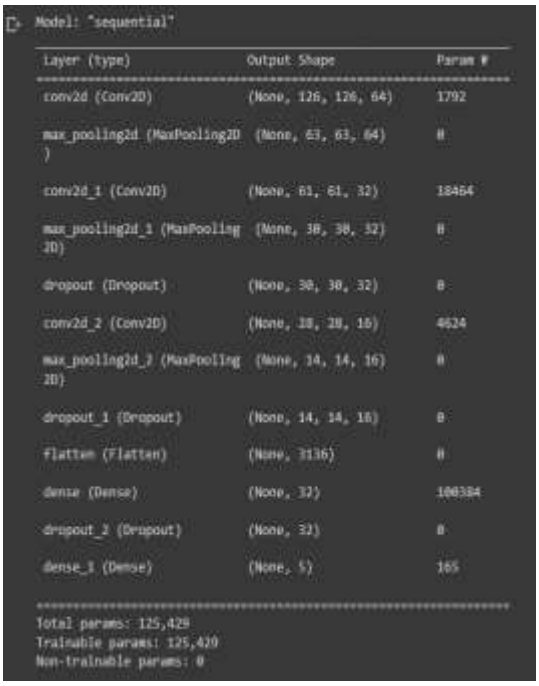
Together, the neurons in the layers above and below form a network. Along with these molecules, data travels from the input layer to the output layer. Every node individually finishes a straightforward mathematical calculation. The data is then sent to all of the connected nodes.



The use of convolutional neural networks (CNNs), a subtype of deep learning, in image processing and interpretation, particularly medical imaging, has a remarkable track record. networks with picture-data-friendly topologies. Unfortunately, neural networks were not practical for increasingly challenging picture identification applications until a number of advancements, such as the introduction of dropout and rectified linear units and the associated gain in processing capacity through graphics processor units (GPUs). To effectively complete extremely challenging photo identification tasks employing a variety of object classes using large CNNs. The yearly ImageNet and COCO challenges are only two examples of the cutting-edge image categorization projects that make use of CNNs nowadays.

When it comes to CNNs in particular, automated grading has two key problems. One benefit is getting the necessary insensitivity and specificity offset (patients correctly classified as having DR) (patients correctly identified as not having DR). For national criteria, which is a five-class problem in the normal, mild DR, moderate DR, severe DR, and proliferative DR classes, this is substantially more difficult. A major problem in neural networks is overfitting. The network overfits to the class that is most prevalent in the data when the dataset is skewed. Extreme skewness is typically present in large datasets. Less than 3% of the photos in the sample were from the fourth and fifth grades; hence, modifications to our network were needed to make sure that it could still recognisethe features of these images. To offer a CNN approach based on deep learning to categorise DR in fundus images. It has been the focus of several research in the past and is increasingly important for diagnosis.





Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 126, 126, 64)	1792
max_pooling2d (MaxPooling2D)	(None, 63, 63, 64)	0
conv2d_1 (Conv2D)	(None, 61, 61, 32)	18464
max_pooling2d_1 (MaxPooling2D)	(None, 30, 30, 32)	0
dropout (Dropout)	(None, 30, 30, 32)	0
conv2d_2 (Conv2D)	(None, 28, 28, 16)	4624
max_pooling2d_2 (MaxPooling2D)	(None, 14, 14, 16)	0
dropout_1 (Dropout)	(None, 14, 14, 16)	0
flatten (Flatten)	(None, 3136)	0
dense (Dense)	(None, 32)	100384
dropout_2 (Dropout)	(None, 32)	0
dense_1 (Dense)	(None, 5)	165

Total params: 125,429
Trainable params: 125,429
Non-trainable params: 0

D. Data Pre Processing

Diabetes has a consequence called diabetic retinopathy, which can damage the retina's blood vessels. Analyzing retinal pictures is commonly used to detect and diagnose

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diabetic retinopathy, and in order to get meaningful findings, thorough data preparation is sometimes necessary.

Image acquisition and quality control: To reduce the likelihood of receiving subpar photos, make sure the images are taken with top-notch retinal cameras. In order to make sure that the photographs are clear and devoid of noise or abnormalities, it is also crucial to examine the image quality.

Picture normalisation is the process of balancing the intensity levels to decrease the impact of varying lighting conditions. This can be accomplished using a histogram equalisation approach, such as contrast-limited adaptive histogram equalization[CLAHE] or adaptive histogram equalization[AHE].

IV.TECHNOLOGIES

*PANDAS:*Data analysis is Pandas' primary goal. Many file types, including comma-separated values, JSON, SQL, and Microsoft Excel, may be used to import data into Pandas. Pandas supports operations including merging, restructuring, and selecting in addition to data cleansing and wrangling.

The csv files are read using the read csv() method from the location that is supplied. This function is used in our project to read the train and test csv files.

Data Frames are two-dimensional data structures with potentially various column datatypes. Add additional parameters to the csv file, such as the file location, and save them in the dataframe. The pandas Dataframe may be used for a greater variety of functions.

*NUMPY:*To work with arrays, utilise the NumPy Python module. In addition, it offers matrices, the Fourier transform, and linear algebra operations.

The reshape() function may be used to change the size of the array, which include the elements toreshape the data to fit any dimension using the reshape() function. This feature is used in our project to alter the image's proportions.

The shape of an array is expanded using the expand dims() function. The position of the new axis will be displayed at the centre of the expanded array form. This function expands the dimensions of the input picture before passing them as a parameter to the trained model.

The minimum value of a Numpy array may be obtained using the amin() function. This function specifies the radius of the circle drawing for the circular crop function. The smallest width and height of the picture are used.

*OPENCV:*The open-source software package OpenCV may be used for developing any real-time computer vision applications. Video capturing, Image processing and analysis—which includes tools for face and object detection—are the main areas of focus. Consequently, fundus pictures are processed using OpenCV.

An image may be saved to any storage media using the imwrite() technique. The filepath must be supplied to this procedure as an argument.

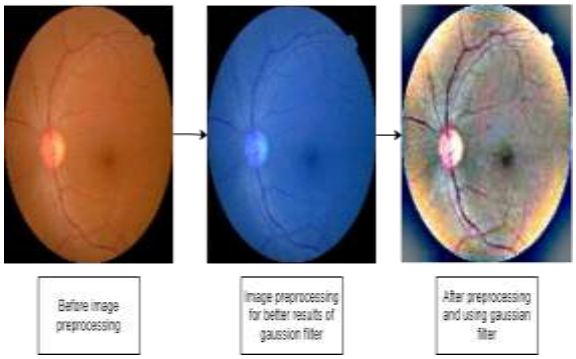
An image may be loaded from any storage media using the imread() API. The filepath must be supplied to this procedure as an argument.

The image's two arguments are passed to the resize() function. both the size and the picture. The picture tocaptured has a 128 by 128 pixel resolution.

GaussianBlur() Moreover, to must supply sigmaX and sigmaY, which stand for the standard deviations in the X and Y axes, respectively. SigmaY is assumed to be the same as sigmaX if only sigmaX is supplied. If either or both are provided as zeros, they are determined based on the kernel size. Gaussian noise may be effectively removed from a picture using gaussian blurring.

$$G(x,y) = \left(\frac{1}{2\pi\sigma^2}\right) e^{-(x^2+y^2)/2\sigma^2}$$

The cvtColor() function is used to change the colour space of an image. OpenCV offers more than 150 different color-space conversion techniques. In our project, employ this technique to convert a BGB image into an RGB one.



*KERAS:*Both Theano and TensorFlow may be used with a straightforward Python deep learning library called Keras. It was developed to facilitate studying and building deep learning models as quick and straightforward as possible. It runs on Python 3.5 and can function flawlessly on CPUs and GPUs given the underlying frameworks. It is made available under the adaptable MIT licence.

Four guiding principles were used by François Chollet, a Google developer, to create and maintain Keras:

*Modularity:*A graph or sequence a by themselves can be used to understand a model. A deep learning model's problems are all separate elements that may be merged in any way.

*Extensibility:*Newly modules or components are purposely designed easy and can be used inside any other framework in order to encourage researchers to try and examine new notions.

*Minimalism:*The library simply provides what is required to complete a task in order to maximise readability.

*FLASK:*The Flask class is initially imported. Our WSGI application will be an instance of this class.

The next step is to construct a class instance.

The first parameter is the name of the application's package or module. The name will change depending on whether the module is imported or launched as an application (for example, "__main__" against the real import name), therefore when using a single module, you

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should use __name__. This is required due to Flask needs to know where to search for the static files, templates, and other objects.

Then, Flask is told which URL should call our function using the route() decorator. The function receives a name, and this name is also used to generate URLs for that particular function.

*GOOGLE DIALOGFLOW:*Platform for building a modern chat bot and interpreting natural language .Integrating and designing conversational and informative user interfaces for websites, mobile applications, online applications, devices and interactive voice response systems requires the usage of Dialogflow.It also provides all the integration platforms which helps to deploy the chat-bot with ease.

*PICKLE:*Serializing and de-serializing Python object structures are performed by the pickle module via binary protocolsPickling and unpickling are Python operations that change an object hierarchy from Python into a byte stream and back again, respectively. It is a powerful Python tool that allows you to save your machine learning models, minimise lengthy retraining, and share, commit, and reload pre-trained models.

*NGROK:*NGROK is an excellent tool for exposing the web servers which are running locally, creating webhook integrations, providing access to SSH, testing, and demonstrating from your own local machine is Ngrok, a reverse proxy which in turn opens a secure tunnels between localhostanpublic URLs.

*DOCKER:*Docker,a software used for deploying,building, testing applications quickly. Using Docker, softwares are packaged into standardised containers which include libraries, system tools, code, and runtime to run. It is easy to deploy and scale applications with Docker into any environment and you can be confident that your code will run there.

*DOCKERIZATION:*The Dockerization process involves packing, deploying, and running applications in Docker containers.The Image of a Docker container is a standalone ,lightweight, and executable package of software that serves as a working computer for an application. It contains all the components necessary for the application to run, including all the code, build files, runtime environment, dependencies, system tools, libraries, and settings.

*AWS-EC2:*Amazon Elastic Compute Cloud is also known as AWS EC2. Using it, users can configure virtual machines according to their own preferences.With Amazon EC2(Amazon Elastic Compute Cloud), you can scale your computing capacity across Amazon Web Services (AWS). With Amazon EC2, you don't need to purchase hardware up front, which enables rapid application development and deployment.

V. Conclusion

The stage of diabetic retinopathy is predicted by the suggested project. The majority of the vessels in the retina can be finely extracted, according to some of the extraction findings of the suggested technique. The signals utilised for classification occur in a region of the picture that is readily apparent to the viewer, according to visualisations of the characteristics learnt by CNNs. The macroscopic characteristics in moderate and severe diabetic retinal pictures are of a scale that can be classified by existing CNN designs, such as those found in the ImageNet visual database. In contrast, the characteristics that distinguish between moderate and normal illness are found in less than 1% of the entire volume of pixels, a degree of subtlety that is frequently challenging for human interpreters to recognise. Image processing is utilised in this study to identify vessel-like structures and suppress non-vessel-like ones. Although the performance for the extraction of micro vessels still has to be improved, this approach is successful for the big vessels. The project's testing findings show that the suggested technique outperforms earlier strategies. For any fundus picture, this programmed method is quite effective. The stage of the disease is diagnosed based on the accuracy, specificity, and sensitivity. It has been noted that this method reduces the quantity of false positives found, increasing the system's sensitivity.

Now as the application is deployed in cloud an one can access and make use of this service in effective and productive way.

References

[1] D.S. W.Ting, C. Y. L.Cheung, G.Lim, G. S. W.Tan, N. D.Quang, A.Gan, ... and T. Y. Wong,"Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes," 2017.

[2] M. D.Abràmoff, Y.Lou, A.Erginay, W.Clarida, R.Amelon, J. C.Folk,and M. Niemeijer,"Improved automated detection of diabetic

retinopathy on a publicly available dataset through integration of deep learning,2016.

[3] R.Gargeya,and T. Leng,“Automated identification of diabetic retinopathy using deep learning”,(2017)

[4] R.Rajalakshmi, R.Subashini, R. M.Anjana, V.Mohan,and M. Deepa,“Automated diabetic retinopathy detection in smartphone-based fundus photography using artificial intelligence,” 2018.

[5] V.Gulshan, L.Peng, M. Coram,M. C.Stumpe, D.Wu, , A.Narayanaswamy ... and D. R. Webster,“Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs,”2016.

[6] K.Simonyan,and A. Zisserman,“Very deep convolutional networks for large-scale image recognition,” 2015.

[7]. Y.Wang, H.Chen, Z.Liu, L.Zhang,and Y. Peng,“Diabetic retinopathy screening using deep learning: a systematic review and meta-analysis,” 2020.

[8]. Z.Li, S.Keel, C.Liu, Y.He, W.Meng, J.Scheetz, ...and D. Ting,“An automated grading system for detection of vision-threatening referable diabetic retinopathy on the basis of color fundus photographs,” 2019.

[9] S.Roychowdhury, D. D.Koozekanani,and K. K. Parhi,“Deep learning based retinal diagnosis systems: a survey,” 2019.

[10] Rajesh, M., &Sitharthan, R. (2022). Introduction to the special section on cyber-physical system for autonomous process control in industry 5.0.Computers and Electrical Engineering, 104, 108481.

[11] S.Keel, P. Y.Lee, J.Scheetz, Z.Li, M. A.Kotowicz,and R. J. MacIsaac, “Feasibility and patient acceptability of a novel artificial intelligence-based screening model for diabetic retinopathy at endocrinology outpatient services: a pilot study, 2018.

[12] Sitharthan, R., Vimal, S., Verma, A., Karthikeyan, M., Dhanabalan, S. S., Prabaharan, N., ...&Eswaran, T. (2023). Smart microgrid with the internet of things for adequate energy management and analysis.Computers and Electrical Engineering, 106, 108556.