iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38233

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Diabetic Retinopathy Detection System

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Abstract: Diabetic Retinopathy is a diabetes problem that affects the eye. Injury to the blood vessels of the light sensitive tissue inside the rear of the eye (retina) is that the most reason for diabetic retinopathy. To begin with, Diabetic Retinopathy may have no symptoms or just cause minor vision problems. It has the potential to lead to blindness. Machine learning approaches can be used for the early detection of Diabetic Retinopathy. This paper proposes an automated Diabetic Retinopathy detection system that can detect the presence of Diabetic Retinopathy from retinal images. This work uses ResNet50 for the detection and classification of Diabetic Retinopathy. ResNet50 is a type of neural network used as a backbone for many computer-vision tasks. This paper proposes a machine learning model which is developed using ResNet50, then the model will be deployed as a user-friendly web application where the user can upload the retinal images as input to the system then system will detect the presence of Diabetic Retinopathy and classifies it into the stage or class which the particular image belongs to.
Keywords: Diabetic Retinopathy, ResNet50, Proliferative diabetic retinopathy, non-proliferative diabetic retinopathy.

I. INTRODUCTION

Diabetic retinopathy is a disease that affects our eyes and it results in vision loss and blindness in diabetes patients. It affects the retina's blood vessels retina is an important part of the eye it can be considered as the light-sensitive layer in the back of our eye. Diabetic retinopathy is the leading cause of adult vision problems and the most major source of vision loss in people who have diabetic mellitus. Diabetic retinopathy may not cause any symptoms at first, but it can eventually lead to vision loss if not detected early. Detecting it early can help you take steps to protect your eyesight. There are frequently no symptoms in the early stages of the disease. Some people report changes in their vision, such as difficulty reading or seeing objects that are far away. These alterations could occur at any time. Vision problems, blurred vision, distorted vision, decreased color vision, seeing spots, and vision loss are all symptoms of diabetic retinopathy. The indications and symptoms may differ from one person to the next. New and aberrant blood vessels are common signs. The blood vessels in the retina begin to leak and fill our eyes with a gel-like substance as the condition progresses. Diabetic retinopathy is caused by excessive sugar within the blood, which might block little blood vessels that nourish the tissue layer, setting apart its blood provide. This causes new blood vessels to develop within the tissue layer. These blood veins might not kind ordinarily and area unit susceptible to leaky.

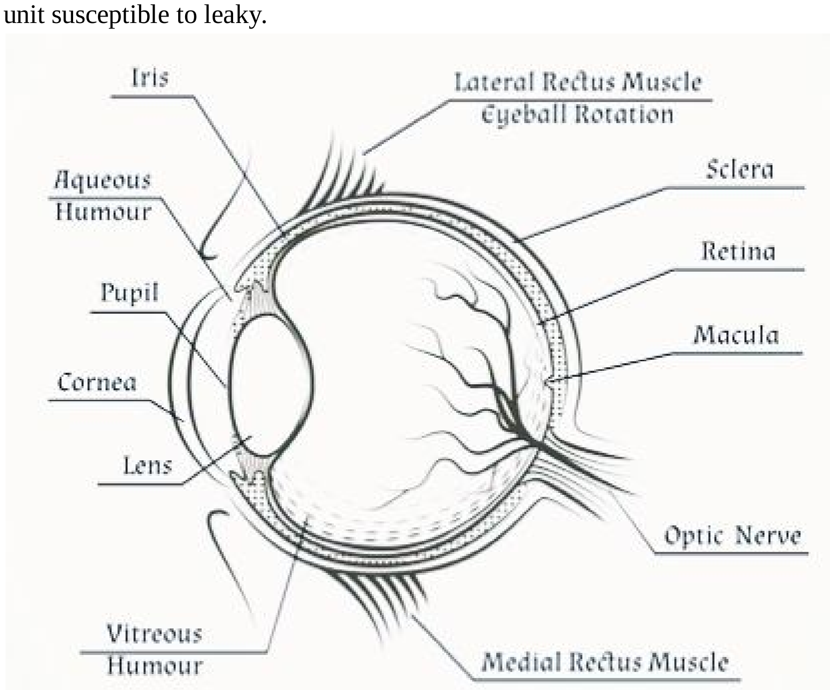

Figure 1. Anatomy of a human eye

There are fundamentally two sorts of Diabetic retinopathy initial one is Early diabetic retinopathy, in this, the most widely recognized structure is non-proliferative diabetic retinopathy (NDPR), in which fresh blood vessels aren't developing. If there should arise an occurrence of NPDR the mass of the veins in the retina is debilitating. Little lumps project from the dividers of the more modest vessels, at times releasing liquid and blood into the retina. Bigger retinal vessels can start to expand and become unpredictable in measurement too. NPDR can advance from gentle to the extreme as more veins become obstructed. Here and there retinal vein harm drives the development of liquid which is called edema, in the middle part (macula) of the retina. If macular edema diminishes vision, treatment is needed to forestall super durable vision misfortune. The other sort of diabetic retinopathy is Advanced diabetic retinopathy, diabetic retinopathy can advance to this more extreme sort, known as proliferative diabetic retinopathy. In this kind, the harmed veins close off, causing the development of new, strange veins in the retina.

These fresh blood vessels are delicate and can spill into the unmistakable, jellylike substance that fills the focal point of your eye (glassy). At last, scar tissue from the development of fresh blood vessels can make the retina disconnect from the rear of your eye. If the fresh blood vessels meddle with the ordinary progression of liquid out of the eye, a pressing factor can work in the eyeball. This development can harm the nerve that conveys pictures from your eye to your mind (optic nerve), bringing about glaucoma. Diabetic retinopathy is the main source of visual deficiency in individuals between the ages of 20-64 in the United States. Diabetic Retinopathy is a significant reason for visual misfortune and visual hindered vision around the world. A legitimate discovery and treatment of this infection is required on schedule. As indicated by late gauges, around 285 million individuals worldwide in the long-term age bunch have diabetes in 2010 and by 2030, 438 million individuals of the grown-up populace, are relied upon to have diabetes. Also, something recognizable is India at the first situation of 50.8 million individuals influenced by diabetics by the overview taken in 2010. The duration of the sickness is linked to the likelihood of developing diabetic retinopathy.

II. LITERATURE REVIEW

Several approaches that can detect diabetic retinopathy and classify them into their types have been proposed so far. These approaches by different authors are discussed below Chakrabarty, Navoneel [1] proposes a strategy for consequently characterize patients having diabetic retinopathy and not having something similar, from any High-Resolution Fundus Image of the Retina. For that an underlying picture handling has been done on the pictures which incorporate, for the most part, a transformation of shaded (RGB) pictures into amazing greyscale and resizing it.

Then, at that point, a Deep Learning Approach is applied in which the prepared picture is taken care of into a Convolutional Neural Network to foresee if the patient is diabetic. This system is applied on a dataset of 30 High-Resolution Fundus Images of the retina. Lokesh Gowda [2] proposes a strategy that straightforwardly utilizes color and domain knowledge. The histogram is produced for the standardized shading forces.

This histogram builds the semantic hole between ordinary areas and strange districts. Histogram proportion and back-proliferation remove the capabilities and the complete area is separated by planning the thickness quantiles. at last, the fuzzy c means clustering is utilized to recognize the real diabetic retinopathy.

Carrera, Enrique V [3] proposes a computer-aided analysis dependent on the computerized preparation of retinal pictures to assist with peopling identifying diabetic retinopathy ahead of time. The primary objective of this work is to consequently order the grade of non-proliferative diabetic retinopathy at any retinal picture. For that, an underlying picture preparing stage segregates vein, microaneurysms, and hard exudates to remove includes that can be utilized by a help vector machine to sort out the retinopathy grade of every retinal picture. This hypothesis was tested using a database of 400 retinal images, each of which was assigned a 4-grade size of non-proliferative diabetic retinopathy.

Using the MESSIDOR dataset, Farrikh and Alzami [4] offer a system for diabetic retinopathy stage classification based on fractal analysis and random forest. Here the system segments the images then, calculates the fractal dimensions as features. By utilizing MESSIDOR datasets and random forest as a classifier they acquired outcomes that fractal measurements can recognize the healthy subjects and diabetic retinopathy patients.

Hakkim [5] introduced an automated identification strategy that utilizes discrete wavelet change (DWT) and Artificial neural organization (ANN) to arrange and investigate the exudates of retinal pictures. To start with, the optic circle and veins are eliminated by staggered versatile thresholding and morphological activities separately, then, at that point, DWT is applied to identify hard exudates. At long last, ANN is applied to discover delicate exudates and the contrast between soft and hard exudates.

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III. METHODOLOGY

For the development of a machine learning model which holds the ability to detect and classify various retinal images as either affected by diabetic retinopathy or not, the initial step is to collect the dataset and analyze it which is verynecessary for building the model

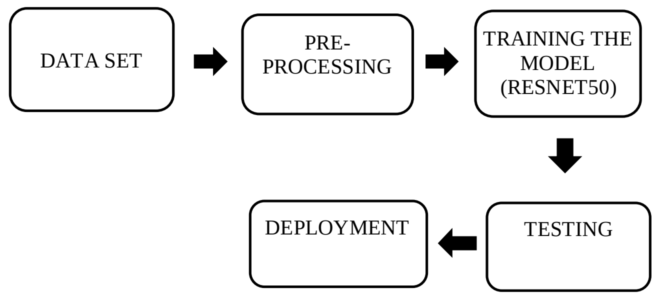

Figure 2. Block diagram of the proposed system

After the preprocessing, the data or images in the dataset have to be divided and separated into training, test, and validation sets. Some of the data or images are used for the training purpose of the model while the remaining are used for the validation testing and overall testing of the detection model.

Next, the model that can predict the presence of diabetic retinopathy from retinal images is being built using a ResNet50 which is a type of neural network and can be used for classification problems. The main advantage of using ResNet is that it contains residual blocks and skip connections which helps to skip training of several layers of the network.

After the development of the model, it has to be trained with appropriate data from the dataset and a validation test will be performed using the validation test set. At last, the results can be tested with a test set to examine whether the retinal images are affected by Diabetic retinopathy or not and then correctly classify them into their respective classes or stages. After the model development, training, and testing this model will be deployed into a user-friendly web application. These whole steps are represented in Figure 2.

The proposed work mainly uses ResNet50 which is a pre-trained model for image classification.

A. ResNet50

ResNet or residual networks is a type of neural network that is used for computer vision tasks. The main building blocks of ResNet are residual blocks and skip connections. Skip connections skip some layers in the neural networks so, the output of one layer can be directly fed into the layers 2-3 hops away. ResNet50 is a variant of the ResNet model which can be considered as a pre-trained model which uses weights that are already aligned to make the prediction.

This work uses 4 stage ResNet50 model. It has the ability to accept images as input. Every Resnet performs initial convolution and max-pooling using 7*7 and 3*3 kernel sizes respectively. Then there comes the first stage of ResNet50. In this stage, the first convolutional layer has a feature filter size of 1*1 and it will have 64 such filters.

The second layer has 3*3 filter size and 64 such filters and the third layer have 1*1 filter size and 256 such filters. These three layers will be repeating 3 times. So, it yields a total of 9 layers in the first stage. Similarly, in the second stage, the first layer consists of 1*1 filter size and 128 such filters.

The second layer has 3*3 filter size and 128 such filters and the last layer have 1*1 filter size and 512 such filters. These 3 layers are repeating 4 times so, the second stage contains a total of 12 layers. Similarly in the third stage, has 3 layers of 256,256,1024 kernel sizes or filter size respectively and these layers will be repeated 6 times resulting in a total of 18 layers in the third stage.

The fourth stage contains 3 layers of 512, 512, 1024 kernel sizes respectively and these layers will be repeated 3 times, it gives a total of 6 layers.

Finally, within the ResNet50 network, there is an average Pooling layer that is followed by a fully connected layer with a thousand neurons (ImageNet category output). ResNet is originally trained on the ImageNet dataset and using transfer learning, it is possible to load pre-trained convolutional weights and train a classifier on top of it.

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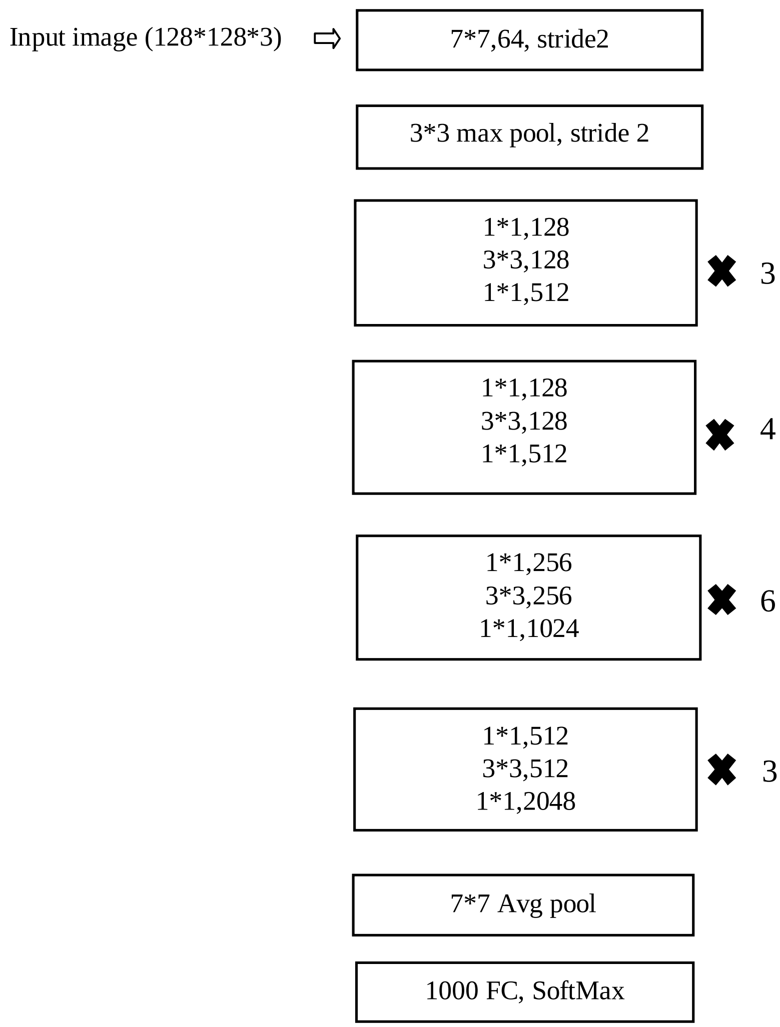

Figure 3. ResNet50 Architecture

IV. IMPLEMENTATION

In this proposed work the implementation is mainly carried out in 4 steps. The following section will give a detailed description of these steps.

A. Data Pre-Processing

The main aim of this step is to process the images from the dataset. Here we use the Kaggle dataset for diabetic retinopathy. Which contains many retinal images. This includes images of different sizes and it may contain noise. Hence, we need to perform various preprocessing steps on the dataset before giving it to the model to learn by itself. This approach uses a large set of high-resolution retina images taken under a variety of imaging conditions. Left and right field are provided for every subject. That is images are labeled with a subject id as well as either left or right. Each image is labeled between 0 to 4 denoting different stages of diabetic retinopathy like 0 for no diabetic retinopathy, 1 for mild, 2 for moderate, 3 for severe, and finally 4 for proliferative diabetic retinopathy. In this work prediction and classification is done based on this scale. Then we perform data analysis and data cleaning. In data analysis, the data or images collected from the dataset will be analyzed. Then we perform data cleaning to remove noise. The most important thing that is carried out in preprocessing step is image resizing. Here each image will be resized into a fixed size of 128*128*3. After these steps, it has to perform data splitting. Here dataset has to be split finally for training and testing of the model. A higher Fraction of images is selected from the dataset for the training purpose and the remaining portion will be used as test data.

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B. Model Building

In this step, a model that can detect and classify Diabetic retinopathy into its different stages will be constructed. This model can be used with a special type of neural network called ResNet50. Which is a pre-trained network. It convolves with input data and extracts the separating characteristics of the different classes and the SoftMax classifier is provided in the fully connected layer of ResNet50 which can be used for multiclass classification. Many DL models that have scored high-performance results when trained on a subset of the ImageNet dataset are made freely available in Keras. ResNet is already trained to extract discriminating features from the ImageNet dataset.

C. Training and Testing

After the DR detection model is built, the ResNet model can be trained with the training data from the training dataset. The validity of the model has to be performed next using the validation data along with the training of the model to determine the training accuracy. Finally, the fully built model can be tested using some test data from the test dataset.

D. Deployment

After the development of the ML model for the detection and classification of diabetic retinopathy, the model will be deployed as a web application for ease of use using Flask which is a microweb framework for python. This web page provides the functionality to upload retinal images and then it automatically detects the presence of DR and it also provides classification results as to which stage the DR belongs.

V. CONCLUSIONS

Diabetic retinopathy is an eye disease that commonly occurs among diabetic patients, in the initial stages of diabetic retinopathy, patients are generally asymptomatic, but in more advanced stages of disease patients may have vision loss. So, there is a need for detection of DR in its early stages. This project proposes a system for automated diabetic retinopathy detection. This work can be mainly divided into two parts the first one is machine learning model development and the other one is model deployment. This paper proposes a system that uses ResNet50, which adapts transfer learning as a classification model classifying Diabetic retinopathy into its different stages. Since we use the ResNet50 model it will help to reduce the training time for model development. After the development of the model which is capable of detecting and classify diabetic retinopathy, it will be deployed as a web application. this application could take retinal images as input and then displays which stage of diabetic retinopathy it belongs to. Hence, this work provides a user-friendly system for diabetic retinopathy detection which can easily detect and classifies diabetic retinopathy at a low cost. By the early detection of diabetic retinopathy damage to the retina can be minimized.

VI. ACKNOWLEDGMENT

I would like to thank my project coordinator, Mr. Valanto Alappatt, Assistant Professor of Computer Science and Engineering Department, and my project guide, Mr. Serin V Simpson, Assistant Professor of Computer Science and Engineering Department, for providing all of the essential resources. I am grateful to Dr. K Vijayakumar, Principal of Thejus Engineering College in Vellarakkad, for providing me with the opportunity to work on this project.

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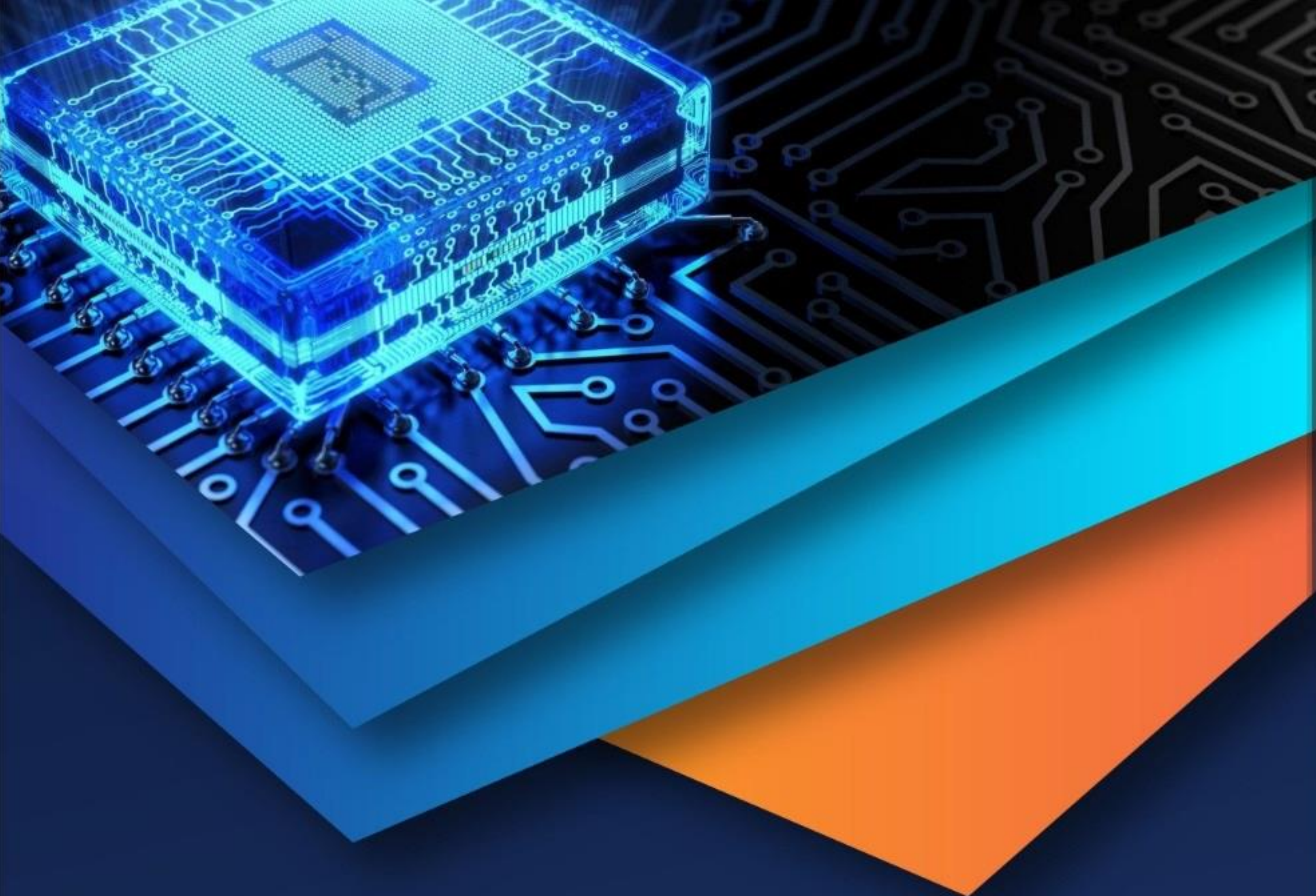

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